Continental

737
FLIGHT MANUAL

CONTENTS

INTRODUCTION

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AUTHORIZATION PAGE

This Continental Airlines / Continental Micronesia Flight Manual contains all the approved Airplane Flight Manual (AFM) operating procedures and performance data as revised and/or modified, and includes any appropriate data or information from revisions dated or numbered:

737-300	D6-8730.3T0	REVISION #22	DATED 09/16/02
737-300	D6-8730.3Q81	REVISION #32	DATED 09/16/02
737-500	D6-8735.524	REVISION #12	DATED 02/08/01
737-700	D6-31A001.724	REVISION #13	DATED 08/27/02
737-800	D6-31A001.824	REVISION #18	DATED 07/01/02
737-900	D6-31A001.924	REVISION #08	DATED 03/20/02

This manual meets or exceeds all requirements of the B737 approved Airplane Flight Manual in accordance with F.A.R. 121.141.

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FLIGHT DECK DATA

The items listed below are provided on the flight deck for flight crew convenience. In the event a listed document is temporarily missing or unusable, operations may be continued using the source material from the applicable Flight, Operations, or Planning & Performance Manual. Missing or out of date documents should be replaced at a station where replacements are available.

ITEM	FORM NO.	DATE
CHECKLISTS		
Jumpseat Rider Brief Card	21.0020	07/01/94
Onboard Security Incident & Medlink Procedures Card	21.9016	01/01/02
③③⑤ 737 Quick Reference Handbook	24.3002	11/15/02
⑦⑧⑨ 737 Quick Reference Handbook	24.3007	11/15/02
737 Normal Checklist	24.8022	11/15/02
737-300/500 AMT Taxi Checklist	47.0035	06/30/00
737-300/500 AMT Towing Checklist	47.0085	06/30/00
737-700/800/900 AMT Taxi Checklist	47.0067	07/10/01R
737-700/800/900 AMT Towing Checklist	47.0095	07/10/01
ERG Red Book	ERG/Red Book	2001/2002

Note: The Emergency Response Guide (ERG) or copies of the appropriate pages must be on board whenever hazardous materials are transported.

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INTRODUCTION

General

The purpose of this manual is to provide Continental Airlines and Continental Micronesia flight crews with a document which serves both as a training aid and as an inflight tool for handling emergency and abnormal situations.

Included in this introduction is an overview of the organization and procedures of Sections 1 through 5 and a detailed discussion of the standard formatting devices used in developing all normal and non-normal checklists.

Flight crews are expected to be familiar with these formatting devices and to be prepared to operate under these guidelines on the line and during simulator training.

All data in this manual is applicable to all B737-300 and subsequent models, except as noted with the following symbols:

Icon	③	3	5	7	8	9
Specific Fleet Type	B737-300 Round Dial	B737-300 EFIS	B737-500 EFIS	B737-700	B737-800	B737-900

CRM

Effective Crew Resources Management (CRM) can substantially improve safety in line operations. Technical proficiency, knowledge of aircraft systems and adherence to standard operating procedures continue as the foundation of aviation safety. Effective CRM should also help a crew achieve safe conclusion of the flight when non-normals or other problems occur. Continental Airlines is committed to fostering a high level of CRM skills. The practice of effective CRM is expected behavior among all crewmembers.

Pilots should routinely utilize effective CRM skills as discussed during the Crew Coordination Concepts (CCC) workshops. All crewmembers are expected to build strong CRM skills, so that each pilot can contribute fully during both normal and abnormal line operations. Industry studies have shown that most airline mishaps were attributable to poor CRM. Failure to follow standard operating procedures, failure of the PM to monitor the PF, and unchallenged tactical decision errors by the Captain were the leading causes identified. Effective CRM would have broken the chain of events leading to an accident in the majority of mishaps studied.

Crew Effectiveness Markers

The following Crew Effectiveness Markers were developed to assist crewmembers in their understanding and practice of Crew Resource Management. The markers were structured in a checklist format for ease of use and recall. Crewmembers should use the markers as a checklist for decision making and as a guide for crew briefings. They should be reviewed periodically to improve CRM proficiency, just as emergency and non-normal checklists are revisited from time to time. CRM will be evaluated in training events, proficiency checks and line checks utilizing the Crew Effectiveness Markers.

The Crew Effectiveness Markers can also serve as a debriefing tool after a line flight or training event. A debrief should always be conducted after a flight which challenged a crew in some manner. Potential exists for valuable new learning if a crew conducts a frank yet positive self-evaluation following significant flight events. Debriefings should be conducted by the Captain, but may be initiated by anyone in the crew. Frequent, open communications and active listening are consistently identified as key characteristics of the most effective flight crews.

Overall Technical Proficiency

- Set a professional example
- Adhere to SOP, FAR's, sterile cockpit, etc.
- Demonstrate high level of flying skills
- Be adept at normal and non-normal procedures
- Maintain thorough systems knowledge

Briefing and Communication

- Set an open tone
- Fully brief operational / safety issues
- Explicitly encourage participation
- All are obligated to seek and give information
- State how SOP deviations will be handled
- Include cabin crew

Leadership and Teamwork

- Balance authority and assertiveness
- Promote continual dialogue
- Adapt to the personalities of others
- Use all available resources
- Must share doubts with others

Situational Awareness

- Monitor developments (fuel, weather, ATC, etc.)
- Anticipate required actions
- Ask the right questions
- Test assumptions, confirm understanding
- Monitor workload distribution and fellow crewmembers
- Report fatigue, stress and overload in self and others

Decision Making

- Fly the aircraft
- Obtain all pertinent information
- All crewmembers state recommendations
- Better idea suggested? Abandon yours
- Clearly state plan or intentions
- Establish "Bottom Lines"
- Resolve conflicts and doubts quickly

Crew Self-Evaluation

- Debrief key events
- Continuously provide information to self-correct
- Openly discuss successes and mistakes
- Ask, "How could we have done better?"
- Discuss what is right, not who is right

USE OF CHECKLISTS

Normal Checklist

Checklist Initiation

There are three ways to initiate a checklist. The proper method is “Called For,” the backup method is “Prompted,” and the method of the last resort is “Self Initiated.”

“Called For” checklist initiation is the checklist habit pattern with the highest reliability. The Captain/PF initiates the checklist at the appropriate time. This manner ensures both crewmembers are aware that the checklist is in progress and specific actions are required.

“Prompted” checklist initiation is used as a backup “second line of defense” to ensure a checklist is accomplished. The pilot (who will accomplish the checklist) reminds the Captain/PF (who was supposed to call for the checklist) that the checklist needs to be accomplished. The Captain/PF, after being prompted, should then call for the checklist. Although it is not desirable, “Prompted” checklist initiation is an acceptable way to manage errors and recover total crew participation. A prompt (by the pilot who will accomplish the checklist) is required if a checklist has not been called for by the time a flight arrives at a certain point or time. This certain point or time is a bottom line for prompting a checklist. The following table lists the bottom lines for prompting all normal checklists.

PROPER “CALLED FOR” CHECKLIST INITIATION	ACCOMPLISHED BY:	BOTTOM LINE FOR PROMPTING
RECEIVING AIRCRAFT Called for by Capt when checks are done and there are no distractions.	F/O	When Agent asks “Are you ready?”.
BEFORE START Called for by Capt when main cabin door is closed, all passengers are seated, carry-on luggage properly stowed, and aircraft movement is imminent.	F/O	Ready for pushback from ramp (or engine start if no pushback).
AFTER START Called for by Capt after the engine(s) have reached a stabilized idle and the headset operator has been cleared to disconnect.	F/O	Prior to brake release for taxi.
TAXI Called for by Capt clearing the ramp.	F/O	Approaching the run-up area for the departure runway.
BEFORE TAKEOFF Called for by Capt when cleared on to the active runway.	F/O	Crossing the hold short line.
AFTER TAKEOFF Called for by PF after flaps retract callout.	PM	10,000 feet MSL.
IN RANGE Called for by PF at approximately 18,000 feet.	PM	10,000 feet MSL.
APPROACH Called for by PF in the approach environment.	PM	Cleared for the approach.
LANDING Called for by PF in conjunction with the “Gear Down” call.	PM	1,000 feet AGL.
AFTER LANDING Called for by Capt after clear of all active runways.	F/O	Approaching ramp.
PARKING Called for by Capt after aircraft comes to a stop at the gate or parking spot.	F/O	Chocks in, parking brake off.
TERMINATION Called for by Capt after PARKING checklist is complete.	CAPT or F/O	Prior to leaving aircraft.

"Self Initiated" is the last chance method of ensuring a checklist is accomplished. The pilot performing the checklist initiates the checklist without participation of the other pilot*[s]*. Self initiating any checklist is unprofessional and increases the chances for error due to lack of crewmember situational awareness. Self initiated checklist action has been contributory in many incidents and accidents. However, accomplishing the checklist under any condition is of such crucial importance that <u>self initiating a checklist is appropriate when it is the only way to complete the checklist</u>.

Checklist Accomplishment

The NORMAL checklist is used as a verification to ensure that certain critical or essential steps of the preceding procedure have been accomplished. The expanded checklists of this section serve the dual purpose of defining the procedure to be accomplished for each phase of flight and providing expanded notes appropriate to checklist accomplishment. Certain items in the expanded sections may be annotated "flow" after the challenge statement. These are items which are accomplished during the procedure, but are not rechecked during the reading of the checklist. The procedure defined for each phase of flight will be accomplished by recall (flow) prior to the reading of the applicable checklist. In all cases the checklist will be read from the printed checklist card At no time is the use of a checklist from memory acceptable.

If the flight deck is left unsupervised (all pilots away from the flight deck) prior to the BEFORE START checklist, all previously accomplished checklists must be re-accomplished in their entirety. If a non-crewmember is present on the flight deck during the absence of one or more crewmembers, the non-crewmember must be supervised by a remaining crewmember or any previously accomplished checklists must be re-accomplished.

The Captain will call for all checklists during ground operations. The Pilot Flying will call for all checklists in flight.

Normally a flow will be accomplished before the checklist is read. The point at which the associated flow may be initiated is defined in the preamble of each checklist. However, no flight control will be moved or positioned until called for.

Each item will be challenged out loud by the designated crewmember unless otherwise noted. The responding crewmember will visually confirm that the challenged action has been properly accomplished and will respond appropriately to the challenge, confirming the action or describing the configuration. Any item which has a numerical value or switch position associated with it, (i.e., reference speeds, altimeter settings, VNAV, etc.) will have the associated value or switch position stated as a part of the response. Any item listing an "AS REQUIRED" response will be responded to by the actual configuration or condition as described in the expanded section. When responses are required by both crewmembers (F, C, or PM, PF), the pilot reading the checklist replies <u>first</u> followed by a crosscheck and identical reply from the other pilot. If a checklist item is not installed in a particular aircraft, the crewmember will nevertheless challenge the item and the response will be "NOT INSTALLED." Any action which has not been performed or completed when challenged must be completed before the next challenge is read. If performance of the challenged action cannot be completed immediately, the crewmember responding will reply "STANDBY" or other suitable response to indicate that further reading of the checklist will be suspended until the item can be accomplished.

Checklist Completion

An unwritten last step of any checklist is for the pilot accomplishing the checklist to call the checklist complete. Calling the checklist complete is a last safeguard that everything is in order. When a checklist is complete, the announcement of "_______ CHECKLIST COMPLETE" mentally closes the loop on the process that began when the checklist was called for. This also mentally opens the door for the next activity. If the "______ CHECKLIST COMPLETE" call has not been made, there is a strong possibility that things are not in order. The pilot performing the checklist should review it to verify all items have been accomplished and then make the "_______ CHECKLIST COMPLETE" call.

Non-Normal Checklists

"Fly the aircraft" is always an unwritten immediate action for any non-normal procedure. Both pilots will first give their attention to continued safe flight of the aircraft, with particular attention to flight path and communications.

Non-normal checklists assume crewmembers will:

- Silence aural warnings and reset Master Caution/Warning lights as soon as the cause of the warning is recognized.
- Test warning/status lights to verify valid indications.
- Check for tripped circuit breakers (refer to Circuit Breaker Procedures, Section 2, Non-Normals).

Caution: The intentional pulling and resetting of a circuit breaker, other than when specifically directed by a non-normal checklist or appropriate technical authority, is prohibited due to the potential impact on multiple aircraft systems.

Procedures that prescribe an engine shutdown must be evaluated by the Captain to ascertain if an actual shutdown or operation of the engine at reduced thrust is the safest course of action. Consideration in this case must be given to probable effects if the engine is left running at minimum required thrust

Checklist Initiation

When a non-normal situation occurs, the Pilot Flying (PF) will stabilize the aircraft and call out Immediate Action items. The Pilot Monitoring (PM) will accomplish the immediate action items and the PF will call for the appropriate checklist.

The Captain will then make the final determination as to who will be the PF and PM. In making this determination, the Captain should give consideration to his primary responsibility of managing the situation, in addition to the necessity of formulating a plan for successful resolution of the problem. By its very nature this includes a comprehensive coordination among ATC, the F/A, the company, and all other aspects of delegation of duties. The Pilot Monitoring (PM) will accomplish the appropriate checklist.

Checklist Accomplishment

Non-normal checklists are designed, with the exception of Immediate Action items, as “Read and Do” checklists. All items of any non-normal checklist will be read aloud. The pilot designated by the Captain to accomplish the checklist (PM) shall first read and respond to Immediate Action items (if applicable) to ensure that such items have been accomplished completely and correctly. The PM shall then complete the Secondary Action items by reading each item, accomplishing the required task, and reading the response. The PM, while accomplishing the checklist, will coordinate with the PF before changing any switch or control position which could potentially affect systems integrity or aircraft configuration.

Non-normal checklists may be combined with other normal or non-normal checklists to reduce or eliminate the need for crews to reference several different checklists in response to a non-normal situation. For example the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist includes the normal IN-RANGE, APPROACH, and LANDING checklists so that the aircraft may be safely landed in this situation with reference to only one checklist.

Checklist Completion

The checklist will be announced as “COMPLETE” when reaching the end of checklist symbol (* * * *). Care must be taken when a checklist is branched by the use of OR arrows as it may not be immediately apparent where the end of this branch of the checklist is located.

When a checklist is complete, the announcement of “________ CHECKLIST COMPLETE” mentally closes the loop on the process that began when the checklist was called for. The pilot performing the checklist should review it to verify all items have been accomplished and then make the “________ CHECKLIST COMPLETE” call.

Quick Reference Handbook (QRH)

To facilitate a more expeditious access to non-normal checklists, a Quick Reference Handbook (QRH) is carried on the flight deck. It contains a copy of most of the non-normal checklists from the Aircraft Flight Manual. This would preclude having to take out the Flight Manual to reference a specific non-normal checklist in most situations.

The QRH is set up in a simple to use and easy to read format. The highlights of its construction are:

- All immediate action items are listed on the front cover.
- All tabs are labeled with the name of the major systems for that section (because of the limited number of tabs, some of the sections are combined into logical system groups).
- The index is cross-referenced by situations and systems.
- Additional information not normally used to operate the aircraft is contained in the multi color pages located in the back of the handbook.

Because the QRH has limited space, some non-normal checklists may have verbiage directing you to other non-normal checklists that will then follow to a logical conclusion. Normal checklist which are referenced in a non-normal checklist will either be printed in its entirety or only have the applicable items listed.

CHECKLIST FORMATTING

General

Checklists will be read from top-to-bottom, left-to-right. Careful attention must be paid to indentation so that only the appropriate items are performed. You may be required to "skip" downward over non-applicable steps or to move downward to a given location in the checklist. You will not be directed to go upward in the checklist (although you may have occasion to reenter a checklist if conditions change). You may be directed to cross reference another checklist. If a checklist is "branched" (by an OR arrow), there will be more than one ending to that checklist. Checklists must be continued until the flight crew reaches an end-of-procedure symbol (four centered asterisks).

Challenge and Response

Checklist challenges are presented on the left with responses on the right in capital letters. A dotted line will separate challenges and responses.

Challenge .... RESPONSE

A comma or ampersand (&) in a response indicates a combined response where more than one item must be verified to indicate compliance with the challenge.

Challenge .... RESPONSE A, RESPONSE B

A slash (/) between multiple responses indicates a choice of responses where only one of the choices is appropriate.

Challenge .... RESPONSE A / RESPONSE B

Under circumstances where both the Captain and First Officer or Pilot Monitoring and Pilot Flying are to respond to a given challenge, this will be indicated by (F, C) or (PM, PF) on the response side.

Oxygen .... CHECKED, SET, 100% (F, C)

Conditional (IF) Statements

In situations where particular steps within a procedure need to be performed only if a qualifying condition exists, these steps (which may be contained in a single-line "conditional" box to visually group the conditional items) will be preceded by an IF statement. This device indicates that the person reading the checklist must determine if the condition applies and if so, perform the items immediately below. If the condition does not apply, the steps immediately below, including all steps in a conditional box, should be skipped.

IF Condition A Applies:

Perform..THIS ITEM

IF Condition B Applies:

Perform..THIS ITEM

OR Arrows

This device connects conditional items or groups of items which are mutually exclusive. This will indicate to the pilot that only one of the connected procedures should be performed and all others ignored. This device in effect "branches" the checklist and will result with more than one ending to the procedure.

IF Condition A Applies:

Perform ....THIS ITEM

OR

* * * *

IF Condition B Applies:

Perform ....THIS ITEM

* * * *

Continue Checklist At ... Statements

If it is necessary to move from one point in a checklist, skip over one or more steps, and re-enter the checklist at another point further down the checklist, this device may be used. You would proceed from that point downward until encountering the appropriate numeric symbol which will be found on the left side of the margin.

IF Condition A Applies:

> **Perform ....THIS ITEM**
>
> **Perform ....THIS ITEM**
>
> **IF** Condition C Applies:
>
> **OR** Continue Checklist at ➊
>
> **IF** Condition D Applies:
>
> Checklist is Complete.
>
> * * * *

IF Condition B Applies:

➊ **Perform..THIS ITEM**

* * * *

The presence of the ➊ next to the above step does not indicate that this step is only to be performed if Condition C applies. Note that this item would be accomplished whether Condition C or Condition B applies.

Phase Lines

A dashed line on either side of a condition statement in a procedure indicates that the crew may delay the performance of the procedure at that point. This is normally used to provide better "pacing" of a procedure. The crewmember reading the checklist is responsible for ensuring that the checklist is resumed at the appropriate time.

- - - - - BEFORE LANDING - - - - -

Cross Referencing

When a cross reference to another checklist is made it will be done in the following manner for normal and non-normal checklists:

Refer to AFTER TAKEOFF checklist, Section 3.

Refer to **ENGINE FAILURE** checklist, Section 2.

Continued Checklists

If a checklist or procedure is continued on the back of the page or on the next page, the word "Continued" will be printed centered in parenthesis at the bottom of the page.

(Continued)

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings will be presented in the following format:

Note: Information requiring special emphasis.

Caution: Instruction concerning a hazard that if ignored could result in damage to an aircraft component or system.

WARNING: Instruction concerning a hazard that if ignored could result in loss of aircraft control, injury, or loss of life.

Action Specific Words

Certain words are used throughout this manual to indicate whether a procedure must be performed exactly as described at all times or if some discretion is allowed. These words are defined below for the purposes of Continental Airlines / Continental Micronesia Flight Manuals. These definitions may differ slightly from certain dictionary definitions, however every attempt has been made to use these terms consistently as detailed.

The words “shall,” “must,” and “will” indicate procedures to be performed exactly as detailed. Deviations will be made only in situations equating to the use of pilot’s emergency authority.

The word / phrase “should” and “strongly recommended” indicate procedures normally performed exactly as detailed. Deviation will be made only in unique situations where a pilot’s best judgment indicates a different course of action. Such deviations would be very rare and briefed to all flight crewmembers.

The word “may” indicates procedures expected to be performed as detailed under most situations. While deviations are not limited to unique circumstances as above, use of these procedures are encouraged in the interest of standardization among flight crewmembers.

Crewmember Duties

Labels will be placed to indicate the crewmember to challenge the item and the crewmember assigned to respond or verify completion of the item. The following abbreviations will be used:

Captain	-	Capt or C
First Officer	-	F/O or F
International Relief Officer	-	IRO
Pilot Flying	-	PF
Pilot Monitoring	-	PM

End-of-Procedure Asterisks

Four centered, bold asterisks indicate the end of a non-normal checklist.

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SECTION OVERVIEW & PROCEDURES

SECTION 1 - LIMITATIONS

There are two separate categories for items contained in the limitations section. The first category, titled “Limitations,” includes limitations from the manufacturers’ FAA approved Airplane Flight Manual and additional items declared to be limitations by the Company. The Company limitations are designated by the symbol ◘. All limitations must be memorized. The second category, titled “Operating Parameters,” contains items which should be complied with to ensure safe and efficient operation of aircraft systems. Flight crews are expected to have a working knowledge of the operating parameters.

SECTION 2 - NON-NORMALS

Non-normal procedures are presented in groups called "modules" composed of the expanded version checklist and in some cases a short narrative description and/or a profile or graphic description of the procedure.

The non-normal procedures in this manual represent the best available information. Flight crews should follow these procedures as long as they fit the situation . At any time they are not adequate or do not apply, the flight crew's best judgment should prevail.

The immediate action items will be memorized by each crewmember.

No throttle, fuel control lever, fire handle, or critical system control will be moved during any non-normal procedure without the concurrence of both crewmembers. All aural warnings should be silenced as soon as the emergency is recognized.

Time permitting, the Captain should utilize all available resources including, but not limited to, radio communications with Maintenance / Engineering personnel.

Non-normal procedures are presented in expanded format grouped by aircraft system. It is not necessary to read the expanded verbiage aloud when performing the checklist unless clarification is desired. Checklist titles will reflect the annunciator light or non-normal condition.

Cockpit Voice Recorder (CVR)

Any incident requiring a report to NTSB, as defined in Section 1 of the Flight Operations Manual, and which results in termination of the flight, requires deactivation of the CVR upon termination of the flight to preserve the recorded information. This is accomplished by pulling the CVR circuit breaker located on the overhead circuit breaker panel. This will be noted in the Aircraft Maintenance Log.

Example: CVR deactivated because of reportable incident.

Ground Proximity Warning System / Enhanced Ground Proximity Warning System

The (Enhanced) Ground Proximity Warning System may be deactivated for approved non-normal procedures where the use of flaps at less than normal landing flap positions are specified. A logbook entry is required.

SECTION 3 - NORMAL PROCEDURES

This section is intended as a training and reference section. Checklists are presented in normal flight order. Additional procedures and information are presented as necessary.

Operating procedures defined in this section are intended to conform with the objectives of the company which are to place safety, comfort, schedule reliability and economy in their proper perspective. Conscientious adherence to these procedures is expected.

SECTION 3-1 - ETOPS / LRN

This section covers route planning and verification specific to ETOPS and Non-ETOPS Long-Range Navigation (LRN) operations. It is organized by phase of flight (preflight, planning, takeoff, enroute, approach, post-flight). An ETOPS/LRN Briefing Card presented at the beginning of the section details specific crew responsibilities pertinent to ETOPS/LRN operations.

This section uses Pacific Operations as the “standard” operating area and covers specific Atlantic Operations in a separate subject at the end of the section.

SECTION 4 - MINIMUM EQUIPMENT LIST

The MEL provides for release of the aircraft for flight with inoperative equipment. When an item of equipment is discovered to be inoperative, it is reported by making an entry in the Aircraft Maintenance Record / Logbook. The item is then either repaired or may be deferred per the MEL or other approved means acceptable to the Administrator prior to further operation.

SECTION 5 - PERFORMANCE

This section is also organized by phase of flight (takeoff, enroute, and landing) and within these phases further divided into "normal" and "non-normal" sections. Most data are presented in tabular form and pilots may interpolate as necessary.

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REQUEST FOR FEEDBACK

This Flight Manual is the result of the combined efforts of Flight Standards and Flight Operations. All flight crews are encouraged to comment on the contents of this manual, since its sole purpose is to provide you, the Flight Crew, with an accurate and effective tool to better help you do your job.

Suggestions, critiques, comments and corrections should be in writing and addressed to the Lead Line Check Airman in your crew base or to the respective Fleet Manager in Flight Standards. The boardmail address for each crew base is the three letter identifier of the base followed by the letters CP (i.e., IAHCP). The boardmail address for each fleet manager is IAHPS.

Your input is both desired and encouraged. All Flight Manuals are designed to be “living” documents, readily adaptable to new and better ideas, and easily revised.

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/15/02	* LEP-1	11/15/02		
* TOC-2	11/15/02	* LEP-2	11/15/02		
* 1	11/15/02				
* 2	11/15/02				
* 3	11/15/02				
* 4	11/15/02				
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* 25	11/15/02				
* 26	11/15/02				

FAA APPROVED
12 NOV 2002
Don R. Klos
Principal Operations Inspector

* Asterisk indicates page(s) revised or added by the current revision.

LIMITATIONS AND OPERATING PARAMETERS

TABLE OF CONTENTS

The information contained in this section meets or exceeds all requirements of the FAA approved Airplane Flight Manual (AFM). Both the AFM and Continental Airlines limitations are identified as "Limitations."

The label ◘ designates an AFM limitation, which has been further restricted by Company policy.

Flight crews are responsible for committing all information labeled "Limitations" to memory.

Additional "Operating Parameters" have been included in this section as a convenient reference. Flight crews are expected to have a working knowledge of these "operating parameters."

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GENERAL LIMITATIONS

1. The B737 airplanes are certified in the transport category (FAR 25) and are eligible for the following types of operation when the required equipment is installed and approved in accordance with the applicable FARs.
   - Visual Flight (VFR)
   - Instrument Flight (IFR):
   - B737 Airplanes are category "C" for Instrument Approaches except for Circling, which is category "D".
   - Night Flight
   - Icing Conditions
   - 7 8 9 Extended Overwater Operations (ETOPS)
2. Minimum Flight Crew:
   - Captain and First Officer

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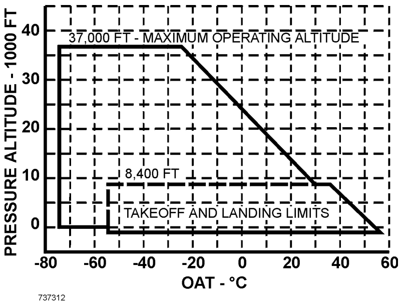
OPERATING LIMITATIONS / PARAMETERS

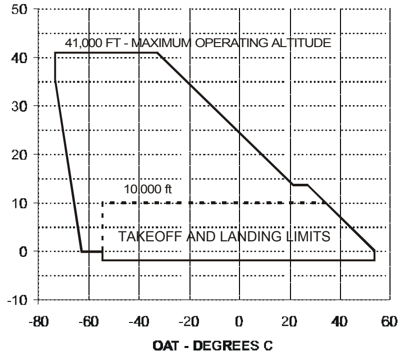
Limitations

1. Operational Envelope

③ 3 5



7 8 9



2. Runway slope: ±2%

3. Maximum takeoff and landing tailwind component:

   ③ 3 5 7 8 9 10 Knots

   7 8 15 Knots in Quito, Ecuador, Runway 35.

   7 8 9 15 Knots in San Jose, Costa Rica, Runway 25.

4. The maximum operating limit speed shall not be deliberately exceeded in any regime of flight.

5. Maximum operating altitude:

③ 3 5	7 8 9
37,000 ft.	41,000 ft.

6. Maximum takeoff / landing altitude:

③ 3 5	7 8 9
8,400 ft.	10,000 ft.

7. Maximum flight operating latitude:

③ 3 5	7 8 9
73° North and 60° South	82° North and 82° South

8. If landing weight exceeds the chart value in the Maximum Quick Turn Around Weight Limits chart, Section 5, wait at least

③ 3 5	7	8 9
53 Minutes	62 Minutes	67 Minutes

then check wheel thermal plugs before making a subsequent takeoff. Maintenance may use an alternate approved procedure to ascertain acceptable brake temperatures for dispatch.

9. 7 8 9 Installation of handle covers on the overwing exits must be verified prior to departure whenever passengers are carried.

Operating Parameters

1. Turbulent air penetration speed:

③ 3 5	7 8 9
280 knots /.73 Mach	280 knots /.76 Mach

Note: If severe turbulence is encountered at altitudes below 15,000 feet and the airplane gross weight is less than the maximum landing weight, the airplane may be slowed to 250 knots in the clean configuration.

2. Maximum tire speed: 195 knots

3. Demonstrated Crosswind Component

   Maximum manufacturer demonstrated takeoff / landing crosswind component: 35 knots - dry runway.

4. ACCULOAD will generate a crosswind advisory when forecast crosswinds for takeoff or landing exceed 25 knots for wet runways or 15 knots for contaminated runways. This advisory will appear on line 10 of the ACCULOAD and in the T/O – LANDING PLAN SUMMARY of the predeparture paperwork.

GROSS WEIGHT, C.G. AND PERFORMANCE

Limitations

Maximum	3 3	5 (A/C 601 - 637)	5 (A/C 638 - 669)
Taxi Weight:	135,500 lbs.	130,000 lbs.	134,000 lbs.
Takeoff Weight:	135,000 lbs.	129,500 lbs.	133,500 lbs.
Landing Weight:	114,000 lbs.	110,000 lbs.	110,000 lbs.
Zero Fuel Weight:	106,500 lbs.	103,000 lbs.	103,000 lbs.

Maximum	7	8	9
Taxi Weight:	155,000 lbs.	174,700 lbs.	174,700 lbs.
Takeoff Weight:	154,500 lbs.	174,200 lbs.	174,200 lbs.
Landing Weight:	128,000 lbs.	144,000 lbs.	146,300 lbs.
Zero Fuel Weight:	120,500 lbs.	136,000 lbs.	140,300 lbs.

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SYSTEM LIMITS AND OPERATING PARAMETERS

Air Conditioning / Pressurization

Limitations

1. System safety relief differential pressure: Maximum

3 3 5	7 8 9
8.65 psi	9.10 psi

2. Maximum cabin differential for takeoff / landing: .125 psi

Operating Parameters

1. When engine bleeds are on, do not operate air conditioning packs in high for takeoff, approach, and landing.
2. Operating Differential Pressure:
   - 7 8 9 8.35 ± .1 psi above 37,000 ft.
   - 7.8 ± .1 psi 28,000 through 37,000 ft.
   - 7.45 ± .1 psi below 28,000 ft.
3. Duct pressure for maximum cooling: 20-25 psi
4. Minimum duct pressure for two pack operation from one bleed source: 20-25 psi

Autopilot / Flight Director

Limitations

1. Minimum altitude for autopilot engagement (climb and cruise) is 1,000 ft. AGL.
2. For coupled single channel approaches with electronic glideslope, the autopilot shall not remain engaged below 50 ft. AGL.
3. Use of Aileron Trim with the Autopilot engaged is prohibited.
4. 7 8 9 Autopilot use prohibited below 100’ RA at airport pressure altitudes above 8400 feet.
5. The autoland capability may only be used with flaps 30 and 40 with both engines operative.

6. Allowable winds for autoland:
   - Headwind - 20 knots
   - Tailwind - 10 knots
   - Crosswind - 15 knots

Operating Parameters

1. For instrument approaches without electronic glideslope, the autopilot must be disengaged before descending more than 50 ft. below DA/DDA/MDA.
2. The Autoland System should not be used for overweight landings.
3. In the dual autopilot mode, the B737 incorporates a Fail – Passive Automatic Flight Control System. This system meets the applicable airworthiness and performance reliability requirements for auto coupled approaches and landings.

Auxiliary Power Unit (APU)

Limitations

1. 3 3 5 Max EGT: 760°C 7 8 9 - N/A
2. 3 3 5 Max Cont: 710°C 7 8 9 - N/A
3. APU bleed and electrical maximum altitude: 10,000 ft.
4. APU bleed maximum altitude: 17,000 ft.
5. APU electrical load maximum altitude:

3 3 5	7 8 9
35,000 ft.	41,000 ft.

Operating Parameters

1. 3 3 5 Do not operate APU above FL 350.
2. Operate one minute before using pneumatic air. Operate one minute with pneumatics off prior to shutdown.
3. Aborted Starts:
   - Ground
     - Allow 4 minutes between starts
     - Maximum 2 start attempts
   - Air
     - Allow 4 minutes between starts
     - Maximum 4 start attempts

4. ③❸❺ Successful starts not assured above FL 250.
5. After shutdown, wait 20 seconds for inlet door to close before turning battery switch to OFF.

Enhanced Ground Proximity Warning System

Limitations

1. Do not use the terrain display for navigation.
2. The uses of terrain awareness alerting and terrain display functions are prohibited within 15 nm and approaching to land at an airport not contained in the GPWS terrain database.

   Note: ALL CAL Ops Spec Authorized Airports have been verified to be included in the EGPWS terrain database.
3. The use of Terrain Awareness and Terrain Display functions are prohibited when the FMC is in IRS only operation.
4. For takeoff, the use of Terrain Awareness and Terrain Display functions are prohibited until position verification has been accomplished.
5. For ditching, or other off-airport landings, the terrain awareness alerting and terrain display functions should be inhibited by selecting the TERR INHIBIT switch in INHIBIT.

Communication

Limitations

The Aircraft Communications And Reporting System (ACARS) is limited to transmission and receipt of messages that will not create an unsafe condition if the message is improperly received, such as the following conditions:

- The message or parts of the message are delayed or not received,
- The message is delivered to the wrong recipient, or
- The message content may be frequently corrupted.

1. Do not use VHF-3 for ATC communications with ACARS operational, or if audio entertainment system is in use.
2. Do not use VHF COMM #2 or VHF COMM #3 on 120.00 MHZ as a primary means of communication. If frequency 120.00 MHZ is required use VHF COMM #1.
3. When placard installed use VHF-2 for primary ATC COMM on ground.
4. 7 8 9 The following HF frequencies are prohibited:
   Listed in MHZ: 11.133 22.434 22.683 22.766

Operating Parameters

7 8 9 Use the VHF radio connected to the top of the fuselage antenna for primary ATC communications on the ground.

Electrical Power

Limitations

1. 7 8 9 Maximum single engine drive generator load: 75KVA – 215 amps (ground operations).

Operating Parameters

1. Minimum battery voltage for APU start: 23 volts
2. 3 3 5 Maximum engine driven generator load: 125 amps
3. 3 3 5 Maximum TR load: 65 amps
   50 amps (ground operation without cooling)
4. TR voltage range: 24 - 30 volts
5. Battery bus voltage range: 22 - 30 volts

Fire Protection

Limitations

1. 3 3 5 Smoke Detection & Fire Suppression System (Ref. STC ST01674AT):
   A. The cargo compartment smoke detector and fire suppression system must be verified to be serviced and operational before cargo can be carried in the cargo compartments.
   B. The aircraft must land at the nearest suitable airport within 60 minutes after the activation of the suppression system.

Operating Parameters

1. Lavatory fire extinguishing: If evidence of overtemperature as indicated by black placard dot(s) or nozzle discharge (nozzle tip turns aluminum color), maintenance action required.
2. Engine fire extinguisher bottle pressure: 800 psi @ 70°F.

Flight Controls

Limitations

1. Maximum flap extension altitude: 20,000 ft.
2. [7][8][9] Holding in icing conditions with flaps extended is prohibited.
3. [7][8] Per Airworthiness Directives 2001-12-51 and 2002-08-52, "Do not operate the airplane at speeds in excess of 300 KIAS with speedbrakes extended.

   <u>WARNING</u>: Use of speedbrakes at speeds in excess of 320 KIAS could result in a severe vibration which, in turn, could cause extreme damage to the horizontal stabilizer."

   <u>Note</u>: Under the Captains Emergency Authority and after careful consideration, speedbrake deployment above 300 KIAS may be accomplished for emergency descent.
4. In flight, do not extend the speedbrake lever beyond the FLIGHT DETENT.
5. Flap limit speeds (IAS):

(3)[3][5] :

1	-	230 knots		15	-	195 knots
2	-	230 knots		25	-	190 knots
5	-	225 knots		30	-	185 knots
10	-	210 knots		40	-	158 knots

[7] :

1	-	230 knots	■	15	-	195 knots
2	-	230 knots	■	25	-	170 knots
5	-	225 knots	■	30	-	165 knots
10	-	210 knots		40	-	156 knots

[8][9] :

1	-	230 knots	■	15	-	200 knots
2	-	230 knots	■	25	-	190 knots
5	-	225 knots	■	30	-	175 knots
10	-	210 knots		40	-	162 knots

The label ■ designates an AFM limitation which has been further restricted by Company policy.

Operating Parameters

1. Alternate flap duty cycle (flight): One cycle:

Flaps 0-15	5 minutes off
Flaps greater than 15	25 minutes off

2. Alternate flap operation: Maximum airspeed - 230 knots to extend.
3. Speedbrake usage:
   A. Should not be deployed in flight at radio altitudes less than 1000 ft.
   B. Speedbrakes should not be deployed with flaps extended beyond flaps 15.
4. Mach Trim Fail (both channels):

3 3 5	7 8 9
280 KIAS / .74 Mach	280 KIAS / .82 Mach

Flight Management Computer

Operating Parameters

1. See MEL for restrictions.
2. Do not use the autopilot or the autothrottle for approach if the associated radio altimeter is inoperative.
3. The Flight Management Computer has been demonstrated to meet the requirement of FAA Advisory Circular 20-130A for a multi-sensor area navigation system when operated with radio or Global Position System (GPS) (if installed) updating. When operated in this configuration, the FMCS may be used for enroute and terminal operations.
4. The FMCS with dual FMC installation may be used as primary means for navigation for instrument approaches (excluding ILS, LOC, LOC-BC, LDA, SDF, and MLS) with ACTUAL (ANP) less than RNP.
5. The FMCS with single FMC installation may be used as a supplement to other primary means navigation for instrument approaches (with the exception of specifically approved and identified RNAV approaches).
6. 7 8 9 ADIRU alignment must not be attempted at latitudes greater than 78 degrees 15 minutes.

Fuel

Limitations

1. 7 8 9 (ETOPS) Perform an operational check of the fuel crossfeed valve during the last hour of cruise flight during each extended range operation. Enter valve failure conditions resulting from the operational check in the airplane log.
2. Maximum tank fuel temperature: 49°C.
3. Inflight tank fuel temperature must be maintained at least 3°C above the freezing point of the fuel being used or -45°C, whichever is higher.
4. Lateral fuel imbalance between wing tanks 1 and 2 must be scheduled to be zero. Random fuel imbalance must not exceed 1000 lbs.
5. Fuel Crossfeed valve must be closed for takeoff and landing.
6. Center tank fuel pump switches

   Ground Operations (Per A.D. 2001-08-24)

   - Center tank fuel pump switches must not be positioned to ON unless the center tank fuel quantity exceeds 1000 pounds (453 kilograms), except when defueling or transferring fuel.
   - Center tank fuel pump switches must be positioned to OFF when both center tank fuel pump low-pressure lights illuminate.
   - Center tank fuel pump switches must not be positioned to ON unless personnel are available on the flight deck to monitor low-pressure lights.

     Note: Once the center tank fuel pump switches are turned on, they do not need to be turned off once the fuel quantity depletes to less than 1000 lbs.
7. 7 8 9 Center tank fuel pump switches:

   Per AD 2002-19-52, and AD 2002-24-51 with AMOC 140S-02-376:

   "The center tank fuel pumps must be OFF for takeoff if center tank fuel is less than 5,000 lbs. with the airplane readied for initial taxi.

   Both center tank fuel pump switches must be selected OFF when center tank fuel quantity reaches approximately 1,000 lbs. during climb and cruise or 3,000 lbs. during descent and landing. The fuel pumps must be positioned OFF at the first indication of fuel pump low pressure."

   The center wing tank fuel quantity indication system must be operative to dispatch with center wing tank fuel.

"Note: The **CONFIG** indicator will annunciate when center tank fuel exceeds 1,600 lbs. and the center tank fuel pump switches are OFF. Do not accomplish the CONFIG non-normal procedure prior to or during takeoff with less than 5,000 lbs. of center tank fuel or during descent and landing with less than 3,000 lbs. of center tank fuel.

Note: In a low fuel situation, both center tank pumps may be selected ON and all center tank fuel may be used.

If the main tanks are not full, the zero fuel gross weight of the airplane plus the weight of center tank fuel may exceed the maximum zero fuel gross weight by up to 5,000 lbs. for takeoff, climb, and cruise and up to 3,000 lbs. for descent and landing, provided that the effects of balance (CG) have been considered.

If a center tank fuel pump fails with fuel in the center tank, accomplish the FUEL PUMP LOW PRESSURE non-normal procedure.

Prior to transferring or defueling conduct a lamp test of the respective fuel pump low pressure lights. When transferring or defueling from either the center or main wing tanks, the **FUEL PUMP LOW PRESSURE** indication lights must be monitored and the fuel pumps positioned to OFF at the first indication of fuel pump low pressure. Fuel may be transferred from tank to tank or the aircraft may be defuled with passengers on board, provided the fuel quantity in the tank from which fuel is being taken is maintained at not less than 2,000 pounds (900 kilograms). Deplane all passengers and non-essential crew when defueling a tank or transferring fuel from a tank that has a fuel quantity below 2,000 pounds (900 kilograms) until the process has been completed and the respective fuel boost pumps are turned off.

The limitations contained in this AD supersede any conflicting basic aircraft flight manual limitations."

Operating Parameters

1. Fuel Loading

   A. Main wing tanks 1 and 2 must be scheduled to be full if the center wing tank contains more than 1000 lbs. of fuel. With 1000 lbs. of center tank fuel or less, partial wing tank fuel may be loaded provided the effects of balance have been considered.

   B. 3 3 5 The center wing tank must contain a minimum of 10,050 lbs. if auxiliary tank fuel is loaded.

2. Fuel Usage

Center Tank:

- If a center tank **LOW PRESSURE** light(s) illuminates during takeoff or initial climb, the center tank pump(s) may remain on until the climb attitude is reduced and the light(s) extinguishes or workload allows for the pump(s) to be positioned OFF. When established in a level attitude at cruise, if the center tank contains usable fuel and the center tank switches are OFF, the center tank pump switches should be positioned ON again.
- If the center tank contains more than 1000 lbs., the center tank switches must be turned ON. Verify the **LOW PRESSURE** lights extinguish and position both switches OFF when both **LOW PRESSURE** lights illuminate.
- Use center tank fuel to depletion, followed by main wing tank fuel. However, a maximum of 1000 lbs. may be retained in the center tank.

Auxiliary tank (if installed):

- 3 3 5 Auxiliary tank installed: Use auxiliary tank fuel and center wing tank fuel equally until auxiliary tank fuel is depleted.

3. Tank Capacity – Usable:

	3 3 5	7 8 9
Wing tanks	1,499 U.S. Gals/10043 lbs.	1,288 U.S. Gals / 8630 lbs.
Center tank	2,313 U.S. Gals/15497 lbs.	4,299 U.S. Gals / 28803 lbs.
Auxiliary tank	390 U.S. Gals/2620 lbs.	N/A

- Jet A and A1 fuels are approved for unlimited use in this engine. Fuels conforming to JP-5 or JP-8 are acceptable alternatives. The use of wide cut fuels (JP-4 and Jet B) is prohibited.
- Fuel Density is 6.7 lb/gal.
- Do not reset any tripped fuel pump or fuel control circuit breaker.

Hydraulic Power

Operating Parameters

1. Minimum fuel for stationary ground operations of electric hydraulic pumps on ground is 1,676 lbs. in each wing tank.

Ice And Rain Protection

WARNING: Do not rely on airframe visual icing cues to activate engine anti-ice. Delaying the use of engine anti-ice until ice buildup is visible from the cockpit may result in severe engine damage. Use the temperature and visible moisture criteria specified in this section.

Note: Icing conditions exist when OAT (ground) – TAT (airborne) is 10°C/50°F or below and:

- Visible moisture (clouds, fog with visibility less than one mile, rain, snow, sleet, ice crystals, and so on) is present, or
- Standing water, ice, slush or surface snow is present on the ramps, taxiways, or runways which may be ingested by the engines or freeze on engines or nacelles

Limitations

1. If the aircraft has been deiced:

   The control column will be smoothly and slowly cycled from the full aft to the full forward position a minimum of three times to minimize the residual fluids in the balance bay during flight.

2. 7 8 Per Airworthiness Directive 2002-08-20 / AMOC 120S-02-907:

   "After ground deicing / anti-icing of the horizontal stabilizer using Type II or Type IV fluids, airspeed must be limited to 270 KIAS until the flight crew has been informed that applicable maintenance procedures have been accomplished that would allow exceedance of 270 KIAS. Once the applicable maintenance procedures have been accomplished, exceeding 270 KIAS is permissible until the next application of Type II or Type IV deicing / anti-icing fluids."

   Note:

   - Aircraft is restricted to a maximum of 270 KIAS after using Type II or Type IV fluid application. No MACH restriction.
   - Flight Plan Release (amended if required) displays 270-knot restriction.
   - Restriction remains in effect for all flights until elevator tab surfaces are cleaned of Type II and Type IV fluids.
   - It has been determined that Type I fluid does not affect the flight controls of the aircraft. If **only** Type I fluid is used for deicing / anti-icing, the speed restriction is not applicable.

   Caution: Flight Crews will evaluate the need to land at the nearest suitable airport if in-flight vibrations (**ELEVATOR TAB LIMIT CYCLE OSCILLATION**) occur as a result of de-icing.

3. Engine anti-ice:

   Must be ON during all ground operations, including after landing, when icing conditions exist or are anticipated.

   Must be ON during all flight operations when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below –40°C SAT.

   Must be ON prior to and during descent in all icing conditions, including temperatures below –40°C SAT.

   Engine ignition must be selected to CONT prior to and during engine anti-ice operation.

4. Wing anti-ice:

   Must be ON during all ground operations between engine start and takeoff when icing conditions exist or are anticipated.

   Do not operate wing anti-ice on the ground when the OAT is above 10°C/50°F.

   Do not use wing anti-ice as a substitute for ground de-icing/anti-icing.

Operating Parameters

1. Do not operate windshield wiper on a dry windshield.
2. Window heat must be ON 10 minutes before takeoff.
3. Pitot heat must be ON prior to takeoff.
4. During takeoff, to meet second segment climb requirements, wing heat will not be used below 800 feet AGL.

Instrument And Navigation

Limitation

Altitude Display limits for RVSM Operations:

7 8 9

Standby altimeters do not meet altimeter accuracy requirements of RVSM airspace.

The maximum allowable in-flight difference between Captain and First Officer altitude displays for RVSM operations is 200 feet.

The maximum allowable on-the-ground display differences for RVSM operations are:

Field Elevation	Max Difference Between Captain & F/O	Max Difference Between Captain or F/O & Field Elevation
Sea Level to 5,000 Feet	50 Feet	75 Feet
10,000 Feet	60 Feet	75 Feet

1. Takeoff with the Forward Looking Predictive Windshear Warning Alert annunciated is not authorized.

Operating Parameters

1. Do not operate weather radar during fueling, near fuel spills, or near personnel except in test mode.

2. Altimeter differences:

3 3 5

ALTITUDE	ELEC/PNEU	ELEC/ELEC
SEA LEVEL	50 FEET	50 FEET
5,000 FEET	80 FEET	50 FEET
10,000 FEET	120 FEET	60 FEET
20,000 FEET	220 FEET	80 FEET
30,000 FEET	280 FEET	120 FEET
40,000 FEET	425 FEET	160 FEET

7 8 9

ALTITUDE	CDS/CDS	CDS/STANDBY
SEA LEVEL	50 FEET	50 FEET
5,000 FEET	50 FEET	80 FEET
10,000 FEET	60 FEET	120 FEET
15,000 FEET	70 FEET	(See Note)
20,000 FEET	80 FEET	(See Note)
25,000 FEET	100 FEET	(See Note)
30,000 FEET	120 FEET	(See Note)
35,000 FEET	140 FEET	(See Note)
40,000 FEET	160 FEET	(See Note)
41,000 FEET	170 FEET	(See Note)

Note: Above 10,000 feet and 0.4 Mach, position error causes the tolerance to diverge rapidly and direct crosscheck becomes inconclusive. Differences greater than 400 feet should be suspect and verified by ground maintenance checks.

Landing Gear

Limitations

1. Landing gear placard speeds:
   A. Retract - 235 knots
   B. Extend - 270 knots/.82M
   C. Extended - 320 knots/.82M
2. Do not apply brakes until after touchdown.
3. Autobrakes: Arming the RTO feature is required on all takeoffs, if operable. Position the RTO selector to OFF if the autobrake system is inoperative.

Operating Parameters

1. Brake wear indicators should extend beyond the brake flange (with parking brake set).

Oxygen

Operating Parameters

1. The graph below is used to determine proper flight crew oxygen bottle pressure for variations of ambient temperature:

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
-10	14	430	600	770
- 5	23	440	610	785
0	32	445	620	800
5	41	455	635	815
10	50	460	645	830
15	59	470	655	840
20	68	480	670	860
25	77	485	680	870
30	86	495	690	885
35	95	505	700	900
40	104	510	715	915
45	113	520	725	930
50	122	530	735	945

Minimum Dispatch Pressure
(PSI) for 114 Cubic Feet Bottle

2. Minimum number of cabin portable oxygen bottles aboard - at least one for each assigned Flight Attendant. (One F/A for each 50 seats or part thereof.)

Power Plant

Limitations

1. Reverse thrust for ground use only, Intentional use of reverse thrust in flight is prohibited.
2. Ignition must be on for:
   - Takeoff
   - Landing
   - Engine Anti-Ice Operation
   - Heavy Rain
3. Maximum and Minimum Engine Limits are red.
4. Caution Engine Limits are amber
5. 3 3 5 Normal Engine operating range is green.
6. 7 8 9 Normal Engine operating range is white.

	3 3 5	7 8 9
7. Maximum N_1:	106%	104.0%
8. Maximum N_2:	105%	105%
9. Maximum EGT:		
Takeoff (5 min):	930°C	950°C
Maximum Continuous:	895°C	925°C
Start (ground):	725°C	725°C
10. Minimum oil pressure:	13 psi	13 psi

Oil pressure must be in normal range for takeoff.

	3 3 5	7 8 9
11. Oil Temp		
Maximum:	165°C	155°C
Maximum Continuous:	160°C	140°C

Maximum Allowable:

3 3 5 160°C – 165°C (15 minutes)

7 8 9 140°C – 155°C (45 minutes)

③ 3 5 Limitations

1. Both PMC's must be either ON or OFF for takeoff.
2. Operation with assumed temperature reduced takeoff thrust is not permitted with the Power Management Computer (PMC) in OFF mode.

7 8 9 Limitations

1. Both EECs must be either ON or ALT for takeoff.
2. Operation with assumed temperature reduced for takeoff thrust is not permitted with the Electronic Engine Control (EEC) in Alternate mode.

Operating Parameters

1. Minimum duct pressure for start:

   ③ 3 5 30 psi at sea level decreasing 1/2 psi per 1000 ft. above sea level.

   7 8 9 N/A
2. Starter duty cycle: 2 min. ON, 20 sec. OFF (first two consecutive start attempts). Three minutes cooling required before third and subsequent consecutive start attempts.
3. Do not engage starter above 20% N_2.
4. Minimum oil quantity prior to engine start: ③ 3 5 3.0 Gals.
   7 8 9 60%.
5. Ambient temperature below -35°C (-31°F): Idle engine 2 minutes before changing thrust lever position.
6. Engine fan blades must be inspected by one of the pilots after flight in icing conditions.

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/15/02				
* TOC-2	11/15/02				
* 1	11/15/02				
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* LEP-1	11/15/02				
* LEP-2	11/15/02				

FAA APPROVED
12 NOV 2002
Don R. Klos
Principal Operations Inspector

* Asterisk indicates page(s) revised or added by the current revision.

NON-NORMAL PROCEDURES

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2.0 - UNANNUNCIATED

TABLE OF CONTENTS

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UNANNUNCIATED

BIOLOGICAL OR CHEMICAL HAZARD / THREAT

Condition: Suspected biological or chemical hazard / threat to the flight.

Contact SOCC: SOCC will coordinate with appropriate agencies to determine if the substance poses a credible threat.

IF SOCC determines that the substance does pose a credible threat:

Cover the material with the wipes and the plastic gown found in the onboard Universal Precaution Kit (UPK). If the UPK is not available, use a wet blanket to prevent airborne spreading of the material.

IF On The Ground:

Follow SOCC guidance.

OR

IF Inflight:

Consideration should be given to landing as soon as practical based on analysis of the situation and coordination with SOCC.

If the material is **airborne** within the aircraft, the following procedures will minimize particulate flow into the flight deck and should be utilized.

Oxygen Masks & Regulators
(Smoke Goggles, If Required)..ON, 100%

Crew Communications...ESTABLISH

Press crew interphone receiver down and set volume arrow at 12 o'clock or greater. Set MASK/BOOM selector to MASK. Use I/C toggle on audio selector panel or bottom position on YOKE ROCKER switch when speaking to other pilot.

Flight Deck Door... CLOSED

Prevents material from penetrating onto the flight deck.

IF Packs ON And Material Confirmed On Flight Deck Or Main Cabin:

L & R Pack Switches ....HIGH

OR

Recirculation Fan Switch(s)..OFF

Pressurization Mode Selector ....(AS INSTALLED) STBY

(Continued)

Cabin Alt Selector (As Installed) .... TO 10,000 FEET MAX

Select higher cabin altitude to increase the ventilation rate.

Cabin Rate Selector (As Installed).......................... MAXIMUM INCR

Digital Controller (As Installed) Land ALT............................... 10,000'

No. 1 & No. 2 Bleed Air Switches....................................... VERIFY ON

This assures maximum ventilation.

Engine Thrust (Max Practical) .... ABOVE 45% N_1

During descent / approach, it is desirable to maintain thrust as high as practical to supply maximum bleed air for ventilation.

Flight Deck Air Cond & Gasper Outlets ....OPEN

This assures adequate flow of ventilating air on flight deck.

Caution: Do not open the flight deck window. Keep the flight deck door closed.

IF Smoke / Fumes Are Uncontrollable:

Aircraft Altitude... MEA OR 10,000 FEET, WHICHEVER IS HIGHER

At 14,000 feet or below:

Pressurization Mode Selector...................................... MAN AC / MAN

Outflow Valve Switch ....OPEN

IF Packs OFF And Material Confirmed On Flight Deck:

Airspeed.. NORMAL HOLDING SPEED

Caution: Window should not be opened unless the source is confirmed to be originating on the flight deck.

Slow aircraft to holding airspeed to minimize the effect of opening a flight deck window.

F/O's Sliding Window..OPEN

Due to resulting high wind noise level, headsets should be on and volume adjusted accordingly.

Land at Nearest Suitable Airport.

* * * *

DITCHING

Checklist usage is based upon the recognition of conditions which preclude continuation of the flight to a suitable landing, requiring aircraft ditching and evacuation.

- Send Distress Signal

  On Captain's command, First Officer will transmit MAYDAY, establish position, course, speed, altitude, situation, intention, time and position of intended touchdown, type of aircraft, and request "SAR" intercept using prevailing air to ground frequency. Set transponder code 7700 and, if practical, advise Captain of course to nearest ship or landfall.

- Advise Crew And Passengers

  Alert crew and passengers to prepare for ditching. If possible, move passengers away from the rear exits towards overwing and forward exits. Assign life raft positions and order all loose equipment in aircraft secured. Put on life vest, shoulder harness, and seat belts.

WARNING: Do not inflate life vest until after exiting the aircraft.

WARNING: Do not open aft entry or aft service door(s) as they may be partially submerged.

- Burn Off Fuel As Required

  Consider burning fuel prior to ditching if emergency permits. This will provide greater buoyancy and a lower V_{REF}. However, do not reduce the fuel to a critical amount, since ditching with thrust available improves the ability to properly control touchdown.

- The terrain awareness alerting and terrain display functions (if installed) should be inhibited by selecting the TERR INHIBIT switch to INHIBIT.
- Accomplish IN RANGE and APPROACH checklists.
- Plan a flap 40 landing unless other configuration is required.

(Continued)

- - - - - BELOW 5,000 FEET - - - - -

Aural Warning C/B (P6-3, D-18) .... PULL

Prevents warning horn with gear retracted and landing flaps selected.

Ground Proximity Warn C/B
(3 3 5 P18-1, A-7) (7 8 9 P18-1,B-7) .... PULL

Ground Proximity Terrain Inhibit Switch (If Installed) .... OVRD

Pack Switches .... OFF

Engine Bleed Air Switches .... OFF

Permits depressurizing the aircraft with outflow valve closed .

Pressurization Mode Selector .... MAN DC / MAN

Enables manual control of outflow valve.

Outflow Valve Switch .... CLOSE

Closed to prevent water from entering the aircraft.

APU Switch .... OFF

Closes the fuel valve and air inlet door.

Flight Deck Loose Gear .... SECURE

Flight Deck Door .... SECURE OPEN

Life Vests .... ON

Don life vests, but do not inflate until after exit from aircraft.

Shoulder Harnesses & Seatbelts .... ON

Put on shoulder harnesses and seatbelts and adjust for snug, comfortable fit.

Passenger Cabin Preparation .... COMPLETE

Verify passenger cabin preparations for ditching are complete. All available food, fluids, flashlights, first aid kits, and other emergency equipment confirmed ready for evacuation.

When ditching without life rafts on board, ascertain that Flight Attendants are prepared to use the evacuation slides as life raft substitutes.

Seat passengers with life vests on and seat belts fastened.

(Continued)

Radio .... TRANSMIT FINAL POSITION

Transmit all pertinent information pertaining to: final ditching position, weather and sea conditions, rescue instructions, and information if ship or other available rescue unit is standing by and any other necessary information.

Emergency Exit Lights.. ON

Insures lighting is available after electrical power is lost.

- - - - - BEFORE LANDING - - - - -

Landing Gear... UP & OFF

Check all landing gear lights extinguished and landing gear lever in OFF position.

Flaps ....____ GREEN LIGHT

Extend flaps to 40 or appropriate landing flap for an existing emergency or non-normal conditions.

- Advise crew and passengers "BRACE FOR IMPACT" when within 30 seconds of touchdown.
- Maintain airspeed at bug (V_{REF} + Wind Additive) and 200 - 300 fpm descent rate.
- Plan to touch down on upwind side and parallel to waves or swells if possible.
- To accomplish flare, rotate smoothly to touchdown attitude of 4 - 5°, maintaining airspeed and rate of descent with thrust. After touchdown, reduce thrust to idle.

- - - - - ON THE WATER - - - - -

Start Levers .... CUTOFF

Provides positive shutdown of engines.

Engine Fire Handles... PULL

Closes fuel shutoff valves to prevent discharge of fuel from ruptured fuel lines.

Initiate Evacuation ....PA COMMAND

(Continued)

Post Landing Duties ....ACCOMPLISH

- Captain Proceed to forward cabin area. Evaluate escape potential. Supervise and assist cabin crew in evacuation of aircraft. Board and take command of any raft, if available.
- First Officer Assist Captain and cabin crew in evacuation of aircraft. Board and take command of any raft, if available.
- Observer Occupy a seat in the cabin if available. If qualified, assist flight attendant in customer evacuation.

The aircraft may remain afloat indefinitely if fuel load is minimal and no serious damage was sustained during landing.

* * * *

DITCHING NOTES

Flight Deck Ditching Responsibilities

	CAPTAIN	FIRST OFFICER	IRO *
BEFORE LANDING	Advise flight deck & cabin crew to prepare for ditching. Don life vest (do not inflate). Determine position and set course for nearest land or surface vessel. Determine if fuel is to be dumped. Confirm cabin is depressurized prior to ditching. Advise cabin crew and passengers when within 30 seconds of impact (seat belt sign **ON**). Emergency light switch **ON**. Land with gear up and full flaps. Land with 4°-5° pitch up.	When advised to prepare for ditching: Don life vest do not inflate Send distress call (Mayday) Give position, status and intentions. Select transponder to 7700. Below 5,000': GPWS: Gear override switch to override. Terrain override switch to override. Depressurize on command: Pack switches off Outflow valve switches both manual Outflow valve manual switches both closed APU switch off If no IRO: Secure loose gear Secure flight deck door open	When advised to prepare for ditching: Don life vest do not inflate. Secure loose gear. Secure flight deck door open.
ON WATER	<u>Fuel control switches to</u> cutoff. Passenger evacuation "Easy Victor, Easy Victor."	Override and pull APU fire switch. Proceed to overwing area. Evaluate escape potential; supervise and assist cabin crew in evacuating aircraft.	Proceed to overwing area. Evaluate escape potential; supervise and assist cabin crew in evacuating aircraft.
ABANDON AIRCRAFT	Verify survival gear, food, water is in raft. After all possible assistance is rendered, board and take command of any raft. Ensure separation from girt.	Verify survival gear, food, water is in raft. After all possible assistance is rendered, board and take command of any raft. Ensure separation from girt.	Verify survival gear, food, water is in raft. After all possible assistance is rendered, board and take command of any raft. Ensure separation from girt.

* Aircraft Qualified Observer assist / perform duties of the IRO. All other observers return to cabin and assist flight attendants with customer evacuation.

737 Flight Attendant Responsibilities - Ditching Without Rafts

F/A	JUMPSEAT	EMER. & NORMAL DEMO	AREA OF RESPON.	BRIEFS ABA	COMM. EVAC.
A	1L, inboard (outboard with F/A D)	P.A.	First class (and forward galley if no F/A D)	2 for 1L (and 2 for 1R if no F/A D)	1L (and 1R if no F/A D)
B	2L, outboard	1st row, first class	Main cabin	3 for each OWE	OWE
C	2L, inboard	1st row, main cabin	Aft galley & main cabin	1 to block 2L and 1 to block 2R	Block aft exits and direct customers forward
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW FOR 737-300/-500/-700 AND 737-800 WITH SEATING CONFIGURATION 18/132					
D	1L, inboard	Middle of main cabin	Forward galley and main cabin	2 for 1R	1R
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW FOR 737-800 WITH SEATING CONFIGURATION 14/141 AND 737-900					
E	2R If no 2R, aisle seat forward of window exit, aircraft right	Assist as needed	Assist as needed	Assist as needed	Assist as needed

- Flight attendant B ensures emergency lights are activated.

Preferred Routes Of Escape

The following are potential evacuation routes:

- 1L door
- 1R door
- Overwing window exits (direct customers off the leading edge of wing).

Flotation Devices

Customers' individual flotation device is the life vest at their seat. On aircraft not equipped with life rafts, slides can be used as flotation devices.

737 Flight Attendant Responsibilities - Ditching With Rafts

F/A	JUMPSEAT	EMER. & NORMAL DEMO	AREA OF RESPON.	BRIEFS ABA	COMM. EVAC.
A	1L, inboard (outboard with F/A D)	P.A.	First class (and forward galley if no F/A D)	2 for 1L and 2 for LR #1 (2 for 1R and 2 for LR #4, if no F/A D)	1L (and 1R if no F/A D)
B	2L, outboard	1st row, first class	Main cabin	3 for each OWE, 2 for LR #2, and 2 for LR #3	OWE
C	2L, Inboard	1st row, main cabin	Aft galley & main cabin	1 to block 2L and 1 to block 2R	Block aft exits and direct customers forward
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW FOR 737-300/-500/-700 AND 737-800 WITH SEATING CONFIGURATION 18/132					
D	1L, inboard	Middle of main cabin	Forward galley and main cabin	2 for 1R and 2 for LR #4	1R
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW FOR 737-800 WITH SEATING CONFIGURATION 14/141 AND 737-900					
E	2R If no 2R, aisle seat forward of window exit row aircraft right	Assist as needed	Assist as needed	Assist as needed	Assist as needed

- Flight attendant B ensures emergency lights are activated.
- Flight attendant A retrieves emergency locator transmitter.
- Flight attendant C retrieves spare life vests.

Preferred Routes Of Escape

The following are potential evacuation routes:

- 1L door
- 1R door
- Overwing window exits (direct customers off the leading edge of the wing).

Flotation Devices

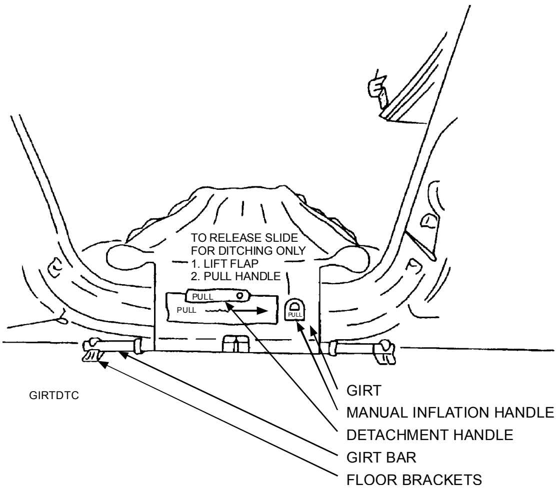
Customers' individual flotation device is the life vest at their seat. On B737-300/-700 aircraft equipped with rafts, there are three 46 person life rafts with an overload capacity of up to 69. B737-800/-900 aircraft have an additional life raft for a total of four.

Detachable Girt For Ditching

The emergency escape slides have not been certified to be part of the water landing emergency equipment. In a water environment, the slide may not properly inflate when deployed. If the deployed slide is recognized to be a potential obstruction to egress, a quick release handle is provided near the top of the slide. This handle is protected by a cover and is placarded. The escape slide is detached from the aircraft by pulling the quick release handle. Once detached from the doorsill, the slide is tethered to the doorsill by a lanyard.

A properly inflated slide could be buoyant and useful as a flotation device for passengers in the water. The overturned slide will support several passengers inside the slide like a raft. Hand grips are positioned along the sides of the slide to provide support for those passengers remaining in the water.

Note: When ditching without life rafts on board, ascertain that Flight Attendants are prepared to use the evacuation slides as life raft substitutes.



Preferred Routes Of Escape - Ditching

1. Main Cabin Door
2. Forward Galley Door
3. Overwing Window Exists (direct passengers off leading edge of wing)
4. Do not open any exit which is below water line.

WARNING: Do not open aft entry or aft service door(s) as they may be partially submerged.

Note: If assured all exits are below water level and conditions require operation of door exits, disarm slide before opening doors.

Ditching Procedures Without Rafts

The slide will serve as a flotation device in a water ditching without rafts.

1. Open doors designated as preferred routes of escape in a ditching.
2. Inflate slides.
3. Passengers are to jump into the water and hold on to the slide.

   Note: Passengers must not attempt to board the slide as it will collapse in the center.

4. Pull quick release handle at top of slide to detach slide from aircraft.
5. Flight Attendant jumps into the water and holds on to the sides of slide.
6. Direct slide toward the wings to pick up additional survivors.

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EMERGENCY EVACUATION

Preparation

For **EMERGENCY EVACUATION - PLANNED** see **TOC**, this section.

CA

Standby Power .... **BAT**

This assures electrical power for the #1 VHF comm radio. The overhead speakers will be inoperative.

Tower / Ground .... **CONTACT**

Contact the tower or ground control with notice of impending evacuation.

FO

Flaps **40**

This aids in overwing passenger evacuation.

Speed Brake Lever .... **DOWN DETENT**

This lowers the spoiler panels to prevent interference with passenger evacuation.

Pressurization .... **MAN DC / MAN & OPEN**

This powers the outflow valve switch from the Standby DC Bus. Opening the outflow valve will ensure complete depressurization of the aircraft to allow opening of the escape hatches and doors.

IF Evacuation Is Confirmed Necessary:

Parking Brake .... **SET**

Tower/Ground .... **NOTIFY**

Notify the tower or ground of actual evacuation taking place.

Start Levers .... **CUTOFF**

Passenger Evacuation ... **"EASY VICTOR, EASY VICTOR"**

The Captain will command evacuation using the standard phrase "EASY VICTOR, EASY VICTOR."

(Continued)

Emergency Exit Lights .... ON

This action ensures the EXIT lights are illuminated.

Engine & APU Fire Handles.................OVERRIDE & PULL

Press the override button located under the handle while pulling the fire handle.

- - - - - CREW EVACUATION DUTIES - - - - -

Captain: Direct and assist passenger evacuation. Ensure all passengers and crew have evacuated the aircraft.

F/O: Assist Flight Attendant as necessary to ensure forward door(s) open and escape slide activated. Proceed to ground without delay. Circle exterior of aircraft as necessary to coordinate and assist with evacuation. Direct passengers to assembly point.

Observer: Will occupy a seat in the cabin. If qualified, assist Flight Attendant in passenger evacuation.

Preferred Routes of Escape - Land

Belly Landing (All Gears Retracted)

Evacuation Routes:

- Forward slides are very shallow.
- Direct passengers off trailing edge of wing, potential fire hazard.
- AFT slides are steeper than normal.

Nose Gear Collapse (Nose Low / Tail High)

Evacuation Routes:

- Forward slides are very shallow.
- Direct passengers off trailing edge of wing, potential fire hazard.
- AFT slides are very steep, but usable.

Main Gear Collapse (Nose High / Tail Low)

Evacuation Routes:

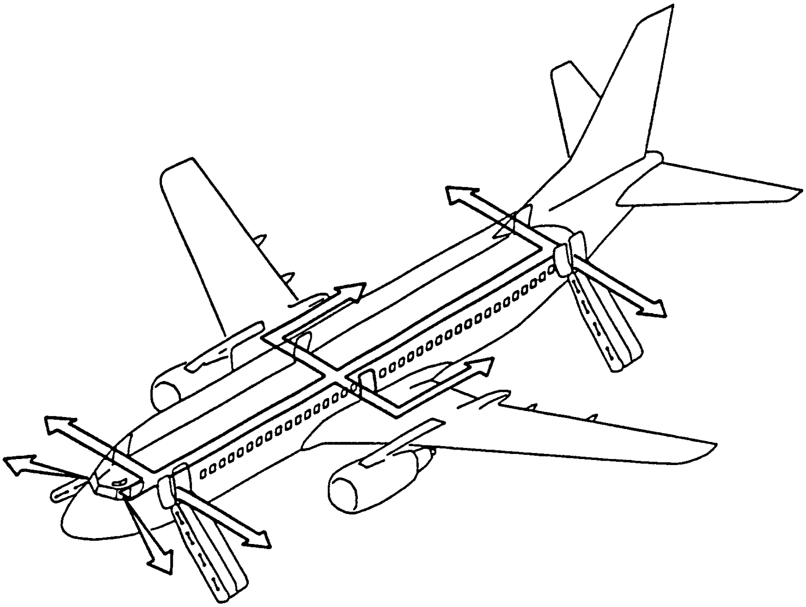
- Forward slides are slightly steeper than normal.
- Direct passengers off trailing edge of wing, potential fire hazard.
- AFT slide is shallow.

(Continued)

One Main Gear Collapse (One Side High / One Side Low)

Evacuation Routes:

- All slides required. Caution should be used at exits on the high side due to possible steep angle of slides.
- Potential fire hazard on low side.



EMERGENCY EVACUATION ROUTES

737 Flight Attendant Responsibilities – Land

F/A	JUMPSEAT	EMER. & NORMAL DEMO	AREA OF RESPON.	BRIEFS ABA	COMM. EVAC.
A	1L, inboard (outboard with F/A D)	P.A.	First class (and forward galley if no F/A D)	2 for 1L (and 2 for 1R if no F/A D)	1L (and 1R if no F/A D)
B	2L, outboard	1st row, first class	Main cabin	3 for each OWE	2L (secondary OWE)
C	2L, inboard	1st row, main cabin	Aft galley & main cabin	2 for 2L and 2 for 2R	2R
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW FOR 737-300/-500/-700 and 737-800 WITH SEATING CONFIGURATION 18/132					
D	1L, inboard	Middle of main cabin	Forward galley and main cabin	2 for 1R	1R
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW FOR 737-800 WITH SEATING CONFIGURATION 14/141 AND 737-900					
E	2R, If no 2R, aisle seat, forward of window exit row, aircraft right	Assist as needed	Assist as needed	Assist as needed	Assist as needed

- Flight Attendant B ensures the emergency lights are activated.

* * * *

EMERGENCY EVACUATION - PLANNED

The Emergency Evacuation Checklist should be used in any situation where the Captain feels the potential for evacuation exists. Initiating the checklist does not indicate that an evacuation will occur, it merely sets in motion a procedure which will prepare the aircraft for orderly evacuation of all passengers and crew immediately after the ultimate decision to evacuate is made by the Captain. The Captain's primary responsibility is to decide if the passenger evacuation is necessary. The F/O's primary responsibility is to configure the aircraft so that if the Captain decides to evacuate, the aircraft is immediately ready.

The checklist and aircraft evacuation placard indicate a two step procedure. The upper portion of the checklist (those steps above the statement "If Evacuation is Confirmed Necessary" defines the preparation and decision making steps. Duties normally performed by the Captain are listed first followed by F/O duties. A blank line separates the steps. Crewmembers should perform their steps simultaneously and by reference to the placard and flow if applicable. The lower portion of the checklist defines the steps to be performed if the Captain has made a decision to evacuate the aircraft. The steps normally performed by the Captain are listed first and the F/O steps printed following a blank line.

Once the aircraft is at a complete stop, the Captain will call for the Emergency Evacuation Checklist. The Captain should then communicate with whomever he feels may be able to offer information which will aid in the evacuation decision, i.e., ATC, ground vehicles and cabin crew. The F/O should take the initiative to configure the aircraft and begin the checklist even if the Captain neglects to call for the Evacuation Checklist. These steps are "transparent" to passengers and cabin crew and should not create a potential for an uncommanded evacuation.

While the Captain is making the evacuation decision the F/O will quickly perform or verify the steps of the checklist down to the statement "If Evacuation is Confirmed Necessary," by flow and/or reference to the evacuation placard. If the placard was not used initially, the checklist should then be performed by Challenge / Response / Response down to the decision point. At this time the checklist should be paused and the F/O should direct his/her attention to the Captain to be ready to proceed with the course of action decided by the Captain. If the Captain decides an evacuation is required, he/she will set the parking brake and position the start levers to cutoff and order the evacuation by using the PA. When the F/O notes the Captain's decision by verbal confirmation from the Captain or by observing the evacuation command, he/she will continue the final steps of the checklist by Challenge / Response / Response. If the Captain decides not to evacuate the aircraft, the F/O will await further direction by the Captain. A "REMAIN SEATED" command and PA announcement to inform and calm the passengers should be given by the Captain or his designee.

Primary evacuation route for the flight deck crew is through the passenger cabin, assisting as necessary, and exiting down one of the evacuation slides.

Secondary evacuation route is through flight deck windows. It is not intended that crewmembers assume unnecessary risks. When all efforts to aid passengers have been expended, the crew should act in the best interest of personal safety.

Advise cabin attendants of emergency and type of landing to be made. The cabin attendants will expect the following information:

T - Type of emergency expected.

E - Evacuation, will it be necessary?

S - Signals for brace evacuation and non-evacuation.

T - Time available for preparation.

- Notify ATC and Company.
- Unlock flight deck door and block open.
- Secure all loose items on flight deck.
- Depressurize aircraft before landing, turn packs OFF.
- Open outflow valve.
- It is recommended that all available landing gear be extended.
- 30 seconds prior to touchdown, make a PA "BRACE FOR IMPACT."
- Activate the emergency **EXIT** lights.

- - - - - AFTER AIRCRAFT COMES TO A COMPLETE STOP - - - - -

IF Evacuation Is Not Required:

Immediately make a PA: "REMAIN SEATED, REMAIN SEATED."

OR

* * * *

IF Evacuation Is Required:

Refer to **EMERGENCY EVACUATION** checklist, this section.

* * * *

PUSHBACK WITHOUT NOSE GEAR LOCKOUT PIN INSTALLED AND TOW BAR CONNECTED

Both Hydraulic System A Pumps .... OFF

WARNING: Do not make any electrical or hydraulic power changes with tow bar connected. Any change to electrical power may cause momentary pressurization of the nose wheel steering actuators causing unwanted tow bar movement.

When Cleared For Pushback Or Tow Out:

Brakes .... OFF

When Aircraft Is Stopped (On Signal From Ground):

Parking Brake .... SET

Tow Bar .... DISCONNECTED

Clearance From Ground Crew..................... TUG, TOW BAR CLEAR

Hydraulic System "A" Pumps.. ON

Interphone.. REMOVED

Note: Powerback procedures are not authorized.

* * * *

REJECTED TAKEOFF

Tower / Ground.. NOTIFY

Passenger PA............................"REMAIN SEATED, REMAIN SEATED"

Parking Brake...AS REQUIRED

IF Engine Failure, Engine Fire, or APU Fire:

Engine Start Lever (Affected Engine) ....CUTOFF

Illuminated Fire Handle ....PULL & ROTATE LEFT & RIGHT

IF Evacuation Is NOT Required:

Identify the malfunction and accomplish the appropriate checklist, as required.

- - - - - AFTER PROBLEM IS STABILIZED - - - - -

Do not taxi until the Flight Attendants verify all passengers are seated and all doors / exits are closed. Make a brief PA reassuring customers and Flight Attendants that the situation is under control and inform them of your intentions.

OR

Caution: If tire damage is suspected, do not retract flaps.

After Landing Checklist...ACCOMPLISH

Brake Cooling..DETERMINE

Refer to the appropriate aircraft **RTO BRAKE COOLING CHART.**

* * * *

IF Evacuation IS Required:

Accomplish **EMERGENCY EVACUATION** Checklist.

* * * *

REJECTED TAKEOFF PROCEDURE

A Rejected Takeoff (RTO) is a maneuver performed during the takeoff roll to expeditiously stop the aircraft on the runway.

Rejected Takeoff Decision

At low speeds, (up to approximately 100 knots), the energy level is low, therefore the aircraft should be stopped if an event occurs that would be considered undesirable for continued takeoff. Examples include Master Cautions or Warnings, unusual vibrations, or tire failure.

As the airspeed approaches V_1, the effort required to stop the aircraft can approach the aircraft's maximum stopping capability. After 100 knots and before V_1, the takeoff should be rejected only for engine failure, a confirmed unsafe configuration, or other conditions that severely affect the safety of flight. V_1 is the maximum speed at which the RTO should be initiated. Therefore, the decision to stop must be made **prior** to V_1.

Historically, rejecting a takeoff near V_1 has often resulted in the aircraft coming to a stop beyond the end of the runway. Common causes include initiating the RTO at or after V_1 and failure to use proper procedures (maximum stopping capability).

Do not reject the takeoff after V_1 unless the Captain judges the aircraft incapable of flight. Even if excess runway remains after V_1, there is no assurance that the brakes and/or reversers will have the capacity to stop the aircraft prior to the end of the runway.

Rejected Takeoff Maneuver

The Captain is responsible for performing all rejected takeoffs. When the First Officer is making the takeoff, he/she will place both hands on the yoke after initially setting takeoff power and the Captain has assumed control of the throttles. The Captain will be prepared to perform the rejected takeoff maneuver, if required. If a rejected takeoff is required or called for by the Captain prior to the First Officer removing his/her hand from the thrust levers, the First Officer will retard the thrust levers to idle and assist the Captain in the rejected takeoff maneuver.

During the takeoff roll, the Pilot Monitoring will monitor all instruments and indicators. Below 100 knots, any abnormality should be called out. Above 100 knots the only callout normally made is "POWER LOSS." This callout is made when any crewmember observes a confirmed engine power loss. Above 100 knots, other conditions that severely affect the safety of flight should also be considered and, if appropriate, a callout made. If a non-normal is verbalized during the takeoff roll, the Captain will evaluate the situation and make the go / no-go decision. If the Captain elects to continue he/she should clearly and loudly call out "CONTINUE." In this case, the Pilot Flying will continue the takeoff using normal procedures.

If the Captain initiates a reject, he/she will clearly and loudly announce, "REJECT." As the aircraft decelerates, the First Officer should ensure that proper aileron control input is maintained. Additionally, during a F/O takeoff and after the Captain assumes control of the thrust levers, the First Officer will relinquish control of the aircraft to the Captain as soon as "REJECT" is heard.

Transition to manual braking should be verbalized with the call "MANUAL BRAKES."

As soon as conditions permit, the First Officer should notify ATC of the rejected takeoff, and will make a "REMAIN SEATED", "REMAIN SEATED" announcement to the cabin.

During any rejected takeoff, the Captain should:

- Close the throttles.
- Disconnect autothrottle.
- Apply maximum reverse thrust.
- Ensure that the speedbrakes automatically deploy.
- Use RTO autobrakes (if available) to a complete stop.

In the event the speedbrakes do not deploy, the First Officer will call "SPEEDBRAKES" and the Captain will manually deploy the speedbrakes. Use RTO brakes or manual braking as required. On a wet or slippery runway, or takeoff at or near maximum runway limit weight, an aborted takeoff at or near V_1 will require <u>MAXIMUM</u> use of all deceleration devices until reaching a full stop.

Whenever a decision is made to reject a takeoff, the following limiting criteria must be considered: weather conditions, runway length and conditions, aircraft weight and takeoff performance limits, and MEL/CDL items affecting aircraft performance.

REJECTED TAKEOFF CONSIDERATIONS	
Below 100 Knots	**Above 100 Knots**
• Engine Failure / Fire • Unsafe / Unable to Fly • Cabin Smoke / Fire • System Failure • Unusual Noise or Vibration • Tire Failure • Abnormal Acceleration • Takeoff Configuration Warning • Windshear Warning	• Engine Failure • Unsafe / Unable to Fly

Once the aircraft has slowed to a safe speed, it is up to the Captain:

- When and where to exit the active runway.
- When and if to set the parking brake.
- To make a decision whether to evacuate the aircraft, return to the gate, or return for takeoff. Additional information may be required.

In order to determine the best course of action, the following factors should be considered:

- What was the reason for the rejected takeoff – a mechanical problem, an ATC call, etc?
- What is the overall status of the aircraft – is it able to safely taxi?
- What is the status of the F/As, passengers and emergency exits – are they seated and are all doors closed?
- Is emergency equipment required, and can they access the aircraft better on the runway or taxiway?
- Is it prudent to set the parking brake while evaluating the situation if the brakes are <u>very</u> hot?
- What are the effects of hot brakes and tires as it pertains to brake fires, blown fuse plugs, and hazards to ground personnel?
- Is there any other relevant information pertinent to assessing the situation?

If there is doubt as to the most appropriate course of action, the aircraft should be stopped straight ahead on the runway until the situation can be resolved. After the aircraft comes to a complete stop, the Captain will call for the **REJECTED TAKEOFF CHECKLIST**.

TAILSTRIKE ON TAKEOFF

Caution: Do not pressurize aircraft due to possible structural damage.

Pressurization Mode Selectors.. MAN DC / MAN

Outflow Valve Switch..OPEN

Hold outflow valve switch in the OPEN position until outflow valve position indicator shows valve full open.

* * * *

VOLCANIC ASH

If volcanic dust is encountered, the following procedure will be accomplished:

WARNING: Exit volcanic dust cloud as rapidly as possible.

Autothrottle .... DISENGAGE

Disengage the autothrottle system to prevent it from increasing the engine thrust.

Throttles (Terrain Permitting) .... IDLE

Terrain permitting, retard throttle to idle to provide additional stall margin and to decrease EGT. Immediately advise ATC of descent, review driftdown charts, if applicable, and determine MEA.

Start Switches .... FLT

Pack Switches .... HIGH

Wing & Engine Anti-Ice .... ON

Increasing bleed air extraction improves engine stall margin.

APU (If Available) .... START

EGT .... MONITOR

If engine has flamed out, stalled, or EGT increases beyond limit, accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist or the **TWO ENGINE FLAMEOUT** checklist as required. Engine may be restarted if needed for safety of flight.

If engine fails to start, repeated attempts should be made immediately. Successful start may not be possible until clear of volcanic dust cloud and airspeed and altitude are within the normal relight area.

Engines are slow to accelerate at high altitudes. This should not be interpreted as failure to start.

When clear of volcanic dust and engine(s) are restarted, continue normal operation and make a detailed Maintenance log report.

* * * *

2.1 – AIRPLANE GENERAL

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AIRPLANE GENERAL

DOORS

A **DOORS** light illuminated on the forward system annunciator panel indicates an exterior door is not properly latched.

ENTRY / SERVICE / 7 8 9 OVERWING DOOR

Handle (Affected Door) .... CHECK CLOSED

WARNING: If the 7 8 9 automatic opening overwing hatch has opened in-flight do not attempt to close.

Check door handle, and position to CLOSE if necessary.

IF The Door Handle Will Not Close And/Or Cabin Pressurization Is Not Normal:

Land At Nearest Suitable Airport.

* * * *

OR

IF The Door Handle Is In The CLOSED Position And Cabin Pressurization Is Normal:

Proceed Normally.

* * * *

EQUIP / FWD CARGO / AFT CARGO DOOR

IF Pressurization Is Normal:

Proceed normally. If the door is open, the pressurization will not be normal.

OR

* * * *

IF Pressurization Is Not Normal:

This procedure is to be used with a light illuminated AND pressurization not normal.

Oxygen Masks and Regulators (If Required)................ON, 100%

Don oxygen masks at cabin altitudes in excess of 10,000 feet.

Crew Communications..ESTABLISH

Press crew interphone receiver down and set volume arrow at 12 o'clock or greater. Set MASK/BOOM selector to MASK. Use I/C toggle on audio selector panel or bottom position on Yoke Rocker switch when speaking to other pilot.

No Smoking and Fasten Belts Switches...................................... ON

Descend to 10,000 feet or MEA, whichever is higher.

Pressurization Mode Selector (If Installed)............................STBY

Cabin Altitude Selector (If Installed)......................... 10,000 FEET

Cabin Rate Selector (If Installed)..............................AS DESIRED

IF MEA Is Above 10,000 Feet:

Pressurization Mode Selector .... MAN DC / MAN

Adjust outflow valve to increase cabin altitude to MEA.

Passenger Oxygen (If Required) .... ON

Activate passenger oxygen if cabin altitude exceeds 14,000 feet.

Land At Nearest Suitable Airport.

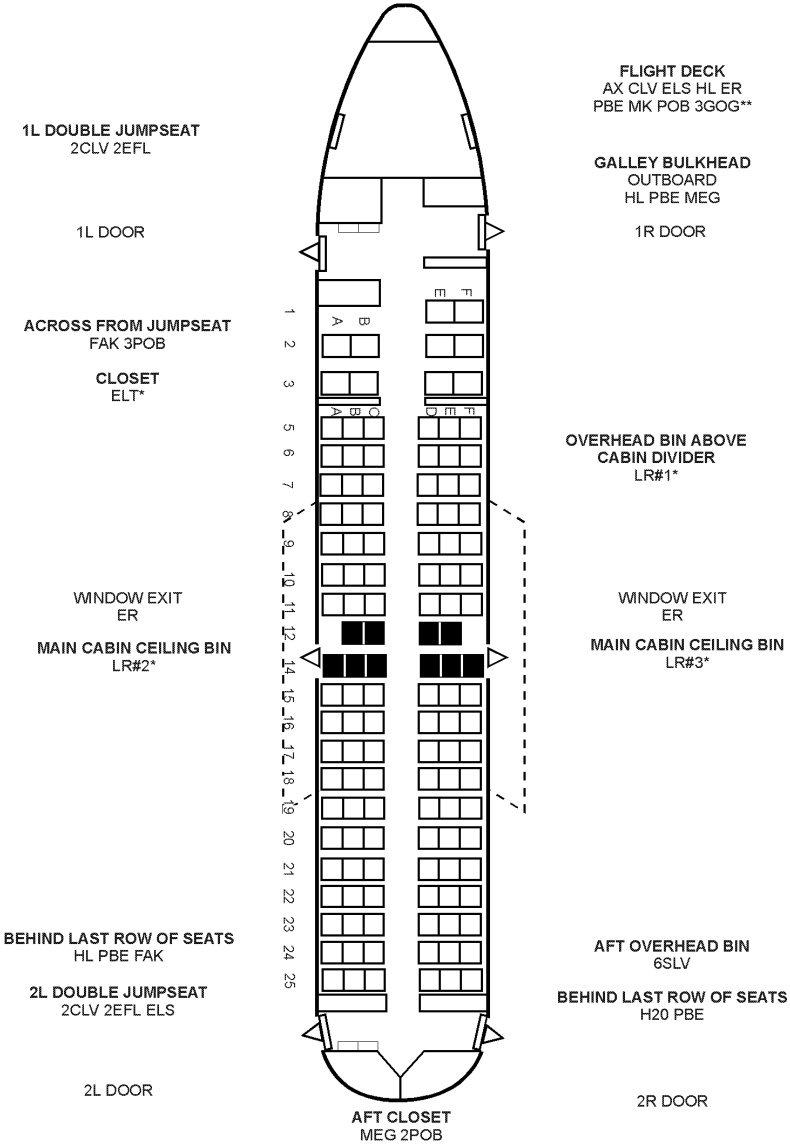
* * * *

EMERGENCY EQUIPMENT

EMERGENCY EQUIPMENT ABBREVIATIONS

AX	Axe	HL	Halon Fire Extinguisher
CLV	Crew Life Vest	LR	Life Raft
EFL	Emergency Flash Light	MEG	Megaphone
ELS	Emergency Light Switch	MK	Medical Kit
ER	Escape Rope	PBE	Protective Breathing Equipment
FAK	First Aid Kit	POB	Portable Oxygen Bottle
GOG	Smoke Goggles	RT	Radio Transmitter
H20	Water Fire Extinguisher	SLV	Spare Life Vest

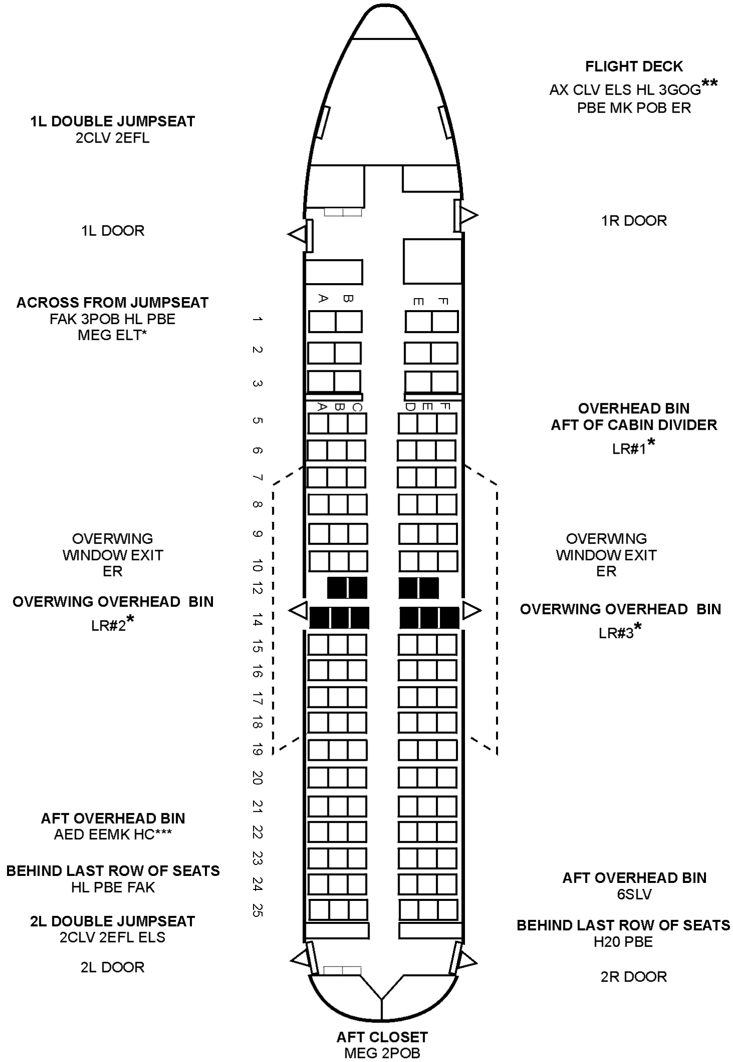
EMERGENCY EQUIPMENT LOCATIONS



* Life Rafts and ELT On Overwater Equipped Aircraft Only.
** On Some Aircraft 4 Smoke Goggles Are Installed.

2560DD10047
737-300-301-358

737-300 EMERGENCY EQUIPMENT LOCATION
(10 / 118 Configuration Aircraft 301 – 358)



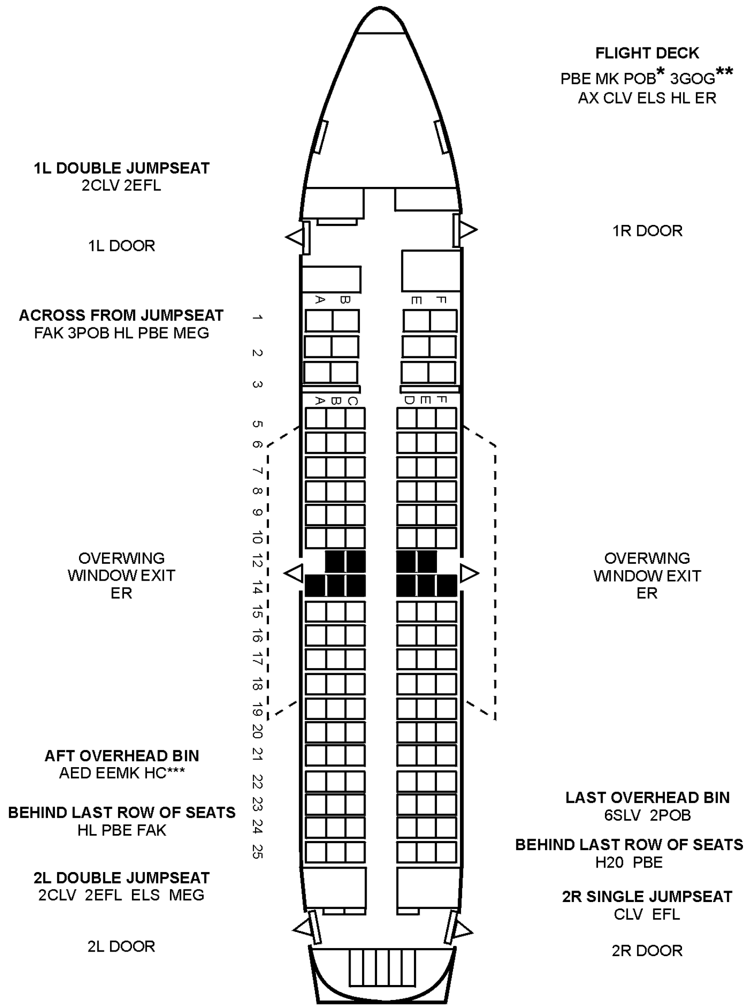
* Life Rafts and ELT on overwater equipped aircraft only.

** On some aircraft 4 smoke goggles are installed.

*** HC not required for flight.

2560DD10860
737-300 A/C 301-358

737-300 EMERGENCY EQUIPMENT LOCATION
(12 / 112 Configuration Aircraft 301 – 358)



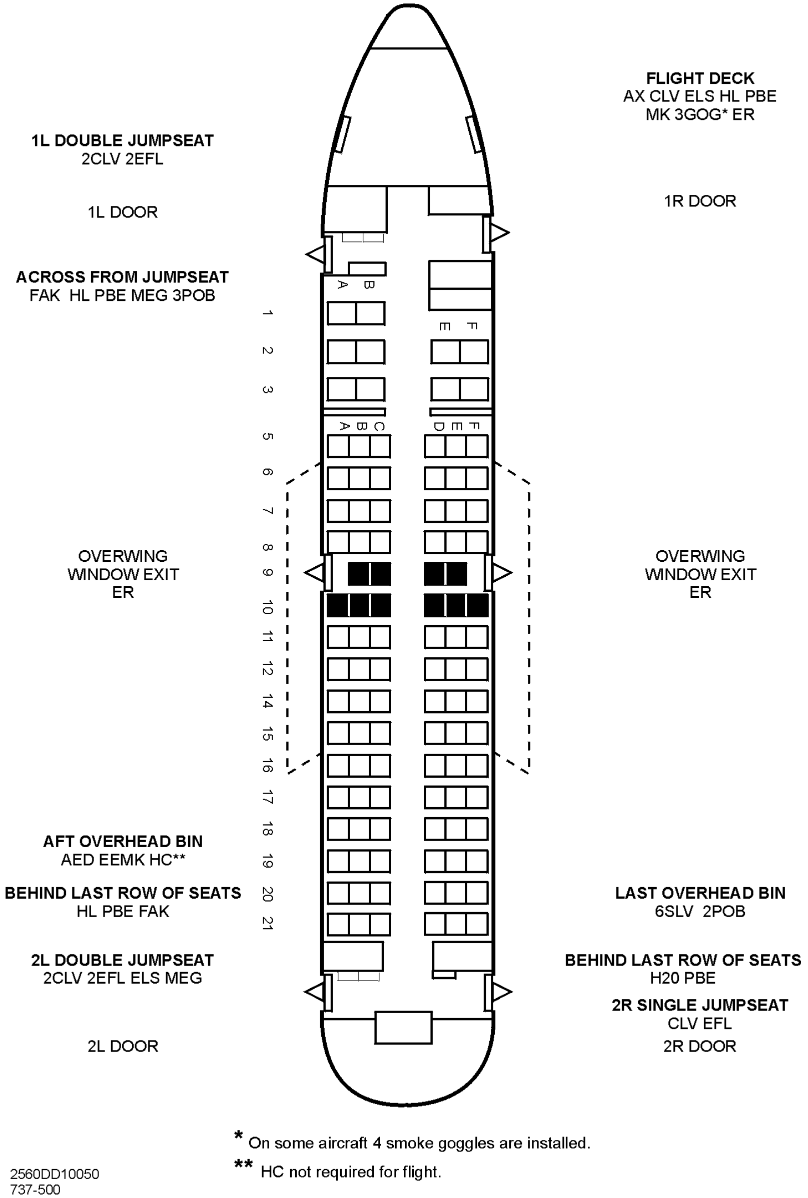
* POB Is not required due to the presence of a PBE in the flightdeck.

** On some aircraft 4 smoke goggles are installed.

*** HC not required for flight.

2560DD10861
737-300 A/C 380-386

737-300 EMERGENCY EQUIPMENT LOCATION
(12 / 112 Configuration Aircraft 380 – 386)



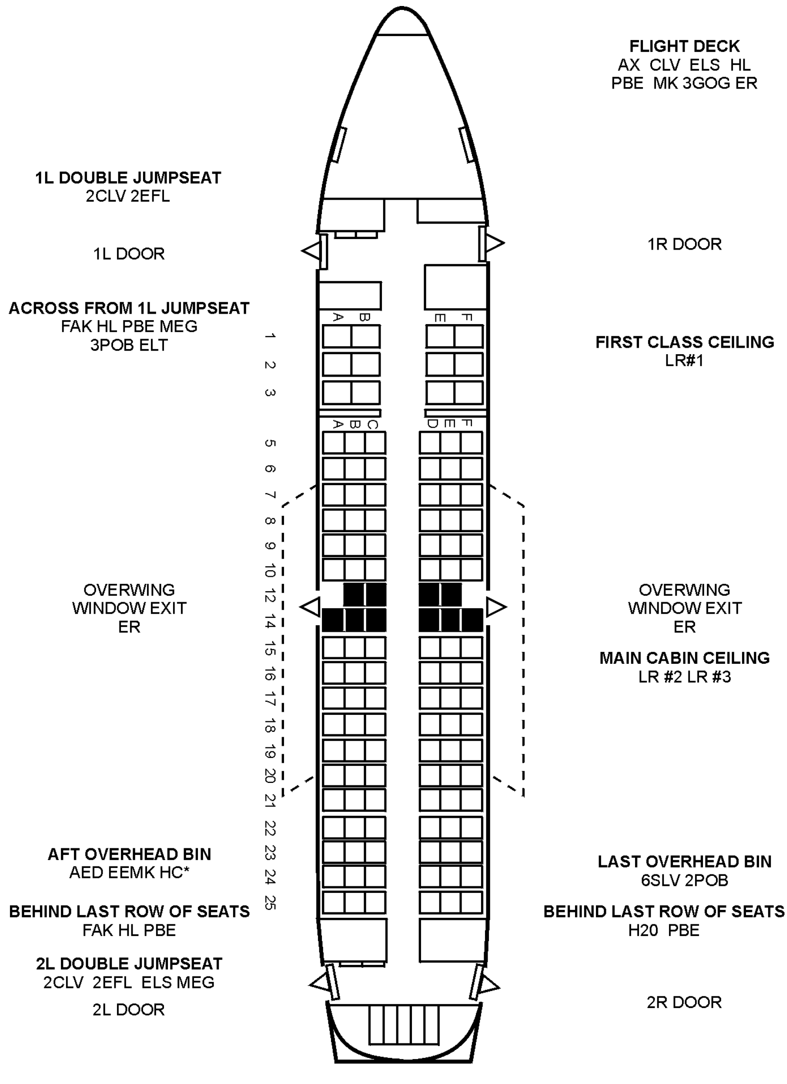
* On some aircraft 4 smoke goggles are installed.

** HC not required for flight.

2560DD10050
737-500

737-500 EMERGENCY EQUIPMENT LOCATION

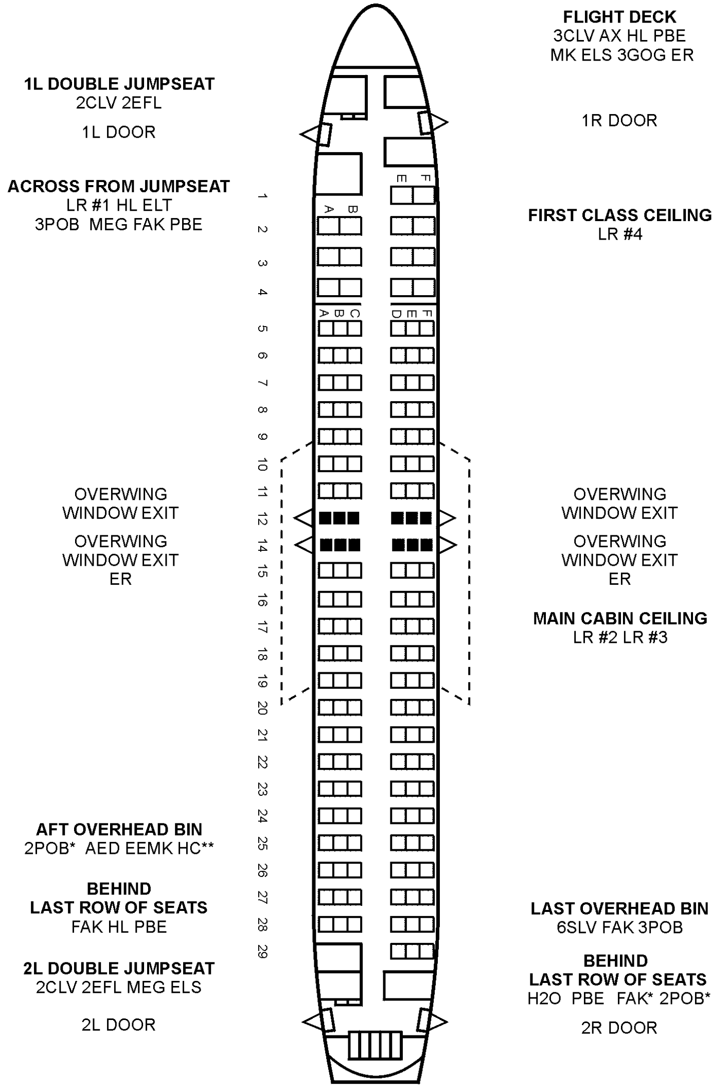
10 / 94 Configuration



* HC not required for flight.

2560DD10697
737-700

737-700 EMERGENCY EQUIPMENT LOCATION
12 / 112 Configuration



2520DD10743
737-800

* Aircraft scheduled to fly pacific routes have one additional FAK and four additional POBs that exceed the minimum equipment list for the aircraft type. This additional equipment is provisioned in the event that a downline station is unable to replace a used one.

** HC not required for flight.

737-800 EMERGENCY EQUIPMENT LOCATION
(14 / 141 Configuration Aircraft 201 – 259)

FLIGHT DECK
3CLV AX HL PBE
MK ELS GOG** ER

1L DOUBLE JUMPSEAT
2CLV 2EFL

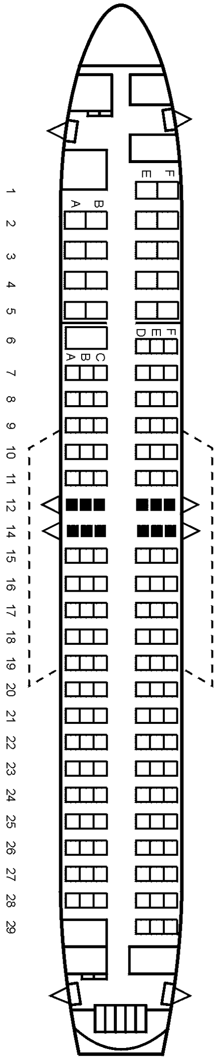
1L DOOR

1R DOOR

ACROSS FROM JUMPSEAT
LR #1 HL ELT
3POB MEG FAK PBE

FIRST CLASS CEILING
LR #4

BEHIND LAST ROW OF FIRST CLASS
H2O PBE



OVERWING
WINDOW EXIT

OVERWING
WINDOW EXIT
ER

OVERWING
WINDOW EXIT

OVERWING
WINDOW EXIT
ER

MAIN CABIN CEILING
LR #2 LR #3

AFT OVERHEAD BIN
2POB* AED EEMK HC***

BEHIND LAST ROW OF SEATS
FAK HL PBE

LAST OVERHEAD BIN
6SLV FAK 3POB

2L DOUBLE JUMPSEAT
2CLV 2EFL MEG ELS

BEHIND LAST ROW OF SEATS
H2O PBE FAK* 2POB*

2L DOOR

2R DOOR

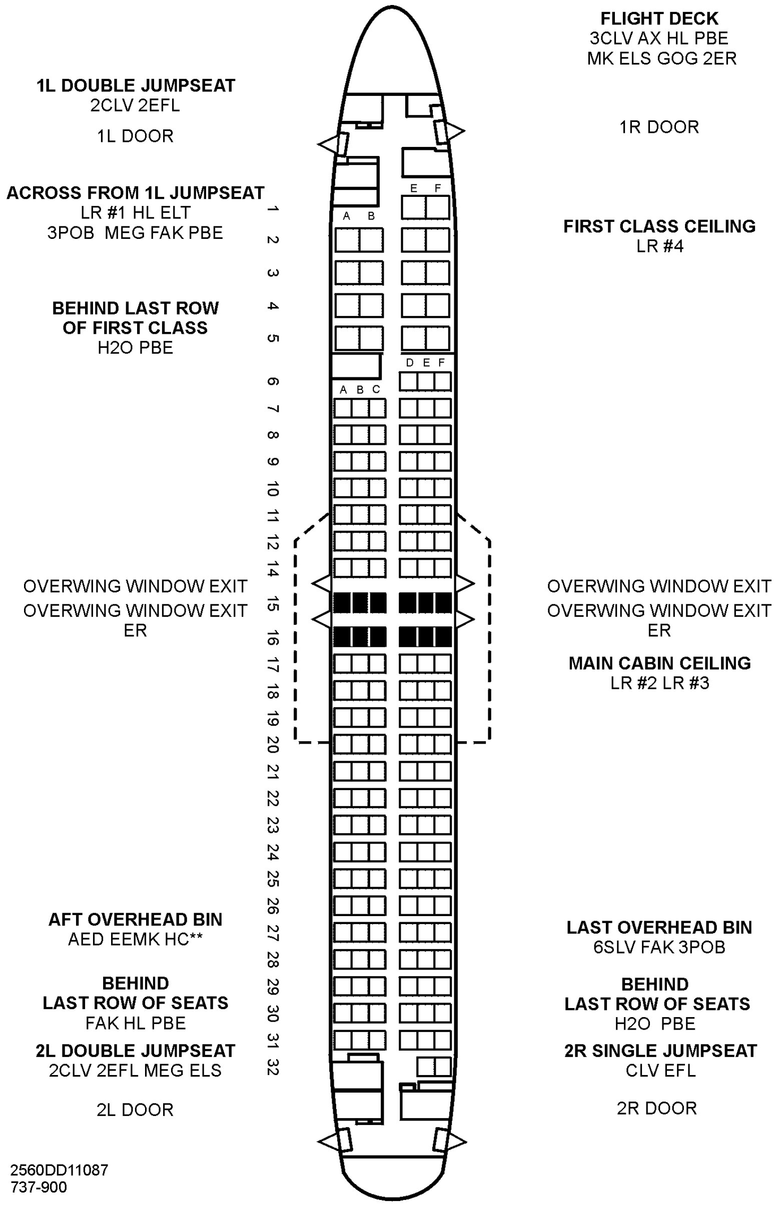
* Aircraft scheduled to fly Pacific routes have one additional FAK and four additional POBs that exceed the minimum equipment list for the aircraft type. The additional equipment is provisioned in the event that a downline station is unable to replace a used one.

2520DD10742
737-800

** Aircraft not equipped with full face masks will have three smoke goggles in the flight deck.

*** HC not required for flight.

737-800 EMERGENCY EQUIPMENT LOCATION
(18 / 132 Configuration Aircraft 260 – 272)



* HC not required for flight.

737-900 EMERGENCY EQUIPMENT LOCATION

18 / 149 Configuration

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FLIGHT DECK DOOR EMRG ENTRY ACTIVE

Condition: The **FLIGHT DECK DOOR EMERGENCY ENTRANCE** system has been activated for emergency flight deck access, or there is a ***significant security incident*** in the cabin.

IMMEDIATE ACTION

Flight Deck Door HARD LOCK Switch ....PUSH

This locks the door for 30 minutes. The 30-minute timer may be reset at any point by pushing the HARD LOCK switch again. Immediately contact the cabin and use the door viewing port to determine the nature of the incident. If communications with the cabin are not possible and the flight crew is unable to determine the severity of the incident, it will be considered a ***LEVEL 4 SECURITY INCIDENT***.

If the HARD LOCK mode is not engaged, it presumes that all pilots are incapacitated, and after 30-seconds the alert warning will stop and the door will be unlocked for ***only 5 seconds*** to allow opening. If the door is not opened during this time, it will relock and the process will have to be repeated.

* * * *

FLIGHT DECK DOOR UNLKD

Condition: There is a fault in the door control system, status lights, or lock mechanism and the security of the door is unknown.

Flight Deck Door Mechanical Lock ....ENGAGE

Insert the mechanical lock pin located on the door, into the hole on the latch to mechanically lock the door.

Note: Use of the mechanical lock will not allow the door to be opened by the **FLIGHT DECK DOOR EMERGENCY ENTRANCE** system. A flight attendant, working crewmember, or other authorized ACM / jumpseat rider must remain on the flight deck to engage / disengage the mechanical lock anytime there is only one pilot on the flight deck. This is to ensure access to the flight deck in the event the one pilot becomes incapacitated.

HARD LOCK Switch .... PUSH

If the **UNLKD** light and **FLIGHT DECK DOOR** lights are illuminated (*indicating a system fault*), pushing the HARD LOCK switch will:

- extinguish the **UNLKD** light
- extinguish the **FLIGHT DECK DOOR** light
- *not* engage HARD LOCK mode
- *not* illuminate **HARD LOCK** light
- *not* ensure the door is locked

* * * *

2.2 – AIR SYSTEMS

TABLE OF CONTENTS

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AIR SYSTEMS

AIR CONDITIONING SMOKE / FUMES

Air conditioning smoke / fumes can be detected by material entering the passenger cabin and/or flight deck from the air conditioning system.

Oxygen Masks & Regulators
(Goggles If Required).. ON; 100%

The 100 % OXYGEN position must be used to prevent the inhalation of smoke or fumes. If smoke concentration affects vision, don goggles and use the EMERGENCY position on the oxygen regulator and open the mask valve to clear the goggle of smoke.

Crew Communications..ESTABLISH

Press crew interphone receiver down and set volume arrow at 12 o'clock or greater. Set mask / boom selector to MASK. Use I/C toggle on audio selector panel or bottom position on YOKE ROCKER switch when speaking to other pilot.

Recirculation Fan Switch(s).. OFF

To eliminate possible source of smoke.

IF Smoke Stops:

Continue flight with the recirculation fan switch(s) OFF.

OR

* * * *

IF Smoke Continues:

Isolation Valve Switch... CLOSE

Prevents the isolation valve from opening in the following procedural step.

R Pack Switch .... OFF

Eliminates Engine No. 2 bleed air and the right pack as a possible source of air conditioning smoke.

(Continued)

IF Smoke Stops:

Continue flight with the right pack switch OFF and isolation valve switch in the CLOSE position.

OR

* * * *

IF Smoke Continues:

R Pack Switch ....**AUTO**

L Pack Switch .... **OFF**

Eliminates Engine No. 1 bleed air and the left pack as a possible source of air conditioning smoke.

IF Smoke Stops:

Continue flight with the left pack switch OFF and the isolation valve switch in the CLOSE position.

OR

* * * *

IF Smoke Continues:

L Pack Switch ....**AUTO**

Land At Nearest Suitable Airport.

Accomplish the **SMOKE / FUMES REMOVAL** checklist in FIRE PROTECTION section, if required.

* * * *

AUTO FAIL OR UNSCHEDULED PRESSURIZATION CHANGE

IF 7 8 9 A **DISPLAYS CONTROL PANEL** annunciation is displayed on the captain's altimeter. This indicates a failure of the Captain's EFIS control panel. All barometric corrections to the **AUTO** and **ALTN** pressurization controllers are lost.

7 8 9 **Displays Control Panel Select Switch (On Overhead Panel) .... BOTH ON 2**

Verify **DISPLAYS CONTROL PANEL** annunciation and **ALTN** flag extinguish, and altimeter reappears.

* * * *

OR

IF The **AUTO FAIL** light has illuminated, it indicates the automatic mode has failed. Illumination of the **STANDBY / ALTN** light indicates the pressurization system has automatically changed to the standby/alternate mode.

An unscheduled pressurization change is indicated by inappropriate change in cabin altitude.

Increasing thrust may insure adequate air supply to control cabin altitude.

③ 3 5 **Pressurization Mode Selector .... STBY/ALTN**

Refer to the **STANDBY / ALTN OPERATION** checklist.

7 8 9 **Pressurization Mode Selector .... ALTN**

The **AUTO FAIL** light extinguishes. Set cabin altitude using cabin/flight altitude placard, before descent set landing field elevation minus 200 feet (as required).

IF STBY / ALTN Mode Cannot Maintain Cabin Pressurization:

Pressurization Mode Selector .... MAN DC / MAN

Outflow Valve Switch...................................... AS REQUIRED

Operate the outflow valve to maintain proper cabin altitude and cabin rate of change. At traffic pattern altitude, position the outflow valve to full OPEN.

* * * *

AUTOMATIC PRESSURIZATION CONTROL
LANDING AIRPORT ELEVATION ABOVE 6000 FEET

Use this procedure when the landing airport elevation is above 6000 feet to maintain the cabin at a lower altitude for reduced crew and passenger fatigue.

IF Flights Less Than One Hour:

Use Normal Procedures

Note: On very short flights where large changes in cabin altitude are required, it may be necessary to use STANDBY mode (if installed) and increase CABIN RATE to achieve the desired cabin altitude in the time available.

OR

* * * *

IF Flight Is One Hour Or Longer:

Use Normal Procedures except as modified below:

Prior to Takeoff:

LAND ALT and CAB ALT (If Installed) ....SET

Set both LAND ALT and CAB ALT (if installed) to 6000 feet or value indicated by the Cabin / Flight Altitude Placard (whichever is higher).

Prior to Landing:

At initial descent or approximately 30 minutes prior to landing:

LAND ALT Selector ....RESET

Reset LAND ALT to the destination airport elevation.

CAB ALT Selector (If Installed)............................RESET

Reset CAB ALT to the destination airport elevation minus 200 feet.

* * * *

BLEED TRIP DURING NO ENGINE BLEED TAKEOFF

Illumination of the **BLEED TRIP OFF** light during a no engine bleed takeoff occurs because a relief valve built into the pneumatic system to limit duct pressure does not have enough flow capacity to limit pressure in the duct below the overpressure switch activation point. The bleed system can be reset if duct pressure falls below the overpressure point.

Trip Reset Button ....PRESS

System may reset if duct pressure fluctuates to a value below the overpressure switch activation point.

IF **BLEED TRIP OFF** Light Extinguishes:

Proceed normally.

OR

* * * *

IF **BLEED TRIP OFF** Light Remains Illuminated (after 30 sec cooling time):

Accomplish the following at a minimum of 1,500 feet AGL or when obstacle clearance height has been attained and TAT is 38°C (100°F) or below:

Engine Anti-Ice Switch(s) (Affected Side)... ON

Reduces the duct pressure.

Trip Reset Button..PRESS

The system will reset if the duct overpressure reduced below the overpressure point.

Cabin Pressurization System......................................RECONFIGURE

Reset the cabin pressure system to a normal engine bleeds on configuration.

Engine Anti-Ice Switch(s)...AS REQUIRED

Turn engine anti-ice switch(s) off unless in visible moisture and TAT is 10°C or below.

IF **BLEED TRIP OFF** Light Remains Illuminated And Wing Anti-Ice Is Required:

Pack Switch (Affected Side).. OFF

The pack switch is used to open the isolation valve. Two pack operation with one engine bleed is not recommended.

* * * *

BLEED TRIP OFF

The **BLEED TRIP OFF** light illuminated indicates that the engine bleed air temperature or pressure is excessive and the bleed air valve has closed automatically. Loss of bleed air causes the respective pack valve to close and the mix valves to drive to full cold.

Trip Reset Button ....PRESS

The system may be reset when the bleed air has cooled. The **BLEED TRIP OFF** light extinguishes if bleed air temperature has cooled below limits. Allow cooling period of 30 seconds.

Note: At high thrust levels, light may not reset. When altitude and airspeed permit, a reduction in thrust may allow a reset.

IF **BLEED TRIP OFF** Light Extinguishes:

Proceed normally.

OR

* * * *

IF **BLEED TRIP OFF** Light Remains Illuminated:

Pack Switch (Affected Side) .... OFF

Two pack operation with one engine bleed is not recommended.

* * * *

CABIN ALTITUDE WARNING OR RAPID DECOMPRESSION / EMERGENCY DESCENT

The cabin altitude warning horn alerts the crew when the cabin altitude exceeds 10,000 feet. A rapid loss of cabin pressure, or control of pressurization, at flight altitudes above 14,000 feet MSL can quickly lead to a situation requiring an immediate descent to a safe cabin altitude. Such pressurization problems are evidenced by the cabin rate of climb and altitude indicators, and prolonged ear distress.

IMMEDIATE ACTION

Oxygen Masks & Regulators..ON, 100%

Crew Communications ....ESTABLISH

No Smoke & Seat Belt Signs ....ON

Note: When using a boom microphone, it may be necessary to use the flight deck speaker and properly set audio panel switches to establish crew communications. Press crew interphone receiver down and set volume arrow at 12 o'clock or greater. Set MASK/BOOM selector to MASK. Use I/C toggle on audio selector panel or bottom position on YOKE ROCKER switch when speaking to other pilot.

Note: The PM should accomplish or verify that the secondary action items are completed. The PM does not need to challenge an item aloud unless it is not accomplished or cannot be visually verified that the item is completed. This is done to reduce the adverse effects of communications with oxygen masks on.

IF Cabin Altitude Is Above 10,000 Feet But Below 14,000 Feet:

L & R Engine Bleed Air Switches..ON

L & R Pack Switches..HIGH

Pressurization Mode Selector..MAN DC / MAN

Outflow Valve Switch..CLOSE

OR

Note: If pressurization is restored, continue manual operation. If cabin altitude is controllable, evaluate alternative options for continuation of the flight to destination, diversion, or alternate airport.

(Continued)

Operate outflow valve to maintain proper cabin altitude and cabin rate of change.

Note: If cabin altitude cannot be controlled, refer to cabin altitude AT OR ABOVE 14,000 FEET procedure below.

* * * *

IF Cabin Altitude Is At Or Above 14,000 Feet:

Determine Structural Integrity.

Note: It may be difficult, or impossible, to accurately determine the structural condition of the aircraft. If structural integrity is unknown or confirmed to be compromised (i.e. cargo door light, explosion, cabin door/window failure), serious consideration should be given to an emergency descent profile which would not increase the stress on the aircraft. Such a descent would be at or below the existing airspeed. Use of speed brakes would be at the discretion of the Captain. Use of LVL CHG would allow control of A/S during descent. Engage MACH/SPEED CHANGEOVER button to SPEED.

Note: High speed descent profile assumes structural integrity and smooth air. Do not assume structural integrity unless it can be positively assured from the flight deck. The cabin crew will be advised on the PA system of impending rapid descent.

7 8 Per Airworthiness Directives 2001-12-51 and 2002-08-52, "Do not operate the airplane at speeds in excess of 300 KIAS with speedbrakes extended.

WARNING: Use of speedbrakes at speeds in excess of 320 KIAS could result in a severe vibration which, in turn, could cause extreme damage to the horizontal stabilizer."

Note: Under the Captains Emergency Authority and after careful consideration, speedbrake deployment above 300 KIAS may be accomplished for emergency descent.

ATC ....ADVISE

The PM will advise ATC of the emergency and the beginning of the emergency descent. Due to the nature of this emergency, it is not necessary to delay the execution of the descent until receiving a clearance from ATC. However, it is imperative that ATC be able to direct other aircraft away from the airspace needed for this emergency.

(Continued)

Emergency Descent ....ACCOMPLISH

With the cabin altitude above 14,000 feet, initiate an emergency descent.

Normally, the descent is initiated straight ahead. If the Autopilot is engaged, descent may be initiated by selecting a lower altitude in the altitude select window of the MCP, and engaging LVL CHG. Ensure that the Autothrottle retards the throttles. If not, disengage and manually retard to idle. The target speed, if structural integrity can be confirmed, will be V_{MO}/M_{MO}.

Start Switches... FLT

Provides ignition from both sets of igniters for maximum protection in the event of icing, severe precipitation, or turbulence.

Throttles ....CLOSED
Speed brake... FLIGHT DETENT
Target Speed (High Speed Profile)....................................... V_{MO}/M_{MO}

Passenger Oxygen Masks.................................... CHECK DEPLOYED

If the **PASS OXY ON** light is not illuminated, move the switch to ON.

Transponder (If Not In Contact With ATC)...................................7700

Pressurization ....ATTEMPT TO CONTROL MANUALLY

L & R Pack Switches .... HIGH
Pressurization Mode Selector ....MAN DC / MAN
Outflow Valve Switch...CLOSE

Note: If pressurization is restored, continue manual operation. Emergency descent may be terminated if cabin altitude is controllable, and alternative options for continuation of the flight to destination, diversion, or alternate airport can be reviewed.

Operate outflow valve to maintain proper cabin altitude and cabin rate of change.

Altimeters ....SET

(Continued)

Level Off Altitude...........10,000 FEET CABIN ALTITUDE OR MEA (WHICHEVER HIGHER)

Once the aircraft has safely descended to 10,000 feet cabin altitude or MEA (whichever higher), further descent to at or below 10,000 feet should be considered if weather, terrain, and fuel permit. Communication capabilities may be significantly enhanced if and when the flight crew can remove oxygen masks.

- - - - - AFTER LEVEL OFF - - - - -

Speed brake...DOWN DETENT

Crew Oxygen Masks & Regulators ....(AS REQUIRED)

Flight crew must use oxygen when cabin altitude is above 10,000 feet. To conserve oxygen, position NORMAL/100% selector to NORMAL.

Start Switches ....(AS REQUIRED)

Select OFF, CONT, or FLT as flight conditions dictate.

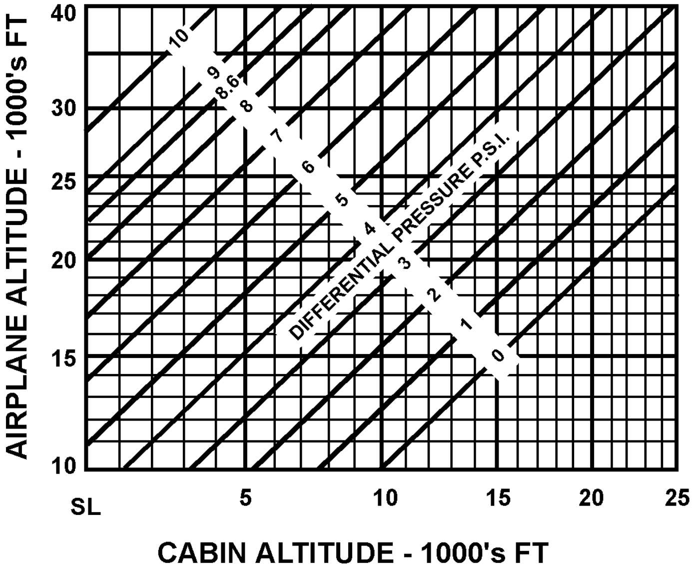
Passenger Address .... ADVISE F/A's OF SITUATION

The new course of action is based on weather, oxygen, fuel remaining, and available airports. Use of long range cruise may be appropriate.

Refer to IN RANGE checklist when appropriate.

* * * *

③③⑤ CABIN DIFFERENTIAL PRESSURE CHART



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* * * *

DUAL BLEED LIGHT

The **DUAL BLEED** light illuminated indicates the APU bleed valve is open and either:

No. 1 engine bleed switch is ON, or

No. 2 engine bleed switch is ON and the isolation valve is OPEN.

Limit engine thrust to idle while light is illuminated. Reposition switches to extinguish light. The **DUAL BLEED** light illuminated is normal for starting.

After Engine Start:

APU Bleed Air Switch .... OFF

* * * *

3 3 5 7 DUCT OVERHEAT

The **DUCT OVERHEAT** light illuminated indicates that supply duct temperature has exceeded limits. The mix valve automatically moves to full cold.

Temperature Selector......................................COOLER TEMPERATURE

Selecting a cooler temperature prevents the mixing valve from programming back to an overheat condition.

Trip Reset Button ....PRESS

The system may be reset as soon as the duct cools. The air mix valve programs to the new selected temperature, and the **DUCT OVERHEAT** light extinguishes if the duct temperature has cooled below limits. Allow approximately 2 minutes for temperature to cool.

IF **DUCT OVERHEAT** Light Extinguishes:

Proceed normally.

OR

* * * *

IF Duct Temperature Increases Rapidly Or The Mix Valve Indicator Moves Toward Full Hot:

Temperature Selector..MANUAL

Adjust the air mix valve position as required.

* * * *

EMERGENCY DESCENT PROCEDURE

This maneuver is desired to bring the aircraft down smoothly to a safe cabin altitude in the minimum time with the least possible passenger discomfort. It is intended as a specialized case to cover an uncontrollable loss of cabin pressurization. When it is used for other than pressurization problems or contamination of cabin atmosphere, the oxygen procedures may be omitted.

Don oxygen masks and establish crew communication at the first indication of a loss of cabin pressurization. Verify that cabin pressure is uncontrollable and attempt to determine if there is structural damage. If structural damage is confirmed or suspected, limit airspeed in the descent to current speed or less. If conditions permit, the cabin crew will be advised, on the PA system, of impending rapid descent.

All immediate action items are to be accomplished by memory. Either pilot will call out any items not completed. Perform the entry procedure deliberately and methodically. Do not be distracted from flying the aircraft.

Emergency descent will be made with the landing gear up. The autopilot may be used if desired.

7 8 Per Airworthiness Directives 2001-12-51 and 2002-08-52, “Do not operate the airplane at speeds in excess of 300 KIAS with speedbrakes extended.

WARNING: Use of speedbrakes at speeds in excess of 320 KIAS could result in a severe vibration which, in turn, could cause extreme damage to the horizontal stabilizer.”

Note: Under the Captains Emergency Authority and after careful consideration, speedbrake deployment above 300 KIAS may be accomplished for emergency descent.

Manual Flight

To manually fly the maneuver, disconnect the autothrottles and retard thrust levers to idle. Extend speed brakes, disconnect the autopilot, and smoothly adjust the pitch attitude, (approximately 10 degrees nose down). About 10 knots before reaching target speed (V_{MO}/M_{MO}), smoothly adjust the pitch attitude to maintain target speed. Keep the aircraft in trim at all times. If V_{MO}/M_{MO} is inadvertently exceeded, change pitch smoothly to decrease speed.

Approaching level off altitude, smoothly adjust pitch attitude to reduce rate of descent. The speed brake lever should be returned to the down detent when approaching the desired level off altitude. After reaching level flight, add thrust to maintain long range cruise or other desired speed.

Use Of The Autopilot

The autopilot may be left engaged and used to accomplish the descent. If the autopilot is used for descent, HDG SEL may be used if desired to effect a turn during the entry. A turn is not required, but is optional.

Combinations of the pitch modes may be used.

Level Change

LVL CHG mode may be used for the entire procedure; however, entry rates are slower. As in the V/S mode entry, the altitude selector must be set to the lower altitude, and then LVL CHG can be engaged. Next, set the command speed bug to V_{MO}/M_{MO} and extend speed brakes. The AFCS will smoothly pitch the aircraft down to capture the target speed while the thrust levers retard to idle for maximum descent rate. Ensure proper altitude is set in the altitude window. When approaching the altitude set in the altitude select window, ALT ACQ will engage automatically. The pitch mode will then control altitude and the thrust levers will increase to hold speed which should be set as desired on the command speed bug. Smoothly return the speed brakes lever to the down detent during the level off maneuver.

Vertical Speed Mode

V/S can be used by selecting an altitude lower than current altitude and selecting maximum rate of descent on the V/S wheel (-7900). Raise the speed brakes and ensure thrust levers retard to idle. Airspeed will increase above cursor speed during the descent. Select LVL CHG prior to increasing cursor speed to preclude autothrottle movement. After LVL CHG is engaged, the airspeed cursor may be increased to V_{MO}/M_{MO} or slightly less. If the autothrottles were disconnected, they may be rearmed at this time.

Check that the altitude selector is properly set for the planned level off altitude.

The ALT ACQ mode should automatically engage and command a smooth level off if the altitude select window has been present during the descent. During the level off maneuver, set the target speed bug as desired and smoothly return the speed brake lever to the down detent.

Control Wheel Steering

CWS may be used to reduce pilot workload and allow the Captain to divert more of his attention away from basic aircraft control. Follow the manually flown procedure but instead of disengaging the autopilot, engage CWS by pushing forward on the yoke.

During Descent

The Pilot Monitoring will check minimum enroute altitude, notify ATC, obtain altimeter setting, and call out altitudes approaching level off. If not in contact with ATC, squawk 7700. Level off at 10,000 feet cabin altitude or minimum enroute altitude whichever is higher. The Pilot Monitoring will call out 2,000 feet above and 1,000 feet above level off altitude.

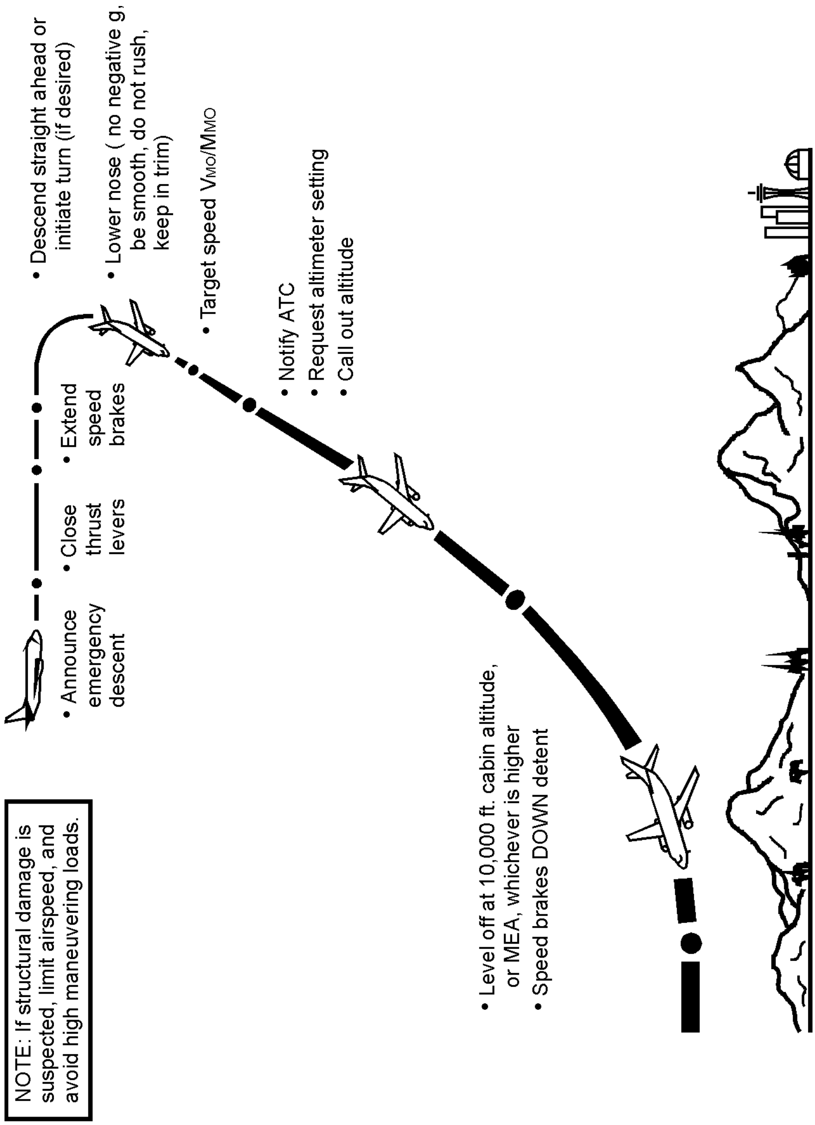
When turbulent air is encountered or expected, reduce to turbulent air penetration speed (280 IAS or .73 Mach 3 3 5 / .76 Mach 7 8 9 whichever is lower).

If descending into icing conditions, use engine and wing anti-ice and thrust as required.

If structural integrity is in doubt, limit speed as much as possible, preferably at or below the existing speed, and avoid high maneuvering loads.

After Level Off

Recheck pressurization system and evaluate the situation. Do not remove the crew oxygen masks if cabin altitude remains above 10,000 feet. Determine new course of action based on weather, oxygen, fuel remaining and available airports, and obtain new ATC clearance.



EMERDES

EMERGENCY DESCENT
<u>Structural Integrity Satisfactory</u>

EQUIPMENT COOLING OFF

③ The **EQUIPMENT COOLING OFF** light illuminated indicates a loss of airflow in the equipment cooling system.

Equipment Cooling Switch .... ALTERNATE

3 5 7 8 9 The **EQUIPMENT COOLING SUPPLY** or **EXHAUST OFF** light illuminated indicates a loss of airflow from the selected cooling fan.

Equipment Cooling Supply / Exhaust Switch (As Req.) ...... ALTERNATE

> Establish a new source of equipment cooling airflow. The light should extinguish within approximately 5 seconds.

No further action is necessary in flight if the **EQUIPMENT COOLING OFF** light does not extinguish.

* * * *

MANUAL MODE OPERATION

This mode is required if the cabin altitude, rate of climb, and differential pressure do not respond to the standby / alternate mode inputs to the pressurization controller. The **AUTO FAIL** and/or **STANDBY / ALTN** lights may be illuminated.

Caution: Switch actuation in manual will cause an immediate response of the outflow valve. Momentary actuation, (toggling) of manual switch should be employed.

Pressurization Mode Selector .... MAN DC / MAN

Check **MANUAL** light illuminated.

Selection of MAN DC will provide slower valve position changes.

Cabin / Flight Altitude Placard .... CHECK

Determine the desired cabin altitude.

IF A Higher Cabin Altitude is Desired:

Outflow Valve Switch (Momentarily)... OPEN

Check the outflow valve position indicator moves right, cabin altitude climbs at the desired rate, and differential pressure decreases. Repeat as necessary.

IF A Lower Cabin Altitude is Desired:

Outflow Valve Switch (Momentarily)...CLOSE

Check the outflow valve position indicator moves left, cabin altitude descends at the desired rate, and differential pressure increases. Repeat as necessary.

During Descent

Throttle changes should be made as slowly as possible to prevent excessive pressure bumps.

Outflow Valve Switch (Momentarily)..CLOSE

During descent, intermittently position the OUTFLOW VALVE switch toward CLOSE, observing cabin altitude decrease as the aircraft descends.

Before entering the landing pattern, slowly position the outflow valve switch to full OPEN, depressurizing the aircraft, and check that differential pressure is zero.

* * * *

OFF-SCHEDULE DESCENT

The **OFF-SCHEDULE DESCENT** light illuminated indicates that the selected flight altitude has not been reached and the aircraft is descending.

IF Returning To Departure Airport:

No action is necessary if the aircraft is returning to the airport of departure for landing.

OR

* * * *

IF Not Landing At Airport Of Departure:

Flight Altitude Indicator .... RESET

Reset to actual aircraft altitude.

Land Altitude Indicator .... (If Required) RESET

* * * *

7 PACK TRIP OFF / 8 9 PACK

Note: A **PACK TRIP OFF** or **PACK** light illuminated indicates the related pack temperature has exceeded limits, **or** both primary and standby pack controls have failed. If a pack light illuminates on recall check, either the primary or the standby control has failed.

If **PACK** light does not extinguish when Master Caution system is reset:

Do Not Takeoff.

All Temperature Selectors.......... SELECT WARMER TEMPERATURE

Reduces the work load on the affected air conditioning pack.

Trip Reset Button ....PRESS

If the **PACK** light illuminated as a result of the pack temperature exceeding limits, the light extinguishes if the pack temperature has cooled below limits. Allow 30 seconds cooling time.

IF The **PACK** Light Extinguishes:

Proceed normally.

OR

* * * *

IF One **PACK** Light Remains Illuminated:

Isolation Valve Switch .... CLOSE

OR

Pack Switch (Affected Side)..OFF

* * * *

IF Both **PACK** Lights Remain Illuminated:

Note: Both pack valves may have closed resulting in a gradual loss of cabin pressure and an eventual CABIN ALTITUDE warning. Monitor cabin altitude during the remainder of the flight.

IF Cabin Altitude Increases:

Descent ....ACCOMPLISH

Monitor cabin altitude and rate. Descend to lowest safe altitude or 10,000 feet, whichever is higher.

(Continued)

At level off:

Airspeed.. 290 KNOTS MINIMUM

290 knots is the minimum airspeed required to maintain appropriate cabin pressure differential with the outflow valve in the full open position.

Pack valves may have failed in full open (hot) position.

Note: Flight deck and cabin temperatures may increase rapidly below 290 knots depending on pack valve position.

Pressurization Mode Selector .... MAN

Outflow Valve Switch .... FULL OPEN

Right Recirculation Fan Switch ....AUTO

Left Recirculation Fan Switch (If Installed).................................... OFF

IF Flight Deck And Cabin Temperatures Are Excessively Warm:

Flight Deck Door ....OPEN

Galley or Cab / Util .... OFF

7 8 9 IFE / Pass Seat (If Installed) .... OFF

In-Flight Entertainment Systems.. OFF

Cabin Lighting ....DIM

Cabin Window Shades...CLOSED

* * * *

③ 3 5 PACK TRIP OFF

The **PACK TRIP OFF** light illuminated indicates the compressor discharge, turbine inlet, or main distribution duct temperature has exceeded limits. This causes the pack valve to close and the mix valve to drive to full cold.

Temperature Selector..AS REQUIRED

Select warmer temperature unless **DUCT OVERHEAT** light is illuminated. If a **DUCT OVERHEAT** light is illuminated, select a cooler temperature.

Trip Reset Button ....PRESS

The system may be reset as soon as the pack cools.

The air mix valve programs to the new selected temperature, and the **PACK TRIP OFF** light extinguishes if the compressor discharge or turbine inlet temperature has cooled below limits. Allow approximately 2 minutes for temperature to cool.

IF **PACK TRIP OFF** Light Extinguishes:

Proceed normally.

OR

* * * *

IF One **PACK TRIP OFF** Does Not Extinguish:

Isolation Valve Switch .... CLOSE

Pack Switch...OFF

* * * *

PASSENGER OXYGEN ON

The **PASS OXY ON** light illuminates to indicate that the passenger oxygen system is activated.

* * * *

STANDBY / ALTN OPERATION

- - - - - BEFORE START - - - - -

Pressurization Mode Selector .... STBY / ALTN

Standby / Altn Light .... ILLUMINATED

Cabin Altitude Selector (If Installed)..SET

Set CAB ALT to takeoff field elevation minus 200 feet.

Cabin Rate Selector (If Installed)... INDEX

Flight Ground Position Switch (If Installed).. GRD

Programs the main outflow valve to full open.

- - - - - AFTER START - - - - -

Air Conditioning Pack Switches .... AUTO

Flight / Ground Position Switch (If Installed)... FLT

This causes the main outflow valve to program toward CLOSE, pressurizing the aircraft to .125 PSI (200 feet below field elevation).

Note: With ALTN the aircraft will pressurize automatically after the engines have recovered 60% N_1 during takeoff roll.

- - - - - AFTER TAKEOFF - - - - -

Cabin Altitude Indicator .... SET / (AS REQUIRED)

Check the placard below the pressurization module for the cabin altitude corresponding to the planned flight altitude. Reset CAB ALT to this altitude.

Cabin Rate Selector (If Installed).. ADJUST

Adjust the cabin rate of climb, if necessary, to maintain the desired climb rate.

- - - - - CRUISE - - - - -

Cabin Altitude Indicator (If Installed) .... RESET

Reset CAB ALT using the placard for flight altitude changes greater than 1000 feet.

(Continued)

- - - - - BEFORE DESCENT - - - - -

Cabin Altitude Indicator (If Installed) ....SET

Set CAB ALT to landing field elevation minus 200 feet.

- - - - - DESCENT - - - - -

Cabin Rate Selector (If Installed).. ADJUST

Adjust the cabin rate of descent, if necessary, to maintain the desired descent rate.

- - - - - AFTER LANDING - - - - -

Flight/Ground Position Switch (If Installed).. GRD

* * * *

UNPRESSURIZED LANDING PROCEDURE – DIGITAL AND NON-DIGITAL

This procedure is used when:

- APU bleed air is inoperative and,
- Engine bleed air switches are required to be OFF and,
- Pressurization system functions normally.

Note: The items that are referenced with (**If Installed**) are additional items that will be complete for aircraft with non-digital controllers.

- - - - - LANDING - - - - -

When below 10,000 ft:

Set cabin altitude indicator 1,500 ft. above landing field elevation.

Cabin Rate Selector (If Installed)...INDEX

Pressurization Mode Selector (If Installed) ....STBY

When Starting Final Approach:

Engine Bleed Air Switches.. OFF

Avoid high rates of descent for passenger comfort.

* * * *

UNPRESSURIZED TAKEOFF PROCEDURE – DIGITAL AND NON-DIGITAL

- - - - - TAKEOFF - - - - -

This procedure is used when:

- APU bleed air is inoperative and,
- Engine bleed air switches are required to be OFF and,
- Pressurization system functions normally.

Note: The items that are referenced with **(If Installed)** are additional items that will be complete for aircraft with non-digital controllers.

Air Conditioning Pack Switches..BOTH AUTO

Isolation Valve Switch.. CLOSE

Engine Bleed Air Switches ....OFF

Cabin Altitude Selector (If Installed)....................... SET 2000 FT ABOVE FIELD ELEVATION

Cabin Rate Selector (If Installed)..INDEX

Pressurization Mode Selector(If Installed) ....STBY

Flight/Ground Switch (If Installed).. FLT

- - - - - AFTER TAKEOFF - - - - -

At not less than 800 ft. and prior to 2,000 ft. above field elevation:

No. 2 Engine Bleed Air Switch..ON

If engine failure occurs, do not position ENGINE BLEED switches ON until reaching 1,500 ft. or until obstacle clearance height has been attained.

When Cabin Rate of Climb Indicator Stabilizes:

No. 1 Engine Bleed Air Switch..ON

Isolation Valve Switch.. AUTO

Pressurization Mode Selector ....AUTO (AS REQUIRED)

Cabin Altitude Selector (If Installed)....................... SET (AS REQUIRED)

* * * *

WING-BODY OVERHEAT

The **WING-BODY OVERHEAT** light illuminated indicates a bleed air duct leak in the fuselage, engine strut, or wing leading edge.

Isolation Valve Switch ....CLOSE

Prevents the isolation valve from opening in the following procedural step.

Pack Switch (Affected Side).. OFF

Engine Bleed Air Switch (Affected Side).. OFF

IF **WING-BODY OVERHEAT** Light Extinguishes:

Avoid Icing Condition.

* * * *

OR

IF The Left **WING BODY OVERHEAT** Light Remains Illuminated & APU Is Operating:

APU Bleed Air Switch (If APU Running) .... OFF

This stops the flow of air from the APU to the left side of the pneumatic ducting.

Note: If APU is the source of bleed air, place the right engine bleed air switch ON to maintain pressurization.

IF Light Extinguishes:

Avoid Icing Conditions.

* * * *

OR

IF The Light Remains Illuminated:

APU Switch .... OFF

The source of the bleed air leak is in the APU compartment "before" the APU bleed air valve.

DO NOT OPERATE THE APU!

IF The Light Extinguishes:

Left Engine bleed air can be used as a source of pneumatics.

Isolation Valve Switch ....AUTO

Engine Bleed Air Switch (Affected Side) .... ON

Left Pack Switch ....AUTO

* * * *

8 9 ZONE TEMP

A **ZONE TEMP** light illuminated indicates temperature in the related duct has exceeded limits or flight deck temperature control has been lost.

If **ZONE TEMP** light does not extinguish when Master Caution system is reset:

Do Not Takeoff.

Temperature Selector.......................................COOLER TEMPERATURE

Prevents trim air modulating valve from returning to an overheat.

Trip Reset Button ....PRESS

The **ZONE TEMP** light extinguishes if the duct temperature has cooled below limits. Allow a 2 minute cooling period.

IF **ZONE TEMP** Light Extinguishes:

Proceed normally.

OR

* * * *

IF Duct Temperature Increases Rapidly:

Trim Air Switch.. OFF

Shuts off trim air.

* * * *

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2.3 – ANTI-ICE, RAIN

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ANTI-ICE, RAIN

ARCING / DELAMINATED / SHATTERED OR CRACKED WINDOW

This condition is recognized by arcing, substantial delamination, shattering, or cracking of any flight deck window. Window 4 is the only window having a middle glass pane. A failed middle pane usually appears shattered and transparency is virtually lost. Window 3 is not electrically heated.

Window Heat Switch (Affected Window) .... OFF

- Limit maximum airspeed to 250 knots below 10,000 feet.
- Use crew and passenger oxygen, if required.
- A high speed descent should only be initiated if maximum cabin pressure differential for the associated cracked pane cannot be maintained or unless loss of cabin pressurization has occurred. A high speed descent will increase the pressure on L1 and R1 when a load carrying pane has failed. The outer pane is not a structural pane.

The flight crew can feel the cracks on a failed inner pane. If the flight crew has limited obstruction to vision, then the outer pain is cracked. If transparency is lost and the inner window feels smooth, then the middle pain is cracked.

IF Window #1, 2, 4, Or 5 Is Affected:

CRACKED PANE	MAX. DIFF PRESSURE	APPROX. FLT. ALTITUDE
Window 1, 2 or 5:		
Outer	No Restrictions	No Restriction
Inner	5 PSI	26,000 ft
Both	2 PSI	15,000 ft
Window 4:		
Outer	No Restriction	No Restriction
Middle	5 PSI	26,000 ft
Both	2 PSI	15,000 ft

OR

(Continued)

IF There Is A Pressure Restriction:

Cabin Altitude Selector (As Installed)......................10,000 FT

Pressurization Mode Selector (As Installed) ....STBY

Aircraft with the Digital Pressure Controllers:

Land Alt...10,000 FT

Reduce pressure differential by limiting flight altitude as indicated in the table above.

Note: For MEA between 15,000 feet and 20,000 feet, select a higher cabin altitude to maintain 2 PSI differential. Above 20,000 feet, select MAN DC and maintain 2 PSI differential.

* * * *

IF Window #3 Is Affected:

CRACKED PANE	MAX. DIFF PRESSURE	APPROX. FLT. ALTITUDE
Window 3:		
Outer	No Restriction	No Restriction
Inner	No Restriction	No Restriction
Both	0 PSI	3 3 5 14,000 ft 7 8 9 13,000 ft

IF Both Panes Of Window #3 Are Affected:

Cabin Altitude Selector (As Installed)......................13,000 FT

Pressurization Mode Selector (As Installed) ....STBY

Aircraft with the Digital Pressure Controllers:

Land Alt...10,000 FT

Reduce pressure differential by limiting flight altitude as indicated in the table above.

* * * *

ENGINE COWL ANTI-ICE

The engine **COWL ANTI-ICE** light illuminated indicates:

- ③ 3 5 overtemperature or overpressure in the cowl anti-ice duct..
- 7 8 9 overpressure condition in the cowl anti-ice duct.

Flight Conditions Permitting:

Autothrottle (If Engaged)..DISENGAGE

Thrust Lever (Affected Side) ....RETARD

Reduce thrust until the **COWL ANTI-ICE** light extinguishes.

* * * *

ENGINE COWL VALVE OPEN

This condition is recognized by the **COWL VALVE OPEN** light remaining illuminated bright blue in flight. This indicates that the cowl valve is in disagreement with the engine anti-ice switch position.

IF Open Position:

IF Total Air Temperature Is Above 10°C:

Limit thrust of the affected engine to 80% N_1 or less if possible.

* * * *

OR

IF Closed Position:

Avoid icing conditions.

* * * *

3 3 5 PITOT STATIC HEAT / 7 8 9 PROBE HEAT MALFUNCTIONS

The following lights illuminated indicate associated pitot-static malfunctions: Avoid icing conditions. Flight in icing conditions may result in erroneous flight instrument indications.

CAPT P/S, **1 AUX STATIC** Light:

Airspeed and static inputs may be unreliable, affecting the Captain's Mach / airspeed indicator, altimeter, IVSI, and Standby Flight Instruments. The cabin pressurization control, cabin altitude indicator, and cabin differential pressure indicator may be affected.

F/O STATIC, **2 AUX P/S** Light:

Inputs to the flap load limit airspeed switch may be affected.

L or **R ELEV PITOT** Light:

Inputs to the elevator feel computer may be affected resulting in the illumination of the **FEEL DIFF PRESS** light.

L or **R ALPHA VANE** Light:

Angle-of-Attack input to the stall warning system, autothrottle, and/or autopilot may be affected.

TEMP PROBE Light:

Inputs to ADC 1 or ADC 2 may be affected. The TAT indicator may be unreliable.

F/O P/S, **2 AUX STATIC** Light:

Inputs to the First Officer's Mach / Airspeed indicator, altimeter, and IVSI may be unreliable. Alternate static source inputs to ADC 2 are not affected.

CAPT STATIC, **1 AUX P/S** Light:

Inputs to the flap load limit airspeed switch, pressurization control, cabin altitude indicator, and cabin differential pressure indicator may be affected.

* * * *

7 8 9 TAI INDICATION

This condition is recognized by an amber **TAI** indication. This indicates that the cowl valve is in disagreement with the engine anti-ice switch position.

IF Open Position:

IF Total Air Temperature Is Above 10°C:

Limit thrust of the affected engine to 80% N_1 or less if possible.

* * * *

OR

IF Closed Position:

Avoid icing conditions.

* * * *

WINDOW OVERHEAT

The **OVERHEAT** light illuminated indicates that the window heat has automatically been removed from the window.

Window Heat Switch (Affected Window)... OFF

Positioning the WINDOW HEAT switch to OFF extinguishes the **OVERHEAT** light and resets the system.

After 2 to 5 Minutes:

Window Heat Switch.. ON

IF The Window **OVERHEAT** Light Re-Illuminates:

Window Heat Switch.. OFF

Limit airspeed to 250 knots maximum below 10,000 feet.

Windshield Air Controls ....PULL

Vents conditioned air to the inside of the windshield for defogging.

* * * *

WING ANTI-ICE VALVE FAILURE

This condition is recognized by the **L** and/or **R VALVE OPEN** lights illuminated bright blue in flight. This indicates that the left and/or right wing anti-ice valve is in disagreement with the wing anti-ice switch position.

IF Open Position And OAT (ground) – TAT (airborne) Is Above 10°C/50°F And No Visible Moisture:

Isolation Valve Switch..CLOSE

Prevents the isolation valve from opening in the following procedural step.

OR

Pack Switch (Affected Side) .... OFF

Engine Bleed Air Switch (Affected Side) .... OFF

Prevents unwanted wing anti-ice operation.

* * * *

IF Closed Position:

Avoid icing conditions.

* * * *

2.4 – AUTOMATIC FLIGHT

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AUTOMATIC FLIGHT

AUTOPILOT DISENGAGE

Condition: The flashing red A/P light illuminated and the aural tone sounding indicates the autopilot has disengaged.

Fly the aircraft manually or re-engage an autopilot.

AUTOTHROTTLE DISENGAGE

Condition: The flashing red A/T light illuminated indicates the autothrottle has disengaged.

Fly the aircraft manually or re-engage the autothrottle.

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2.5 – COMMUNICATIONS

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COMMUNICATIONS

ACARS ELECTRICAL POWER LOSS

If 115V AC power is lost (DC power normal), the ACARS automatically reverts to VOX MOD(the DATA MODE is inoperative). GMT and memory will continue to function as long as DC power is available.

* * * *

ACARS MU FAIL OR CU FAIL

The ACARS system is inoperative.

Check the AC and DC circuit breakers (③ 3 5 18-2, E 14 & 15) (7 8 9 6-1, E 7 & 9). If the circuit breakers are in, consider the "ACARS" system inoperative and use normal ARINC voice procedures for reporting.

* * * *

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2.6 – ELECTRICAL

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ELECTRICAL

7 8 9 BATTERY DISCHARGE

The **BAT DISCHARGE** light illuminated indicates excessive battery discharge is detected with the battery switch ON.

Note: A fully charged battery provides a minimum of 30 minutes of standby power.

* * * *

3 3 5 BUS OFF

The **BUS OFF** light indicates the respective generator bus is unpowered.

Engine Generator Switch.. ON

IF **BUS OFF** Light Remains Illuminated:

APU (If Available) .... START & ON BUS

Note: If **BUS OFF** light is not associated with Engine Failure or Shutdown, accomplish the CSD High Oil Temperature or CSD Low Oil Pressure checklists, if appropriate.

* * * *

CIRCUIT BREAKER PROCEDURES

WARNING: Resetting of any **tripped** fuel boost pump circuit breaker, fuel quantity indication system circuit breaker, or lavatory flush motor circuit breaker is prohibited.

Caution: The intentional pulling and resetting of a circuit breaker is prohibited due to potential impact on multiple aircraft systems, except when specifically directed by a non-normal checklist or appropriate technical authority.

A circuit breaker found in the **out position** may be the result of:

- **Tripped** condition due to an electrical fault.
- Inadvertent pulling out by contact / catching with an object.
- Intentional pulling during a MX / operational procedure and failure to reset.

A **tripped** CB refers to a circuit breaker that was previously verified to be in the normal closed position, then subsequently pops out due to an electrical fault.

Given the significance of any circuit breaker that is found in the **out position**, the following guidelines should be adhered to in order to address the issue:

Preflight Before Block Out:

A circuit breaker that is found in the **out position** during preflight inspection of cockpit preparation (i.e. the crew does not know whether it has tripped or has been pulled out) may be reset one time, **unless** any of the following conditions are noted:

- There is reason to believe that is has **tripped** due to an electrical fault, or
- The crew heard the CB pop or observed a change in the associated aircraft, system / warning light, which was previously normal but is now unpowered as a result of the CB being out, or
- There is a previous logbook entry about the same CB being **tripped** in the previous 3 calendar days, or
- There is any associated electrical smoke / smell, or evidence of overheating of any aircraft system.

If **any** of the above conditions are noted, *the crew should not reset the CB*, but instead enter the findings in the logbook and call maintenance for investigation prior to departure.

(Continued)

After Block Out and Before Takeoff:

Any CB that is confirmed to have **tripped**, _should not be reset by the crew_. The crew can continue the flight with the CB left in the **tripped** mode, provided the affected system is not required as per the MEL, and all appropriate MEL procedures are complied with. Also there must be no electrical smoke / smell, or evidence of overheating of any aircraft system. In all cases a logbook entry is required.

From Takeoff to Block In:

One reset of a **tripped** circuit breaker may be attempted after a cooling period of approximately two minutes when:

- Called for during a published non-normal checklist or procedure, or
- At the discretion of the Captain, **provided resetting the CB is necessary for the safe completion of the flight**.

Caution: If the circuit breaker trips again, **do not attempt another reset**.

In all cases a logbook entry is required.

Aircraft Logbook Entries:

All **tripped** circuit breakers regardless of phase of flight and whether reset or not, _must be written up in the aircraft logbook_. This entry should include:

1. Time of occurrence (if known) in Z
2. Aircraft parameters when **trip** occurred (phase of flight, altitude / airspeed)
3. Weather conditions if appropriate
4. Name of the CB
5. Location of the CB
6. Any pilot action that occurred prior to or during the **trip** sequence
7. Attempted reset and results
8. 7 8 9 Fault Reporting Manual (FRM) fault codes

Example:

> "At 1408Z, during climbout, 15,000 MSL, 290 KIAS, VMC conditions, the RT PITOT HT CB, location D-18, tripped open. Flight continued and no reset of the CB attempted.
>
> [FRM code 123-123-1] 2"

* * * *

③ 3 5 CSD HIGH OIL TEMPERATURE

Temperature, Frequency, And Voltage .... CHECK

Temperature in caution range or at or above 157°C, check rise temperature 20°C maximum, or voltage and frequency out of limits or erratic.

IF Indications Normal:

Generator .... MONITOR

OR

* * * *

IF Any Indication(s) Abnormal:

Gen Switch .... OFF

Monitor CSD temperature. If the temperature is above 157°C, CSD should be disconnected.

Caution: CSD disconnect inflight is irrevocable.

CSD Switch .... DISCONNECT

Hold CSD disconnect switch for no more than 3 seconds.

APU .... START AND ON BUS

Yaw Damper .... CHECK/ON

* * * *

③ 3 5 CSD LOW OIL PRESSURE

Light illuminated indicates a malfunction in the constant speed drive.

Frequency, Voltage, And Temperature .... CHECK

IF Indications Normal:

Generator .... MONITOR

OR

* * * *

IF Indications Abnormal:

<u>Caution</u>: CSD disconnect inflight is irrevocable.

CSD Switch .... DISCONNECT

Hold CSD disconnect switch for no more than 3 seconds.

APU .... START & ON BUS

Yaw Damper .... CHECK/ON

* * * *

7 8 9 DRIVE

A generator **DRIVE** light illuminated indicates a malfunction in the related generator drive.

Generator Drive Disconnect Switch .... DISCONNECT

Hold in the DISCONNECT position momentarily.

APU (If Available) .... START & ON BUS

* * * *

7 8 9 ELEC

The **ELEC** light illuminated indicates a fault exists in the DC or standby power system.

<u>Note</u>: The **ELEC** light only illuminates on the ground.

* * * *

ELECTRICAL SMOKE / FUMES OR FIRE CHECKLIST

Oxygen Masks & Regulator
(Goggles If Required)..ON, 100%

If smoke / fumes affect vision, use EMERGENCY position on the regulator to clear the goggles.

Crew Communications..ESTABLISH

Recirculation Fan Switch(s)..OFF

IF Smoke Source <u>Can</u> Be Determined:

Electrical Power ....REMOVE

<u>Note</u>: Electrical fires may isolate themselves through normal protective devices such as circuit breakers. Smoke sources may be determined by open circuit breakers and/or warning flags associated with affected components.

Accomplish the **SMOKE / FUMES REMOVAL CHECKLIST**, in FIRE PROTECTION section, if required.

OR

* * * *

IF Smoke Source <u>Cannot</u> Be Determined:

Bus Transfer Switch ....OFF

Galley or Cab / Util..OFF

7 8 9 **IFE / Pass Seat (If Installed) ....OFF**

Equipment Cooling Supply / Exhaust Switch(s).....ALTERNATE

Cabin Reading & Galley Attendant Work Lights ....ON

Instruct Flight Attendants to turn on cabin reading lights and galley work lights.

Cabin Equipment ....OFF

Instruct Flight Attendants to turn off galley power switches and cabin fluorescent light switches.

(Continued)

Land At Nearest Suitable Airport.

The flight crew's immediate concern with any type of fire should be an expeditious and safe landing.

Accomplish the **SMOKE / FUMES REMOVAL CHECKLIST**, in FIRE PROTECTION section, if required.

* * * *

ELECTRICAL SYSTEM POWER DISTRIBUTION

3 3 5 No. 1 Generator Inoperative, Failure In Flight, Transfer Busses Normal

Inoperative Components	Indication
No. 1 Tank Forward Fuel Pump Center Tank Right Fuel Pump	**LOW PRESSURE** Light **LOW PRESSURE** Light
Galley(s)	Inoperative
Generator Bus No. 1	**BUS OFF** Light
Left Forward Window Heat Right Side Window Heat Left No. 4 & No. 5 Window Heat	**ON** Light - Extinguished **ON** Light - Extinguished Inoperative
Left Elevator Pitot Heat	**L ELEV PITOT** Light
System B Electric Pump	**LOW PRESSURE** Light
LEFT OUTBOARD LANDING Light **RIGHT INBOARD LANDING** Light **LEFT RUNWAY TURNOFF** Light **NOSE GEAR TAXI** Light	Inoperative Inoperative Inoperative Inoperative
Equipment Cooling - Normal	**OFF** Light

③❸❺ No. 2 Generator Inoperative, Failure In Flight, Transfer Busses Normal

Inoperative Components	Indication
No. 2 Tank Forward Fuel Pump Center Tank Left Fuel Pump Fuel Temperature Indicator	**LOW PRESSURE** Light **LOW PRESSURE** Light Inoperative
Galley(s)	Inoperative
Generator Bus No. 2 TR Unit No. 3	**BUS OFF** Light TR No. 3 Voltage - Zero
Equipment Cooling - Alternate	If Switch is to Alternate, **OFF** Light
Left Side Window Heat Right Forward Window Heat Right No. 4 & No. 5 Window Heat	**ON** Light - Extinguished **ON** Light - Extinguished Inoperative
Right Elevator Pitot Heat Temp Probe Heat	**R ELEV PITOT** Light **TEMP PROBE** Light
System A Electric Pump	**LOW PRESSURE** Light
Recirculating Fan	Inoperative
RIGHT OUTBOARD LANDING Light **LEFT INBOARD LANDING** Light **RIGHT RUNWAY TURN** Light	Inoperative Inoperative Inoperative
Engine Vibration Amplifier	Inoperative

All Generators Inoperative

The following list identifies the significant equipment that operates when the battery is the only source of electrical power.

Airplane General

- Position Lights
- Standby Compass Light
- White Dome Lights
- Emergency Instrument Flood Lights

Air Conditioning

- A/C Pack Valves
- **PACK TRIP OFF** Lights

APU

- APU Operation (3 3 5 start attempts not recommended above 25,000 ft.)

Communications

- Flight Interphone System
- Passenger Address System
- VHF No.1
- Audio Selector Panels

Electrical

- External Power Control
- APU & Engine Generator Power Control
- **STANDBY POWER OFF** Light
- **TRANSFER BUS OFF** Light
- **GEN OFF BUS** Light

3 3 5

- **OFF BUS** Light

7 8 9

- **SOURCE OFF** Light

Emergency Equipment

- Flight Crew Oxygen
- Passenger Oxygen

Fire Protection

- APU & Engine Fire Ext. Bottles
- APU & Engine Fire Detection System

Flight Instruments

- Standby Airspeed / Altimeter
- Standby Horizon Indicator
- Clocks
- Magnetic Compass
- Captain's RDMI

③

- Captain's ADI & HSI

7 8 9

- Captains Inboard Display Unit
- Altimeter, Vertical Speed
- Indicator, Navigation Display
- Captain's Outboard Display Unit
  Mach / Airspeed Indicator, Attitude Indicator, Altimeter, Vertical Velocity Indicator, HSI
- Standby RMDI
- Left EFIS Control Panel

Fuel

- Crossfeed Valve
- Engine Fuel Shutoff Valve
- Fuel Quantity Indicator
- Fuel **FILTER BYPASS** Light

③ 3 5

- **FUEL VALVE CLOSED** Light

7 8 9

- Spar fuel Shutoff Valve
- **SPAR VALVE CLOSED** Light
- **ENG VALVE CLOSED** Light

Hydraulic Power

- Engine Hydraulic Shutoff Valve
- Standby Rudder Shutoff Valve

Landing Gear

- Inboard Antiskid System
- **ANTISKID INOP** Light
- Parking Brake
- Landing Gear Position Lights

Navigation / Flight Management

- Left IRS
- VHF No. 1

3 3 5

- ADF No. 1

7 8 9

- Left GPS
- Left FMC
- Left CDU
- Marker Beacon

Pneumatics

- **BLEED TRIP OFF** Lights

Pressurization

- Manual Pressurization Control
- Altitude Warning Horn

Engines

- Thrust Reversers
- Starter Valves
- Right Igniters

3 3 5

- N_1 & EGT Indications
- Indications
- **LOW OIL PRESSURE** Light
- **START VALVE OPEN** Light

7 8 9

- Upper display unit
  N_1, N_2, fuel flow, EGT, fuel quantity, oil pressure, oil temperature, oil quantity, hydraulic pressure, hydraulic quantity

Warnings

- Stall Warning System
- Aural Warnings
- Master Caution Light Recall

LOSS OF BOTH ENGINE GENERATORS CHECKLIST

Loss of both engine driven generators is indicated by instrument warning flags, master caution system, and by illumination of:

③ 3 5 **TRANSFER BUS OFF**, **BUS OFF**, and **GEN OFF BUS** lights.

7 8 9 **TRANSFER BUS OFF**, **SOURCE OFF**, and **GEN OFF BUS** lights.

Upon the failure of all generators, the electrical system will automatically switch to standby power when airborne. The Captain's essential radios, navigation equipment, and flight instruments are powered through the standby system.

Note: With main tank fuel pumps inoperative above 30,000 feet, thrust deterioration or engine flameout may occur.

7 8 9 Note: Reversion to Standby power may cause the Barometric setting to revert to Standard. Reset as necessary.

Bus Transfer Switch .... OFF

Prevents high electrical loads during attempts to restore power.

Electric Hydraulic Pump Switches .... OFF

Prevents high electrical loads during attempts to restore power.

No. 2 Generator Switch .... ON

No. 1 Generator Switch .... ON

IF One Or Both ③ 3 5 **BUS OFF** 7 8 9 **SOURCE OFF** Lights Remain ON:

APU (If Available) .... ③ 3 5 START & ON BUS
7 8 9 START & ON BUS(ES)

- With both busses OFF, only one APU start attempt is recommended. The probability of a start is increased below 25,000 feet. Multiple start attempts deplete the battery and reduce standby power capacity. APU starting may result in loss of IRS alignment.
- ③ 3 5 If the APU is the only operating generator, connect it to the No. 2 bus as it will power TR No. 3. (Selecting Equipment Cooling Fan(s) to Alternate will restore color on EADI and EHSI.) If the APU cannot be connected to the No. 2 bus, connect it to the No. 1. bus.

(Continued)

IF One Or Both 3 3 5 BUS OFF 7 8 9 SOURCE OFF Lights Extinguish:

Bus Transfer Switch .... AUTO

3 3 5 This insures the transfers buses are powered.

Electric Hydraulic Pump Switches...........ON (ONE AT A TIME)

Positioning the pump switches ON one at a time prevents high peak electrical loads.

IF Both Primary Attitude Displays Are Inoperative:

IRS Mode Selector Switches ....ATT

Maintain straight and level, constant airspeed flight until attitude display recovers (approximately 30 seconds).

Magnetic Heading .... ENTER

Allows attitude function of IRS to be restored if starting the APU causes the battery voltage to drop below the minimum for IRS operation.

Heading may be entered on the POS INIT page or on the overhead IRS display unit by selecting HDG/STS.

* * * *

OR

IF Both 3 3 5 BUS OFF 7 8 9 SOURCE OFF Lights Remain ON:

All Exterior Lights .... OFF

Conserves battery power.

Avoid icing conditions.

Note: Flight in icing conditions may result in erroneous flight instrument indications.

Land at the nearest suitable airport. The battery furnishes standby power (up to 30 minutes depending on the condition of the battery and the number of radio transmission).

(Continued)

- - - - - PRIOR TO LANDING - - - - -

③ 3 5 **Standby Power Switch..BAT**

Notes:
- BATTERY POWER ONLY (Approx 30 min.):
- Use headsets for communications.
- Flight directors, autopilots, autothrottles, and mode control panel are inoperative.
- Hydraulic systems are operative but hydraulic panel indicators and lights are inoperative.
- Stabilizer trim is manual only.
- Cabin pressure is manual DC only.

* * * *

7 8 9 SOURCE OFF

The **SOURCE OFF** light indicates the respective transfer bus is not powered by the last selected source.

Engine Generator Switch...ON

IF **BUS OFF SOURCE OFF** Light Remains Illuminated:

APU (If Available) ....START & ON BUS

Note: If the **SOURCE OFF** light is not associated with Engine Failure or Shutdown and the **DRIVE** light is also illuminated accomplish the DRIVE checklist.

* * * *

STANDBY POWER OFF

The STANDBY PWR OFF light illuminated indicates the ③ 3 5 AC standby bus is not powered. 7 8 9 one or more of the following busses are unpowered:

- AC standby bus
- DC standby bus
- Battery bus

Standby Power Switch .... BAT

The standby busses are powered by the battery bus. A fully charged battery will provide a minimum of 30 minutes of standby power.

IF Either Generator Bus Is Re-Established:

Standby Power Switch .... AUTO

* * * *

7 8 9 TR UNIT

The TR UNIT light illuminated indicates one or more TRs has failed.

Do not use the AFDS approach mode.

Note: Autoland is not available.

* * * *

TRANSFER BUS OFF

The TRANSFER BUS OFF light indicates the related transfer bus is not powered.

③ 3 5 Bus Transfer Switch .... OFF THEN AUTO

7 8 9 Engine Generator Switch .... ON

IF TRANSFER BUS OFF Light Remains Illuminated:

APU (If Available) .... START & ON BUS

* * * *

2.7 – ENGINES, APU

TABLE OF CONTENTS

ENGINES, APU

APU DETECTOR INOPERATIVE

The **APU DET INOP** light illuminated indicates the APU fire detection system is inoperative.

APU Switch... OFF

Caution: Do not operate the APU. An APU fire would not be detected and the APU would continue to run.

* * * *

3 5 7 8 9 APU FAULT

The **APU FAULT** light illuminated indicates an APU fault. The APU shuts down automatically.

APU Switch... OFF

The air inlet door and fuel shutoff valve closes. If the **APU FAULT** light extinguishes after 5 minutes, additional restarts may be attempted.

* * * *

APU FIRE (INFLIGHT)

This condition is recognized by the fire warning bell ringing and the **APU FIRE** warning light illuminated.

APU Fire Handle ....PULL & ROTATE

Rotate to the stop and hold until **APU BOTTLE DISCHARGE** light illuminates. To manually unlock the APU fire handle, press the override button (located under the handle) and pull.

Illumination of the **APU FIRE** warning light causes automatic shutdown of the APU and unlocks the APU fire warning handle. Pulling the handle manually backs up the APU shutdown feature, closes the fuel and APU bleed air valves, closes the APU inlet door, trips the generator field, and arms the fire extinguisher system.

Rotation in either direction discharges the fire extinguisher bottle.

APU Switch...OFF

IF The **APU FIRE** Warning Light Remains Illuminated:

Land At The Nearest Suitable Airport.

* * * *

APU GEN OFF BUS LIGHT FAILS TO ILLUMINATE DURING START

If after the starter engagement, the **APU GEN OFF BUS** light fails to illuminate within the time limit of the starter motor, the APU may have failed to attain starter cutout speed. If ignition has occurred, a hung start may be in progress.

APU Switch..OFF

The **OVERSPEED** light may illuminate. The air inlet door and fuel shutoff valve will close.

EGT ....CHECK

Check for a decreasing indication if ignition has occurred.

DC Ammeter ....CHECK

If the aircraft is electrically powered, the ammeter will show a large positive reading. If the battery is the only source of power, the ammeter will show a negative reading.

* * * *

③ APU HIGH OIL TEMP

The **APU HIGH OIL TEMP** light illuminated indicates APU oil temperature is excessive. The APU shuts down automatically.

APU Switch..OFF

The air inlet door and fuel shutoff valve closes. The **APU HIGH OIL TEMP** light extinguishes.

* * * *

APU LOW OIL PRESSURE

The APU LOW PRESSURE light illuminated indicates the APU oil pressure is low. The APU shuts down automatically.

APU Switch..OFF

The air inlet door and fuel shutoff valve closes. The APU LOW OIL PRESSURE light extinguishes.

* * * *

APU OVERSPEED

The APU OVERSPEED light illuminated indicates one of the following situations: the APU has automatically shut down due to the APU RPM limit being exceeded, an APU start has been manually aborted prior to the APU reaching normal operating speed, or if illuminated during a normal APU shutdown, the overspeed shutdown protection feature has failed a self-test.

APU Switch..OFF

The APU inlet door and fuel shutoff valve closes. Do not attempt subsequent starts unless the light illuminated as the result of an aborted start.

Note: If the OVERSPEED light illuminated due to RPM limit being exceeded or self-test failure, maintenance action is required.

* * * *

APU STARTER FAILS TO ENGAGE

If the APU fails to start because the starter did not engage (no indication on the DC ammeter, selector BAT), place the APU switch to OFF and wait 20 seconds to allow the air inlet door to recycle.

* * * *

BATTERY START (EXTERNAL OR APU ELECTRICAL POWER NOT AVAILABLE)

Wheels .... CHOCKED

Tow Bar .... DISCONNECTED

Parking Brakes .... SET

The red PARKING BRAKE ON light will not illuminate until the battery switch is turned ON. The brakes pressure gauge is inoperative until AC power is applied.

DC Meter Selector (23 V Minimum) .... BAT

Battery Switch .... ON/CAPPED

Electric Hyd Pumps .... OFF

Landing Gear Lever .... DOWN/3 GREEN

Radar Switch .... OFF

Circuit Breakers and Emergency Equipment .... CHECKED

Air Conditioning and Pressurization .... SET

Fire Control Panel .... CHECKED

Conduct a fire test (wheel well fire warning is not powered at this time).

IRS Mode .... OFF

Before Start Checklist .... ACCOMPLISH

The door lights and pneumatic pressure gauge are inoperative.

When Ready to Start:

External Air .... CONNECTED

If APU is source of start air:

APU .... START

APU Bleed Air .... ON

Standby Power Switch .... BAT

Selecting BAT powers the standby bus and provides AC power for the right ignition and VHF communications on the #1 radio.

(Continued)

Ignition Selector Switch ....RIGHT

Only the N_1 and EGT instruments and **LOW OIL PRESSURE** low lights operate.

The engine start switch must be held to GRD. Move the engine start lever to IDLE after 30 seconds. Release the ENGINE START switch at 16-17% N_1.

If APU air is being used, starter cutout can be confirmed by a definite drop in APU EGT.

Starting No. 1 engine first will allow greater safety to ground personnel handling external air/elec.

If the isolation valve cannot be opened, start No. 2 engine first and advise ground personnel to use extreme caution. It is preferred to wait for external electrical power rather than to start No. 2 engine with external air and battery.

Engine No. 1 Start ....ACCOMPLISH

Generator No. 1 Switch .... ON

Standby Power Switch .... AUTO

Engine Instruments .... CHECK

IRS Mode Selectors .... NAV

FMC/CDU ....SET

External Air..DISCONNECT

Receiving Aircraft Checklist ....COMPLETE

Engine No. 2 Start ....USE APU AIR OR CROSSBLEED PROCEDURE

After Engines are Started:

Wheel Well Fire Warning.. CHECKED

After Start Checklist ....COMPLETE

* * * *

7 8 9 EEC ALTERNATE MODE

An **EEC ALTN** light illuminated indicates the EEC is in alternate control mode.

IF On Ground:

Consult MEL Section 73 for effectivity. If aircraft is not in compliance according to the MEL, **Do Not Takeoff**.

EEC Mode Switches (Both)..ALTN

Thrust.......................................7 USE FULL RATED THRUST
8 9 REDUCE MAX TAKEOFF THRUST N1 BY 2.2%

Do not use the FMC Takeoff N1 or Vspeed values.

Autothrottle..OFF

Use manual takeoff thrust settings procedures. Assumed temperature reduced thrust takeoff not allowed. Autothrottle may be used during flight, but not for takeoff.

OR

IF In Flight:

Autothrottle (If Engaged)..OFF

Allows thrust levels to remain where manually positioned.

Thrust Levers (Both)................... RETARD TO MID POSITION

Prevents exceeding thrust limits when switching to alternate mode.

EEC Mode Switches (Both)..ALTN

Push one switch at a time. This Ensures both engines operate in alternate mode

Autothrottle..ON

Note: Maximum thrust limiting is available with autothrottle engaged.

Observe engine limits in manual operation.

* * * *

ENGINE / APU FIRE ON GROUND

Standby Power Switch ....BAT

This assures electrical power for # 1 VHF Comm radio. The overhead speakers will be inoperative.

Tower/Ground .... NOTIFY

Attempt to notify tower or ground control on VHF #1 of your location and condition. If normal power is lost, it is necessary to use a headset for reception.

Engine Start Lever (If Engine Fire)... CUTOFF

If fire is in APU, an automatic shutdown will occur as soon as the **FIRE** light illuminates.

Fire Handle ....PULL & ROTATE LEFT & RIGHT

Verify that **APU BOTTLE DISCHARGE** light (If APU fire) or both **LEFT** and **RIGHT BOTTLE DISCHARGE** lights (if engine fire) are illuminated.

APU Switch (If APU Fire)...OFF

Passenger Evacuation Procedure (If Necessary) ....ACCOMPLISH

* * * *

7 8 9 ENGINE CONTROL

Do Not Takeoff.

An **ENGINE CONTROL** light illuminated indicates an engine control system fault.

Note: An **ENGINE CONTROL** light illuminates on the ground only.

* * * *

ENGINE FAILURE/FIRE/SHUTDOWN/ SEVERE DAMAGE/SEPARATION

This procedure is to be used for engine failure, engine fire, or an engine shutdown due to severe damage, separation, or for precautionary reasons. It should also be reviewed and appropriate items re-accomplished after a single-engine missed approach.

Autothrottle .... OFF

This action prevents undesired autothrottle activity.

Throttle (Affected Engine) .... CLOSED

Note: Precautionary engine shutdowns (no fire indications), should only be done when flight conditions permit. If possible, operate for 3 minutes at idle thrust.

Start Lever (Affected Engine) .... CUTOFF

IF

- FIRE Light Has Illuminated
- ENG OVERHEAT Light Has Illuminated
- **Severe Damage**
- **Airframe Vibration**
- **Abnormal Engine Indications**
  (Note: If engine is shutdown for low oil pressure, it is not recommended to pull the fire handle.)
- **Separation Is Suspected:**

Fire Handle (Affected Engine) .... PULL

To manually unlock the fire handle, press the override button (located under the handle) and pull.

This action closes the fuel, engine bleed air, and hydraulic shutoff valves; deactivates the engine driven hydraulic pump LOW PRESSURE light; trips the generator field, and closes the thrust reverser isolation valve.

IF FIRE Light Or ENG OVERHEAT Light Remains Illuminated:

Fire Handle .... ROTATE L OR R

(Continued)

Rotate to the stop and hold until the respective BOTTLE DISCHARGED light illuminates.

After 30 seconds, if fire or overheat persists:

Fire Handle.................................... ROTATE TO REMAINING BOTTLE

Rotate to the stop and hold until the respective BOTTLE DISCHARGED light illuminates.

IF FIRE Light Or ENG OVERHEAT Light Remains Illuminated:

Note: If high airframe vibration occurs and continues after engine is shut down:

Without delay, reduce airspeed and descend to a safe altitude which results in an acceptable vibration level. If high vibration returns and further airspeed reduction and descent are not practicable, increasing airspeed may reduce vibration.

Continue The Checklist.

Isolation Valve .... CLOSE

Note: If Cabin is Pressurized Using APU Bleed Air, DO NOT Close the APU Bleed Valve or turn the Left Pack Switch OFF.

Pack Switch (Affected Side) .... OFF

APU Bleed Switch... OFF

APU (If Available).. START & ON BUS

③ 3 5 APU starts are not assured above 25,000 feet.

Fuel.. BALANCE

Normally, if center tank fuel is available and the pumps are on, no action is required. If center tank fuel is not available opening of the CROSSFEED switch allows fuel to feed from both main tanks, however any pressure differential from the operating pumps may cause an imbalance. Continue to monitor fuel and balance fuel as necessary to maintain within aircraft limitations.

Transponder Mode Selector..TA

TCAS equipped transponders communicate between aircraft to provide appropriate coordinated avoidance maneuvers. When performance is limited, such as with an inoperative engine, select TA ONLY to prevent receiving RAs beyond the aircraft's capabilities, and to prevent communicating to other aircraft an ability to perform a RA maneuver.

(Continued)

IF Wing Anti-Ice Is Required:

Do not open isolation valve unless the fire has been extinguished.

Isolation Valve Switch ....AUTO

IF Emergency Occurred During Takeoff or Missed Approach, Abbreviated AFTER TAKEOFF checklist Items Are:

Gear .... OFF, LIGHTS CHECKED

③ 3 5 Red gear lights will remain illuminated if either or both throttles are at IDLE. Advance throttle(s) to ensure gear lights.

Flaps... AS REQUIRED

Position flaps as required for maneuvering.

Land At Nearest Suitable Airport.

IF Considering a restart of the engine, refer to **ENGINE START – IN FLIGHT** checklist, this section.

OR

* * * *

IF Not considering a restart **accomplish** the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist at the appropriate time.

Logbook entries, if time and conditions permit:

1. Windmill RPM
2. Windmill time
3. Windmill oil pressure
4. Length of time engine windmilled without oil pressure
5. Oil pressure at time of shutdown

Note: Coordinate any procedure requiring an engine shutdown with ATC as soon as possible. If the shutdown occurs at an altitude above the single engine ceiling, initiate driftdown procedures. FMC information is available on the engine-out climb or cruise pages as applicable. Use these pages for driftdown speeds and power settings.

* * * *

Engine Failure After V1 Procedure

If engine failure occurs at or after V_1, follow this procedure:

PILOT FLYING (PF)	PILOT MONITORING (PM)
Maintain directional control, rotate to takeoff attitude at V_R.	Call "ROTATE" at V_R.
When a positive rate of climb is indicated, call "GEAR UP."	Call "POSITIVE RATE" when positive rate of climb indicated. Position the landing gear lever UP on command.
* Climb at V_2, limit bank angle to 15 degrees.	Monitor engine and flight instruments.
400 feet AGL, call "HEADING SELECT."	Select HDG SEL.
** At flap retraction altitude "SET TOP BUG," retract flaps (as required on the flap/speed schedule). Maintain pitch attitude indicated by F/D. (See Note below.)	Set airspeed cursor to V_M Flaps 0. Retract the flaps on command. Monitor flap indications and leading edge lights.
At flap retraction (as required), call for "MAXIMUM CONTINUOUS THRUST," climb at V_M for existing flap setting. Call for the "**ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION CHECKLIST**."	Set Maximum Continuous Thrust after flaps are retracted. Complete the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist on command.
Determine the next course of action.	Advise ATC of the Captain's intentions.

Note: If a fire is indicated, the **ENGINE FAILURE / FIRE** checklist should be called for by the PF and executed by the PM immediately upon reaching flap retraction altitude: "SET TOP BUG, ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION CHECKLIST."

* If an engine failure occurs prior to V_2, maintain V_2 up to the altitude required for obstacle clearance. If an engine failure occurs after V_2, but less than V_2 + 20 knots, maintain the speed reached at the time of the engine failure.

If an engine failure occurs at a speed higher than V_2 + 20 knots with the flaps at takeoff setting, increase pitch attitude to reduce speed to and maintain V_2 + 20 knots until clear of obstacles.

F/D pitch commands maintain the above engine failure speeds.

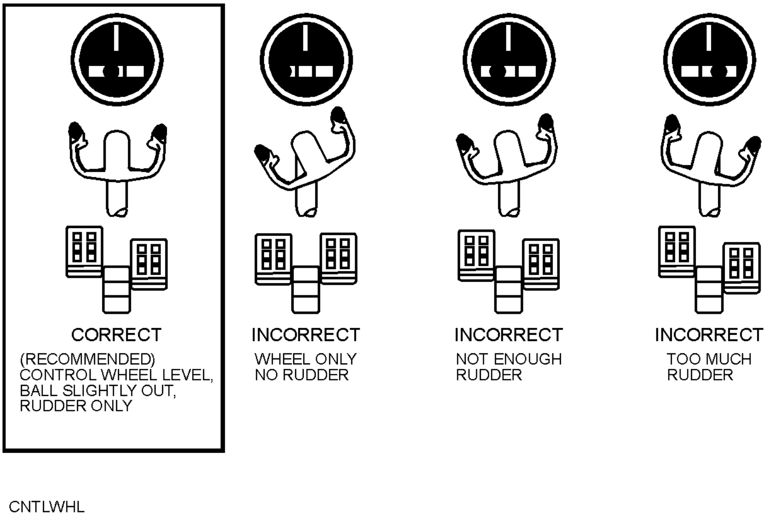
** Normally flap retraction occurs after an engine failure at 800 feet AGL. However, obstacle clearance requirements may define non-standard flap retraction altitudes. If non-standard altitudes are required, they will be noted on the 10-7 page.

Liftoff (Single Engine)

The aircraft will attain V_2 approximately 35 feet above the runway. Gear retraction will not be initiated until a positive rate of climb has been verified on the IVSI and altimeter and called by either pilot. Then PF calls "GEAR UP."

The pitch attitude must be adjusted to maintain desired airspeed. Indicated airspeed and vertical speed are the primary instruments for pitch control, consequently, the initial climb attitude should be immediately adjusted to maintain a minimum of V_2 and a positive climb.

Continue a smooth rudder application as required to maintain a constant heading and to keep the control wheel centered. Correct rudder application technique is depicted below.



ENGINE NO. 2 INOPERATIVE

Maintain V_2 to V_2+ 20 until reaching 800 feet or published obstacle clearance altitude, then decrease pitch attitude to maintain slight climb or level flight. "SET TOP BUG" will be called by the Pilot Flying, and set by the Pilot Monitoring. The F/D pitch attitude will decrease to provide acceleration and may provide a climb. At this point, the Pilot Flying will determine whether to leave flaps extended to maneuver for approach and landing, or retract flaps on schedule. At flap retraction (as required), call for "MAXIMUM CONTINUOUS THRUST", climb at V_M for the existing flap setting. Call for the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist. If an engine fire occurs prior to 800 ft. AGL (or obstacle clearance altitude as per 10-7 page), it is imperative that the crew address the emergency in a timely manner. Upon reaching flap retraction altitude, the PF should call "SET TOP BUG, ENGINE FAILURE / FIRE CHECKLIST." This will allow the aircraft to accelerate, and will begin the management of the emergency in a timely fashion. The PM should accomplish the portions of the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist through the discharging of the fire bottles as soon as practical. Completion of the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist should be delayed until the aircraft is at the configuration and thrust setting desired for maneuvering.

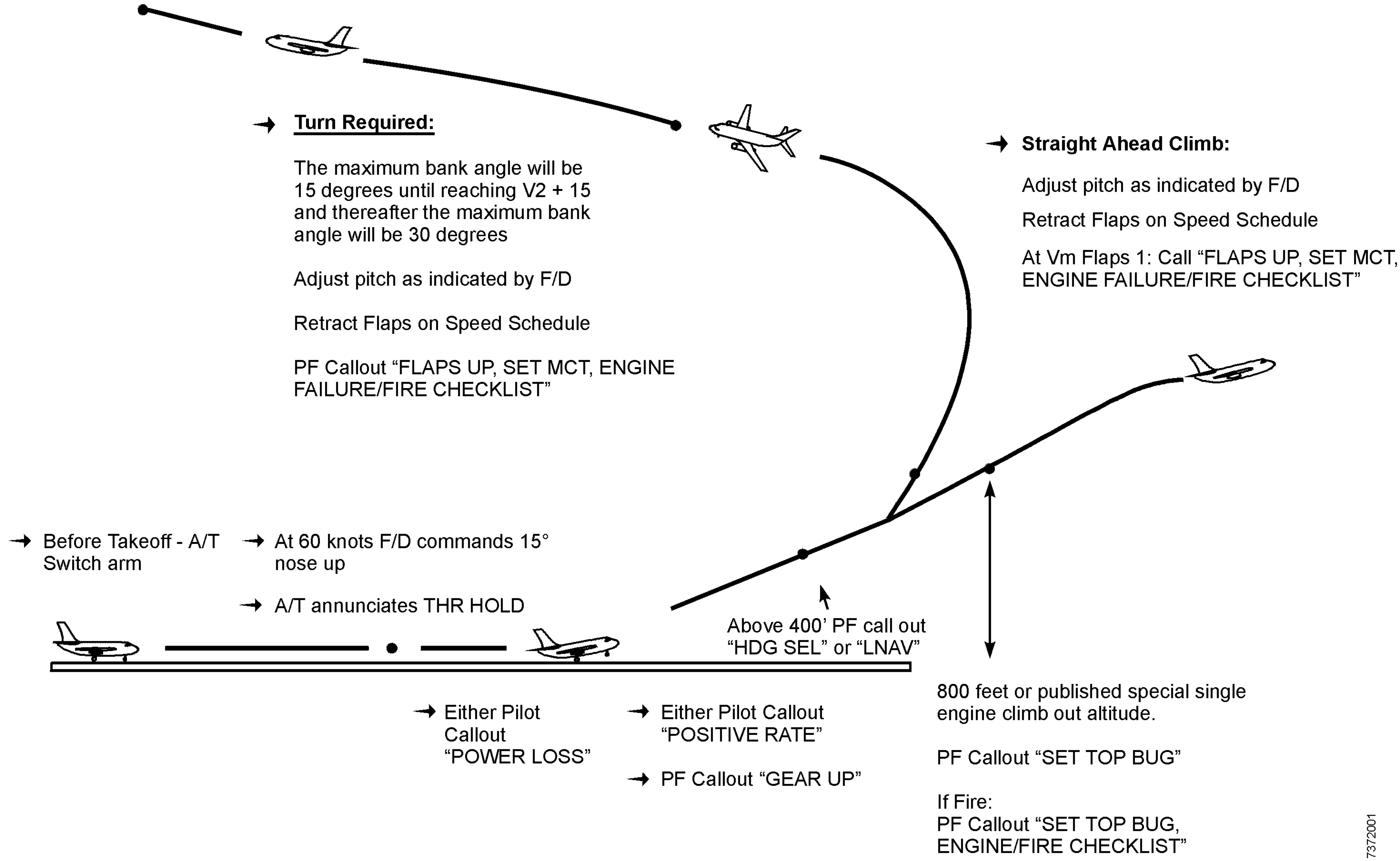
Note: In situations where departure procedures require a close-in turn or minimum climb gradient profile, maintain takeoff flap setting and V_2 (max bank angle 15 degrees) until those conditions have been satisfied. At speed of V_2 + 15 or greater, bank angles of 30 degrees are permissible.

Continue climb at applicable V_M for the existing flap setting.

When using the Assumed Temperature method for reduced thrust, takeoff performance is always guaranteed in the event an engine should fail at the critical point during the takeoff roll. This guarantee applies to runway, obstacle, and second segment climb gradient requirements.

WARNING: The untimely application of additional thrust during takeoff may introduce undesirable yaw moments. If a decision is made to increase thrust during takeoff, do so smoothly and compensate with rudder.

* * * *



TAKEOFF - ENGINE FAILURE AFTER V_1

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Engine Failure On Final Approach

Should an engine failure occur during final approach with the aircraft in the landing configuration, the aircraft may not be able to maintain a normal glideslope under the most adverse conditions in high headwinds and climb performance limited gross weights.

Continue The Approach In The One Engine Inoperative Landing Configuration

Upon recognition of an engine failure, disengage the autothrottle and increase thrust concurrent with the selection of flaps 15. Speed should be increased to V_{REF} 30 or 40 speed plus 15 knots. This speed is equal to or greater than V_{REF} 15. The internal speed bug may also be increased to this speed to provide proper flight director pitch guidance for approach. Inhibit the GROUND PROXIMITY FLAP INHIBIT switch to prevent a flap configuration warning.

Execute A Go-Around

If the Captain decides to go-around when the engine fails in the landing configuration, disengage the autothrottle and increase thrust concurrent with the selection of flaps 15. Speed should be increased to V_{REF} 30 or 40 speed plus 15 knots. This speed is equal to or greater than V_{REF} 15. The internal speed bug may also be increased to this speed to provide proper flight director pitch guidance for approach and go-around. After the aircraft has stabilized, the normal single engine go-around procedures will then be accomplished. Maintain V_{REF} + 15, retract flaps to position 1, and continue the one engine inoperative go-around. V_{REF} + 15 knots is approximately equal to V2 for flaps 1. Subsequent flap retraction should be made at 800 ft. AGL or higher altitude if special procedures apply.

ENGINE FIRE / OVERHEAT DETECTOR FAULT

The detector **FAULT** light illuminated indicates both loops in any circuit have failed. Neither the master caution nor the fire handle will illuminate.

The fire detection system in one or both engines is inoperative. Consideration should be given to landing as soon as practicable.

* * * *

ENGINE HIGH OIL TEMPERATURE

Accomplish this procedure when oil temperature is in the yellow band or, at or above the red radial.

IF Temperature Is In The Yellow Band:

Throttle (Affected Engine) .... **RETARD**

Disconnect Autothrottles, if required.

Decreasing the thrust slowly may lower oil temperature into the green band by reducing the amount of heat generated by the engine.

IF Temperature Exceeds 3 3 5 15 Minutes 7 8 9 45 Minutes In The Yellow Band, Or Is At Or Above Red Radial:

Accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist.

* * * *

ENGINE LIMIT / SURGE / STALL

Failure of engine or fuel control system components or loss of thrust lever position feedback has caused loss of engine thrust control. Control loss may not be immediately evident since many engines fail to some fixed RPM or thrust lever condition. This fixed RPM or thrust lever condition may be very near the commanded thrust level and therefore difficult to recognize.

Accomplish Checklist If One Or More Of The Following Conditions Exist:

- Engine RPM or EGT indications are abnormal, approaching or exceeding limits
- No response to thrust lever movement
- Abnormal engine noises

Autothrottle ....OFF

Thrust Lever (Affected Engine) ....RETARD

Retard until indications remain within appropriate limits or the thrust lever is closed.

IF Indications Remain Abnormal Or EGT Continues To Increase:

Accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist.

OR

* * * *

IF Indications Are Stabilized Or EGT Decreases:

Thrust Lever (Affected Engine)....................................ADVANCE

Advance slowly. Check that RPM and EGT follow thrust lever movement. Operate engine normally or at reduced thrust setting that is surge and stall free.

* * * *

ENGINE LOW OIL PRESSURE

Accomplish this procedure when

- ③ 3 5 the amber **LOW OIL PRESSURE** light is illuminated.
- 7 8 9 engine oil pressure is in the amber band with takeoff thrust set, **LOW OIL PRESSURE** alert illuminated, or oil pressure is at or below the red line.

IF Engine Oil Pressure Is In The Amber Band Or The Amber **LOW OIL PRESSURE** Light Is Illuminated With Takeoff Thrust Set:

Do Not Take Off.

③ 3 5 The amber **LOW OIL PRESSURE** light illuminates at a pressure below 13 PSI.

7 8 9 The **LOW OIL PRESSURE** alert blinks indicating an impending low oil pressure, and remains steady when oil pressure is at or below red line.

IF Engine Oil Pressure Is At Or Below The Red Line:

Accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist.

* * * *

ENGINE OIL FILTER BYPASS

The **OIL FILTER BYPASS** light illuminated indicates an impending bypass of the main oil filter.

Throttle (Affected Engine) .... RETARD

Disconnect Autothrottle, if required.

If not in a critical phase of flight, slowly retard the throttle.

IF The **OIL FILTER BYPASS** Light Extinguishes:

Operate the engine at reduced thrust to keep the light extinguished. Monitor fuel balance.

OR

* * * *

IF The **OIL FILTER BYPASS** Light Remains Illuminated:

Accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist.

* * * *

ENGINE OIL PRESSURE IN THE YELLOW BAND

IF On The Ground At Takeoff Thrust:

Do Not Takeoff.

OR

* * * *

IF Inflight:

Oil pressure in the yellow band is normal at low thrust settings.

* * * *

ENGINE OVERHEAT

Autothrottle .... OFF

Throttle (Affected Engine) ....CLOSE

IF The **ENG OVERHEAT** Light Remains Illuminated:

Accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist.

OR

* * * *

IF The **ENG OVERHEAT** Light Extinguishes:

Operate the engine at reduced thrust to keep the light extinguished due to the possibility of a bleed air leak. Monitor fuel balance.

It is recommended to configure the aircraft for a single engine approach and landing due to the overheat and/or fire uncertainty with application of thrust on the affected engine.

Accomplish the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist at the appropriate time.

* * * *

ENGINE OVER TEMPERATURE DURING TAKEOFF OR INFLIGHT

Over temperature above the red radial should be noted in the aircraft log. Note the maximum temperature reached and the duration of the over-temperature.

Autothrottle.. OFF

Throttle (Affected Engine) .... RETARD

Retard the throttle until EGT is within limits.

If unable to maintain EGT within limits, accomplish **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist at the appropriate time.

* * * *

ENGINE START - AIR START (BOTTLE PRESSURE)

When the B737 APU is inoperative, a low pressure ground air source may be provided as an alternate, but because of the high bypass jet engines, both compressor-type and bottle-type ground air units must meet certain specifications and capabilities which are in some cases greater than other narrow-body two engine aircraft. Units meeting the criteria listed below will normally meet the B737 starting requirement.

Compressor-Type Unit

Must be capable of producing 125 - 135 PPM (pounds-per-minute) and 30 to 40 output PSIG (pounds-per-square-inch).

Bottle Type Unit

Must be capable of 450 - 500 PSIG operating pressure. At these pressures, the amount of air should be between 4,000 and 5,000 standard cubic feet.

* * * *

ENGINE START - CROSSBLEED START

If difficulties are experienced with an external air source with one engine running, a crossbleed start can be made. Prior to using this procedure, notify tower and ensure that the area to the rear is clear. Increase thrust on the operating engine until there is a minimum of 30 PSI duct pressure and use this air source to start the remaining engine.

Engine Bleed Air Switches...ON

APU Bleed Air Switch..OFF

Air Conditioning Pack Switches...OFF

Isolation Valve Switch...OPEN

Ensures pneumatic air supply for engine start.

Throttle (Operating Engine)...ADVANCE

Duct Pressure...30 PSI

(Continued)

Non-Operating Engine..START

Use normal start procedures with crossbleed air. After starter cutout, reduce thrust.

Isolation Valve Switch.. AUTO

After Start / Delayed Engine Start Checklist ....ACCOMPLISH

* * * *

ENGINE START – FIRE DURING START

IF Reported By Ground Personnel And <u>No Fire Warning</u>:

This is an internal fire. Place the start lever to CUTOFF position and continue to motor the engine with the start switch. If the start switch has been previously released, re-engage starter at 20% N_2 or less to motor the engine. Engine air will purge fuel quickly and eliminate the fire.

OR

* * * *

IF Fire During Start <u>With Fire Warning</u>:

Bell and light indicate the fire has progressed to the area between the cowling and the engine to where the fire detector units are located. Complete the **ENGINE / APU FIRE ON GROUND** checklist.

* * * *

③ 3 5 ENGINE START - HIGH ALTITUDE

At high-altitude airports with a field elevation above 7000 feet MSL a normal engine start may not occur.

This would be indicated when after normal starter cutout at 46% N_2, if:

- N_2 decreases below 40%,
- Or EGT rises rapidly toward 725° C,
- Or engine does not reach idle RPM within 5 minutes.

If this situation occurs, you would:

- Place Start Lever in CUT OFF.
- Motor Engine for 60 seconds. If starter has disengaged, do not re-engage starter until N_2 is below 20%.
- Place Start Switch to OFF.

For the second start attempt:

- Manually hold the start switch to GRD to keep the starter engaged until N_2 reaches 50%.
- If possible, use the Cross Bleed Start procedure on the second engine to ensure maximum start pressure and volume.

The above procedures should only be used for specific cases and should not become the norm. If an APU is consistently weak for engine start, enter a maintenance discrepancy.

Note: If normal start procedures do not provide a normal start for the specified engine, consideration may be given to starting the opposite engine next, then use the Cross Bleed Start procedure on the initial engine.

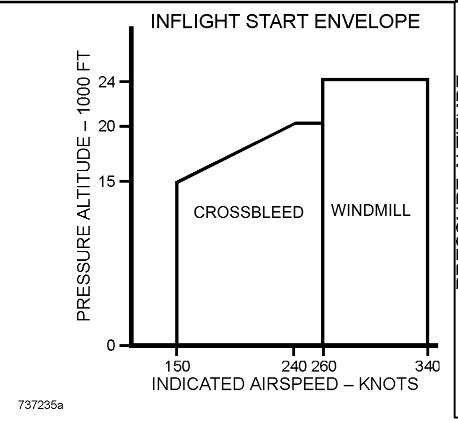
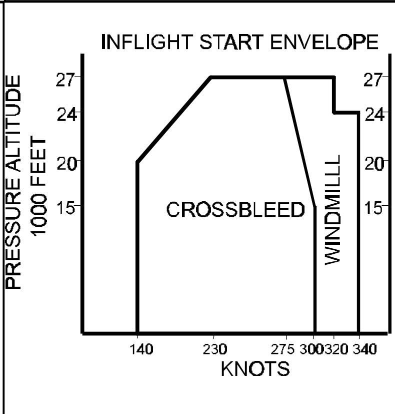
* * * *

ENGINE START - IN FLIGHT

Complete the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist before attempting a restart. Evaluate engine indications for evidence of damage, which would preclude a restart attempt.

Inflight Start Envelope .... CHECK

To determine if a windmilling start or starter assist is required check:

3 3 5	7 8 9
	

3 3 5 **Caution:** Crossbleed start should be used if N_2 is below 15 percent.

Fire Handle (Affected Engine) .... PUSH IN

Throttle (Affected Engine) .... CLOSED

Start Lever (Affected Engine) .... CUTOFF

IF Crossbleed Start Required:

Ensure that the aircraft is pressurized with engine bleed air.

OR

Pack Switch (Affected Side) .... OFF

Isolation Valve Switch .... AUTO

(Continued)

Duct Pressure .... MINIMUM 30 PSI

If required, advance the operating thrust lever to increase duct pressure.

Ignition Select Switch .... BOTH

Start Switch .... GRD

At a minimum of 3 3 5 15% N_2 7 8 9 11% N_2.

Start Lever .... IDLE DETENT

Monitor engine instruments.

If no increase in EGT is observed within 30 seconds, return start lever to CUT OFF and start switch to OFF.

Monitor EGT to ensure it does not rise rapidly or exceed the start limit of 725°C during the start attempt.

IF Starter Assist NOT Required:

Start Switch .... FLT

Start Lever .... IDLE DETENT

Monitor engine instruments. If no increase in EGT is observed within 30 seconds, return start lever to CUT OFF.

IF Engine Starts:

- - - - - AFTER THE ENGINE IS STABILIZED - - - - -

Electrical .... GENERATOR ON

Pack Switch .... AUTO

Start Switch .... AS REQUIRED

APU .... AS REQUIRED

OR

Transponder Mode Selector .... TA/RA

Fuel System .... AS REQUIRED

IF Neither IRS Attitude Display Recovers After A Generator Bus Is Restored:

IRS Mode Selector Switches .... ATT

Magnetic Heading .... ENTER

* * * *

IF Engine Does Not Start:

Accomplish the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist at the appropriate time.

* * * *

ENGINE START – NON NORMAL

IF One Or More Of The Following Conditions Exist Abort The Start:

- No N_1 rotation before the engine start lever is raised to IDLE
- No oil pressure indication by the time the engine is stabilized at idle
- No increase in EGT, within 10 seconds on the ground or 30 seconds in flight, after the engine start lever is raised to IDLE
- No increase in, or a very slow increase in N_1 or N_2 after EGT indication
- EGT rapidly approaching or exceeding the start limit

Note: See MEL if applicable.

IF Before Start Lever Raised To IDLE:

Engine Start Switch .... OFF

* * * *

OR

IF After Start Lever Raised To IDLE:

IF Before Starter Cutout:

Engine Start Lever .... CUTOFF

Continue to motor the engine for 60 seconds to clear fuel and cools engine components.

Engine Start Switch .... OFF

Note: Check Engine Ignition Circuit Breakers (3 3 5 6-2, B5-8) (7 8 9 6-2, A1 & 3, 18-2, D4 & 6). If tripped, refer to Circuit Breaker Procedures, Section 2.6.

* * * *

OR

IF After Starter Cutout:

Engine Start Lever .... CUTOFF

After N_2 decreases to below 20%.

Engine Start Switch .... GRD

Motor the engine for 60 seconds to clear fuel and cools engine components.

Engine Start Switch .... OFF

* * * *

ENGINE START - START VALVE DOES NOT OPEN

Circuit Breakers .... CHECK & RESET

Circuit Breakers labeled **START VALVES**. If tripped, refer to CIRCUIT BREAKER PROCEDURES Section 2.6.

Note: See MEL.

* * * *

ENGINE START - START VALVE OPEN LIGHT ON OR START VALVE FAILS TO CLOSE BY 3 3 5 50% 7 8 9 60% N_2

If the engine start valve remains open after engine start, or if the **START VALVE** light illuminates during ground or flight operations, accomplish the following procedures:

Engine Start Switch .... OFF

IF No Starter Cutout Or **START VALVE OPEN** Light Remains Illuminated:

Flight or Ground Operations:

Isolation Valve Switch .... CLOSED

Engine Bleed Air Switch (Affected Engine).................................... OFF

APU Bleed Air Switch (No. 1 Engine Only).................................... OFF

Isolates bleed air to prevent starter disintegration and possible aircraft damage.

Additional Ground Operation Items:

Ground Air Source (If In Use).......................................DISCONNECT

Ensure air source is removed PRIOR to next step:

Start Lever .... CUTOFF

* * * *

HIGH ENGINE VIBRATION

This condition is indicated by AVM levels in excess of 4.0 units accompanied by perceivable airframe vibrations.

IF Not In Icing Conditions:

Throttle (Affected Engine)..RETARD

Disconnect autothrottle, if required.

Flight conditions permitting, reduce N_1 to maintain AVM below 4.0 units.

OR

* * * *

IF In Icing Conditions:

Accomplish the following on one engine at a time:

Start Switches..FLT

Throttle (Affected Engine)...........................REDUCE TO 45% N_1

Engine Anti-Ice Switches.. ON

After 5 seconds:

Thrust.................ADVANCE SLOWLY TO 80% N_1 MINIMUM

Disconnect autothrottle, if required.

If vibration does not decrease, accomplish the procedure for "IF Not In Icing Conditions" above. Other engine problems may be indicated.

* * * *

3 3 5 LOW IDLE

The **LOW IDLE** light illuminated indicates the engine “RPM” for one or both engines is below the minimum required for acceleration for go-around or minimum required with engine cowl anti-ice ON.

Throttles... ADVANCE THROTTLES UNTIL LIGHT EXTINGUISHES

Disconnect autothrottles, if required.

Note: **LOW IDLE** light illuminates at 25% N_1.

* * * *

MANUAL START / INOPERATIVE STARTER VALVE

An engine with an inoperative starter valve may be started by operating the valve manually. When this procedure is to be used, review the items listed and coordinate the procedure closely with the ground personnel.

Use Normal Start Procedures With The Following Additions:

Direct ground crewmen to open the starter valve when “START ENGINE NO.________” is announced.

Direct ground crewmen to release starter valve override when “RELEASE” is announced.

Engine Start Switch.. GRD

Captain announces over interphone, and to flight crew, “START ENGINE NO.__________.”

Inform ground crewmen when N_2 is rotating.

Normal Start Procedures..OBSERVE

When N_2 RPM indicates 3 3 5 46%, 7 8 9 56% Captain announces over interphone, “RELEASE.”

Engine Start Switch.. OFF

Check the start switch moves to OFF and duct pressure increases to the prestart value.

* * * *

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ONE ENGINE INOPERATIVE APPROACH AND LANDING

For ease of use, the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist has been designed to incorporate all normal checklists from the In Range phase through the Landing checklist. By incorporating both normal and abnormal procedures, the flight crews will only have to refer to one checklist.

Plan a Flap 15 landing. Flap 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

IN RANGE

Air Conditioning & Pressurization ....SET

If operating in the Standby Mode (as installed), verify the cabin altitude is set 200 feet below the landing elevation.

Seat Belt Sign .... ON

Recall.. CHECKED

The PM should press recall. This is the last check of canceled warnings prior to landing. With an engine shutdown, there will be one or more master caution annunciator lights illuminated, referencing the affected system(s). Make certain the items which recall are consistent with the intended configuration of the aircraft.

Altimeters & Flt. Instruments ....SET & CHECKED (PM, PF)

Set barometric pressure on all altimeters. If transition altitude is below 18,000 ft. MSL, set barometric pressure on all altimeters when passing through transition altitude. Cross check all flight instruments for indications and flags.

Airspeed Bugs .... SET (PM, PF)

V_{REF} .... V_{REF} 15

7 8 9 If using V_{REF} 15 and If icing conditions have been experienced or are anticipated prior to landing set V_{REF} =V_{REF} 15 + 10.

(Continued)

Target.. V_{REF} 15 + WIND ADDITIVE

3 3 5 Position the white movable reference bugs at 80 knots, V_{REF}, V_{REF} + 15, and V_M Flaps 0 for the appropriate weight.

3 3 5 If ice formations are observed on the aircraft surfaces, (wings, windshield wipers, window frames, etc.) add 10 knots to the V_{REF} for establishing Target speed to ensure maneuvering capability.

3 5 7 8 9 Once the desired landing flaps have been determined, the flight crew will select the FMC computed speed or manually enter another value into the field corresponding to the desired landing flap configuration. This speed will then be transmitted by the FMC and the symbol generator will:
3 5 display the "-R" symbol opposite that speed on the speed tape.
7 8 9 display V_{REF}, V_{REF} + 15.
On final approach when landing flap has been selected, position the internal bug to V_{REF} Flaps 15 plus 1/2 the reported wind and all the gust not to exceed plus 20 knots. The minimum cursor speed is V_{REF} Flaps 15 + 5. The maximum cursor setting is V_{REF} Flaps 15 plus 20 knots. Examples: Reported wind 15 gusting 20. Cursor setting is V_{REF} Flaps 15 plus 12 knots.

Autobrake...SET

The autobrake system should be used for landing. It is estimated that manual braking techniques frequently involve a 4 to 5 second delay between main gear touchdown and brake pedal application, even when conditions reflect the need for a more rapid initiation of braking. This delayed braking can result in the loss of 800 to 1000 feet of runway. Directional control requirements for crosswind conditions and low visibility may further increase the above delays as can the distraction arising from a malfunctioning reverser system.

A setting of 2 or 3 provides moderate deceleration rates. The MAX setting provides for maximum deceleration.

(Continued)

Shoulder Harnesses (Flow) .... ON

Approach Briefing ....COMPLETED

Normally the approach briefing should be accomplished at cruise altitude when the destination ATIS information becomes available. However, if this is impractical, the crew briefing will be accomplished as soon as approach information is available.

Note: Since it is not recommended to fly the approach with the autothrottles engaged, special emphasis should be placed on how the approach will be flown. The autopilot is available, and its use may significantly assist in completing a successful approach.

The briefing must include the destination weather, the date and type of approach plate to be used, and the transition level. The approach itself should be thoroughly reviewed covering courses, frequencies, altitudes, terrain, timing, missed approach procedures, and the type of runway lighting system. The failure of any aircraft system affecting the approach and landing phase, as well as any unusual or special circumstances, should be briefed to include the specific procedures and responsibilities of the individual crewmembers. The Continental Airlines 10-7 page should also be reviewed.

WARNING: Prior to descent into mountainous terrain all enroute charts, STARS, and approach charts associated with arrival will be out and available. The Captain will brief all Grid MORAs MEAs MOCAs AMAs to include position of high terrain along the route.

The briefing should also include what HSI mode selections are planned for the approach. The MAP mode normally provides the best situational awareness. Since raw data is primary it must be displayed prior to commencing the approach. The ADI display of LOC/GS information, and the RDMI display of NDB azimuth information suffice for this requirement. However;

Note: During a VOR approach, at least one pilot will have VOR data displayed on his/her HSI prior to intercepting the final approach course.

(Continued)

- - - - - PRIOR TO APPROACH - - - - -

Ground Proximity Flap Inhibit Switch..INHIBIT

Eliminates the warning associated with flaps being out of the normal landing configuration.

Go-Around Procedure .... REVIEW

Accomplish normal go-around except:

- Use flaps 1.
- Maintain V_{REF} 15 + 5 to flap retraction altitude.
- Limit bank angle to 15 until reaching V_{REF} 15 + 15 knots.
- Accelerate to V_M Flaps 1 prior to flap retraction.
- Set Max Continuous Thrust
- Reaccomplish appropriate items on the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist, followed by the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist at the appropriate time.

Note: Use of TOGA switches provides proper pitch if both flight director switches are ON for the approach.

Note: Because of reduced performance capabilities and the critical nature of an engine being inoperative, consideration should be given to asking ATC for assistance in simplifying complex missed approach procedure, if possible.

- - - - - BELOW 10,000 FEET MSL - - - - -

IF Additional Go-Around Thrust Is Desired, Configure The Pneumatic System For A No-Engine Bleed Landing:

Isolation Valve Switch .... CLOSE

To preclude a possible dual bleed situation.

Left Pack Switch.. AUTO

No. 1 Engine Bleed Air Switch..OFF

Note: If the APU is inoperative, plan for an unpressurized landing.

(Continued)

Note: Do not open the APU bleed air valve in the next step if an engine FIRE light has remained ON.

APU Bleed Air Switch (See Notes Above).. ON

No. 2 Engine Bleed Air Switch.. OFF

APPROACH

Start Switches.. CONTINUOUS

Verify that the ignition selector switch is set at L or R. If moderate to severe precipitation is a factor, select start switches to FLT.

Altimeters/Bugs .... SET (PM, PF)

Verify all barometric altimeters are set. On a CAT I ILS or a non-precision approach, the barometric/electric altimeter is the primary reference to DA or DDA. The radio altimeter should be set for all precision approaches and will be set as a backup indication on non-precision approaches.

Radios...IDENTIFIED

All appropriate radios must be tuned and identified for the approach planned.

NAV Displays ....SET

For VOR or LOC (BC) approaches, at least one pilot must select either 3 5 FULL or EXPANDED VOR/ILS 3 VOR/ILS on the HSI display prior to reaching the final approach fix. Since raw data for NDB approaches is available on the RDMI indicators, and raw data for ILS, LOC approaches are available on the ADI display selections are at the discretion of each pilot. However, for maximum situational awareness, the HSI MAP mode is recommended.

7 8 9 The recommended display option for this aircraft is MAP since the diplay unit will always have an HSI diplayed.

For all ILS, LOC, and LOC (BC) approaches, the Standby Attitude Indicator ILS selector switch should be placed in the appropriate position.

Course Arrow...AS REQUIRED

Landing Announcement ....COMPLETED

(Continued)

LANDING

All Main Tank Fuel Boost Pumps .... **ON**

Fuel Crossfeed .... **CLOSED**

Speedbrake .... **ARMED**

Gear .... **DOWN 3 GREEN (PM, PF)**

Flaps .... **____ GREEN LIGHT**

Since an engine is inoperative, the flaps will not be in a normal landing position. Verify the flap position indicator corresponds to the flap handle position selected for landing (should be in flap 15 position unless mechanical problems dictate a lesser setting).

Note: After touchdown, be prepared to use rudder and brakes as necessary to counter the effects of asymmetrical reverse thrust.

* * * *

ONE ENGINE INOPERATIVE APPROACH AND LANDING PROCEDURE

ILS - One Engine Inoperative

Thorough planning is the key to a safe, unhurried, professional approach. Complete the approach preparations before arrival in the terminal area.

Adequate thrust and normal maneuvering margins are available if the approach is flown as illustrated. Good speed control is mandatory. Allowing airspeed to decrease below that recommended increases drag and could result in inadequate thrust for altitude control. Keep the rudder in trim at all times.

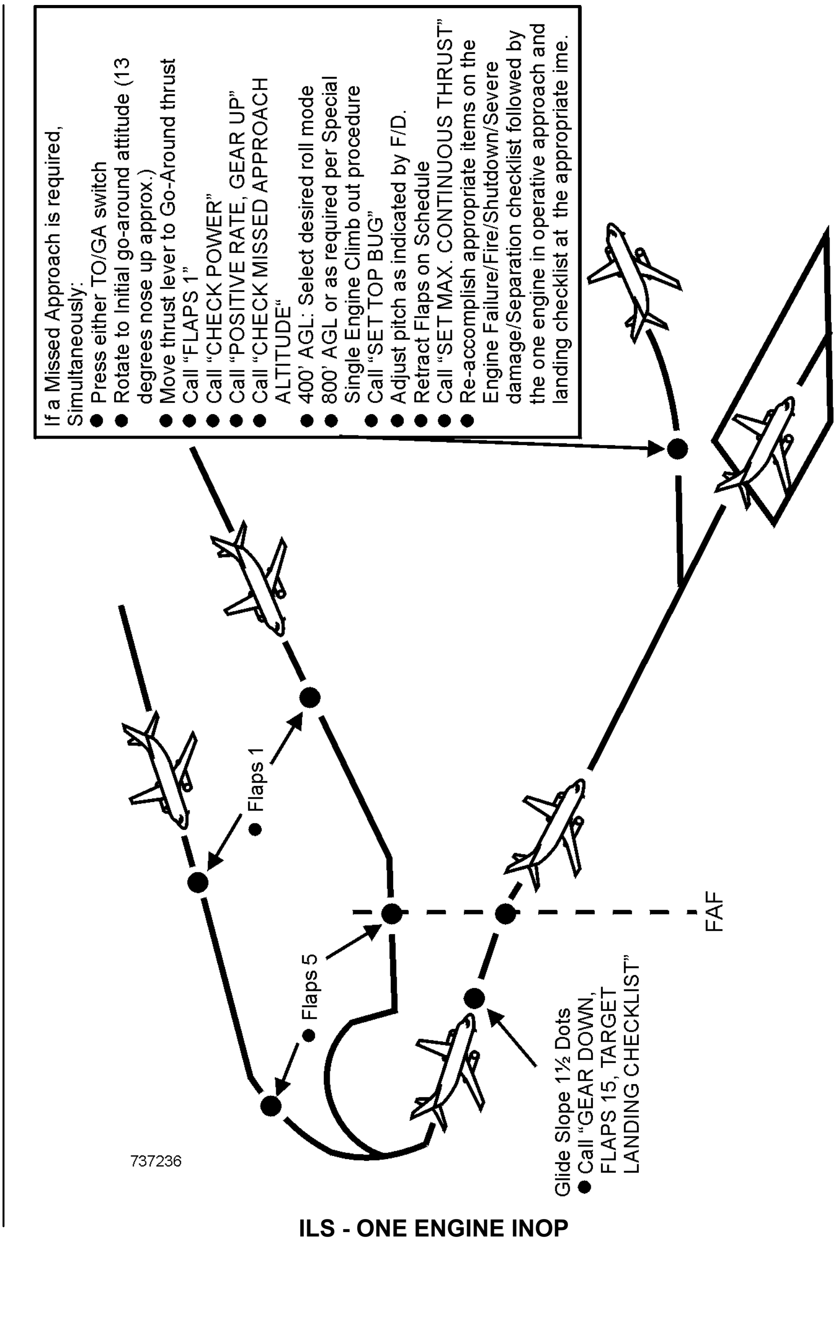
Intercept the localizer with flaps 5 and VM Flaps 5 speed. When the glideslope deviation is approximately 1 to 1 ½ dots, lower the landing gear, extend flaps to 15, and arm the speed brakes. Decelerate to VREF 15 + 5 knots minimum, depending on wind and gusts. Do not decelerate below VREF 15 + 5 during the approach.

Go-Around (One Engine Inop)

- Simultaneously apply go-around thrust, press TOGA, call for flaps 1, and manually rotate to the F/D pitch command (approx. 13 degrees). Call, "CHECK POWER" and at a positive rate of climb, call "POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE" and adjust the pitch attitude to maintain target speed. (VREF 15 + 5 is approximately V2 for flaps 1 and should be considered a minimum speed.) Accomplish the missed approach procedure as illustrated at flaps 1. At 800 feet AGL, or special obstacle clearance altitude (whichever is higher). Call "SET TOP BUG." Setting the airspeed cursor to TOP BUG (VM Flaps 0) will decrease the F/D pitch attitude. Adjust pitch as indicated by F/D. Accelerate to appropriate speed and retract flaps. If returning for another approach, flaps may be left at 1 for maneuvering. Call, "SET MAX CONTINUOUS THRUST" for climb. Re-accomplish appropriate items on the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist, followed by the **ONE ENGINE INOPERATIVE APPROACH AND LANDING** checklist at the appropriate time. The normal After Takeoff checklist does not need to be accomplished.

Accomplish the missed approach procedure as illustrated on the approach chart. If a turning missed approach is required, accomplish the go-around procedure through gear up before initiating the turn. Delay further flap retraction until initial maneuvering is complete and a safe altitude and appropriate speed are attained. Limit bank angle to 15 degrees while maintaining target speed with go-around flaps.

Note: Use of autothrottle is not recommended during one engine inoperative approaches and missed approaches.



ILS - ONE ENGINE INOP

Non-Precision Approach One Engine Inoperative

Intercept the final approach course with flaps 5 at V_M flaps 5. At 1.0 - 1.5 miles from the FAF, extend the landing gear, select flaps 15, and reduce speed to V_{REF} 15 plus wind additive (minimum V_{REF} 15 + 5). Complete the LANDING checklist.

Descent on the gradient path should be maintained to establish a normal descent to DA/DDA. If a gradient path is not available, a descent of 1,000 feet per minute should be maintained to ensure MDA is reached in time to establish a normal descent to the runway in the event visual contact is attained prior to the MAP.

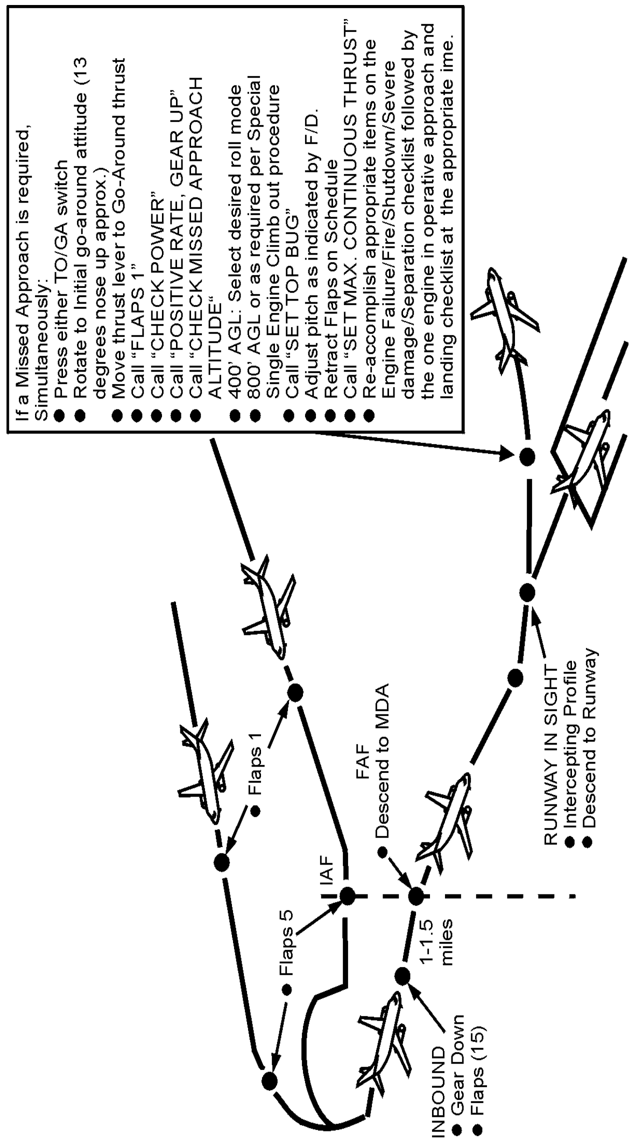
Keep the rudder in trim at all times.

Aircraft operating above max landing gross weight at temperatures in excess of 80 degrees F and pressure altitudes greater than 2,000 feet may be unable to maintain the level flight portion of the approach with gear down and flaps 15.

To preclude this situation, an option is to descend from the final approach fix with the gear up, flaps 10 or 5, and at the appropriate V_M. When the runway is in sight and the aircraft is on the visual profile and a safe landing is assured, select gear down and flaps 15 and reduce speed to V_{REF} 15 plus wind correction (minimum V_{REF} 15 + 5 knots).

Note: A single autopilot can be used for engine inoperative non-precision approach. Autothrottles are disconnected prior to beginning the approach.

Use the same techniques to control yaw as described for an engine inoperative ILS approach.



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NON-PRECISION APPROACHES - ONE ENGINE INOP

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③ 3 5 POWER MANAGEMENT CONTROL (PMC) INOPERATIVE

The power management control INOP light illuminated indicates the PMC is inoperative or selected OFF.

Takeoff

When a takeoff is performed with the PMC's off or inoperative, engine rpm may be expected to increase as speed increases during the takeoff roll. This increase in rpm may be as much as 7% at high airport elevations.

The takeoff performance charts for PMC OFF take into account the rpm change. Normal thrust setting technique for takeoff should be employed, with thrust set by 60 kts. Do not reduce thrust during takeoff after once correctly setting thrust, unless engine parameters increase above maximum limits (red radials).

PMC OFF takeoffs may be performed using the autothrottle.

Reduced thrust takeoff not authorized.

Refer to Section 5 for thrust setting, weight penalties, and speed restrictions.

Inflight

Throttles (If Required).. ADJUST

Flight may continue with autothrottle ON.

In manual operation, adjust the throttles as required.

Observe engine limits.

* * * *

REVERSER LIGHT ON

The **REVERSER** light illuminated indicates additional system failures may cause uncommanded reverser deployment.

IF In Flight:

Additional system failure may cause inflight deployment.

Expect normal reverser operation after landing.

* * * *

OR

IF On Ground:

DO NOT TAKEOFF.

* * * *

REVERSER UNLOCKED (INFLIGHT)

Illumination of the **REVERSER UNLOCKED** light indicates that either of the two reverser sleeves has mechanically unlocked or that the **REVERSER UNLOCKED** light is giving a false indication.

Only multiple failures could allow the engine to go into reverse thrust. Such failures may preclude returning the engine to forward thrust. Unstowed reverser sleeves produce buffet and increase aircraft drag.

Movement of the reverser sleeves to the reverse thrust position mechanically retards the throttle to the idle thrust position, and the interlock limits movement of the throttle as long as the engine is in reverse thrust.

Throttle.. CHECK

Caution: Do not actuate the reverse thrust lever.

IF The Throttle Is Unrestricted And No Buffet Or Yaw Exists:

Operate the engine normally.

If the throttle has not moved toward IDLE, and movement of the lever is unrestricted, the engine is in forward thrust.

OR

* * * *

IF The Forward Thrust Lever Is Restricted, Or Buffet Or Yaw Exists:

Accomplish the **ENGINE FAILURE / FIRE / SHUTDOWN / SEVERE DAMAGE / SEPARATION** checklist.

* * * *

TWO ENGINE FLAMEOUT

The **TWO ENGINE FLAMEOUT** checklist demands prompt action regardless of altitude or airspeed. It is a situation designed specifically to take advantage of the inertia of high engine RPM to increase the probability that a windmill restart will be successful. The probability of a successful windmill start is improved at altitudes below 30,000 feet. Loss of thrust at higher altitudes may require driftdown to a lower altitude to improve windmill capability.

The inflight start envelope is provided to identify the region where windmill starts were demonstrated during certification. It should be noted that this envelope does not define the only areas where a windmill start may be successful.

The APU start should be initiated as soon as practical so as to be available for a starter assisted start attempt if the rapid relight does not succeed.

If the Immediate Action Items are not accomplished either during high engine RPM and/or in the windmill regime, the engine(s) must be started from the APU bleed source if both engines are inoperative or the Crossbleed Start procedure on the **ENGINE START- INFLIGHT** checklist if only one engine successfully started.

During descent, this condition may first be indicated by illumination of the ③ 3 5 **BUS OFF**; 7 8 9 **SOURCE OFF** or **LOW OIL PRESSURE** lights. If ③ 3 5 **BUS OFF**; 7 8 9 **SOURCE OFF** lights illuminate, check N_2 and EGT to verify engine operation.

Several attempts should be made while the engines are spooling down before continuing with the non-memory items of the procedure. However, the number of windmill start attempts could vary depending on altitude and other conditions. If the engines have flamed out due to severe weather, volcanic ash, etc., it may be appropriate to attempt additional windmill starts after exiting these conditions. Based on circumstances, the Captain must make the decision when to continue with the non-memory items of the procedure.

If the rapid relight is not successful and the windmilling RPM has stabilized and a bleed air source (APU) is available, follow this checklist for one start attempt for each engine then use the **ENGINE START - INFLIGHT** checklist. With no bleed air available, increasing airspeed and decreasing altitude, if possible, will enhance the windmill starting capability of the engines.

(Continued)

IMMEDIATE ACTION

Start Switches	**FLIGHT**
Start Levers	**CUTOFF**
Start Levers (After EGT Decreases)	**IDLE**

The immediate action items should be accomplished expeditiously to hopefully effect an immediate restart before the engines have spooled down completely.

This emergency is most likely the result of flight into areas of heavy/extreme precipitation. In such conditions, it may take up to 3 minutes to accelerate to idle thrust. Successful start(s) may not be possible until after leaving the precipitation. Repeated attempts at restarting the engine(s) may be necessary once clear of heavy rain, sleet, or hail.

The start levers should remain in cutoff only long enough to indicate a decrease in EGT.

IF EGT Reaches 3 3 5 930 Degrees; 7 8 9 950 Degrees:
Repeat above steps.

APU (If Available)..START & ON BUS

Note: Do not wait for successful engine start prior to starting the APU.

The APU generator powers the respective generator Bus and both transfer Busses. This provides electrical power to both igniters on each engine which improves start capability.

7 8 9 The APU has demonstrated the capability to provide electrical and pneumatic power to 20,000 feet.

(Continued)

IF One Or Both Engines Start:

❶ When engine parameters have stabilized (either or both engines):

APU Bleed Air Switch.. OFF

Start Switch..FLT

Thrust Lever ....ADVANCE

Generator Switch.. ON

Pack Switch ....AUTO

OR

IF Only One Engine Has Restarted:

Accomplish the **ENGINE START - INFLIGHT** checklist.

IF Neither IRS Attitude Display Recovers After A Generator Bus Is Restored:

IRS Mode Selector Switches ....ATT

Magnetic Heading... ENTER

* * * *

IF Neither Engine Has Restarted:

Start Levers ....CUTOFF

IF N_2 Is Below ③ 3 5 15%; 7 8 9 11% **With** APU Air Available:

Throttles...CLOSED

Wing Anti-Ice Switch .... OFF

Pack Switches .... OFF

OR

APU Bleed Air Switch .... ON

Ignition Select Switch ....BOTH

Either Start Switch .... GRD

At A Minimum Of ③ 3 5 15% N_2; 7 8 9 11% N_2:

(Continued)

Start Lever..IDLE DETENT

Monitor engine instruments. If no increase in EGT is observed within 30 seconds, return start lever to CUTOFF and start switch to OFF.

IF Engine Starts:

Accomplish ❶ above.

IF First Start Attempt Is Not Successful:

Repeat above steps on other engine.

IF Second Attempt Is Not Successful:

Accomplish the **ENGINE START - INFLIGHT** checklist.

IF APU Bleed Air Is Unavailable **OR** N_2 Is Above ③ 3 5 15% N_2; 7 8 9 11% N_2 :

Note: If altitude permits, with no APU Bleed Air available, accelerate to a speed where N_2 Is Above ③ 3 5 15% N_2; 7 8 9 11% N_2 :

Throttles..CLOSED

Wing Anti-Ice Switch .... OFF

Pack Switches .... OFF

Ignition Select Switch ....BOTH

Start Switches...FLT

Start Lever..IDLE DETENT

Monitor engine instruments. If no increase in EGT is observed within 30 seconds, return start lever(s) to CUTOFF.

IF Engine Starts:

Accomplish ❶ above.

OR

IF Neither Engine Starts:

Accomplish the **ENGINE START - INFLIGHT** checklist.

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2.8 – FIRE PROTECTION

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FIRE PROTECTION

③ 3 5 CARGO FIRE DETECTION INDICATION WITH NO FIRE WARNING

The **DET** light has illuminated in a single loop causing the Master **CAUTION** and **OVHT/DET** to illuminate.

ARM Selector Switch .... **AUTO**

Test Switch .... **PUSH**

Verify normal system test.

Test Switch .... **RELEASE**

Verify that **DET** LED(s) is illuminated.

Check and monitor affected compartment for further smoke indications.

If necessary, complete **CARGO FIRE** Checklist.

* * * *

7 8 9 CARGO FIRE DETECTOR FAULT

The **DETECTOR FAULT** light illuminated indicates both loops in one or both cargo compartments have failed.

The fire detection system is one or both cargo compartments is inoperative.

* * * *

③③⑤ CARGO FIRE INDICATION

IF Affected Cargo Door is Open:

Ground Personnel .... REMOVE FROM COMPARTMENT

Affected Cargo Door ....CLOSE

IF Affected Cargo Door is Closed:

ARM Switch...AUTO

BTL 1 PUSH TO DISCHARGE Switch .... PUSH

Note the time. Second halon bottle must be discharged after 15 minutes. Verify **BTL 1** and appropriate **FWD/AFT** green squib lights extinguish, indicating they have fired. Verify **BTL 1 DSCH** light illuminates after 30 seconds, indicating the bottle has discharged.

WARNING: The aircraft must land at the nearest suitable airport within 60 minutes after the activation of BTL 1.

- - - - - - AFTER 15 MINUTES (30 SECONDS IF ON GROUND) - - - - -

BTL 2 PUSH TO DISCHARGE Switch... PUSH

Verify the **BTL 2** green squib light extinguishes, indicating it has fired. **BTL 2 DSCH** light illuminates after approximately 30 seconds, indicating the bottle has discharged.

Recirculation Fan Switch...OFF

Either Pack Switch ....OFF

WARNING: Do not open the affected cargo compartment door until ground emergency personnel and equipment are prepared to fight the cargo compartment fire.

Caution: Evacuation is not mandatory if there are no secondary indications of fire. Secondary indications of fire include smoke, heat, or flames reported by the cabin crew, ATC, or Aircraft Rescue Fire Fighters.

(Continued)

Note: Fire suppression will last 60 minutes. Maneuvering the aircraft, acceleration or deceleration, changing the pitch angle, rolling or yawing movements will cause the extinguishant to move inside the cargo compartment. Within limits, frequent movement of the agent may help keep it mixed and evenly distributed, especially if flight must be continued beyond 60 minutes.

Note: False cargo fire indications can occur due to moisture and/or dust from live animals in the cargo bay.

* * * *

7 8 9 CARGO FIRE INDICATION

IF Affected Cargo Door is Open:

Ground Personnel .... REMOVE FROM COMPARTMENT

Affected Cargo Door ....CLOSE

IF Affected Cargo Door is Closed:

Cargo Fire ARM Switch (FWD/AFT)..........................PUSH TO ARM

Cargo Fire Discharge Switch .... PUSH

DISCH light may require up to 30 seconds to illuminate.

<u>Note</u>: The second bottle will discharge automatically 60 minutes later.

Recirculation Fan Switch(s) .... OFF

7 8 Either Pack Switch .... OFF

9 Operating Pack Switches .... HIGH

<u>WARNING</u>: Do not open the affected cargo compartment door until ground emergency personnel and equipment are prepared to fight the cargo compartment fire.

<u>Caution</u>: Evacuation is not mandatory if there are no secondary indications of fire. Secondary indications of fire include smoke, heat, or flames reported by the cabin crew, ATC, or Aircraft Rescue Fire Fighters.

<u>Note</u>: Fire suppression will last 60 minutes. Maneuvering the aircraft, acceleration or deceleration, changing the pitch angle, rolling or yawing movements will cause the extinguishant to move inside the cargo compartment. Within limits, frequent movement of the agent may help keep it mixed and evenly distributed, especially if flight must be continued beyond 60 minutes.

Plan to land at nearest suitable airport.

* * * *

③ 3 5 CARGO FIRE LOOP FAILURE

A **FAIL** light illuminated indicates the respective loop has failed.

ARM Selector Switch .... AUTO

Test Switch.. PUSH

Verify normal system test except for failed loop(s) LED's are not illuminated.

Test Switch.. RELEASE

Verify that **FAIL** LED(s) is illuminated.

The loop with the illuminated LED has failed. The system has automatically switched to single loop mode. If both **A** and **B** LED's are illuminated for one or both compartments, then the fire detection system for that compartment is inoperative.

* * * *

LAVATORY SMOKE PROCEDURE

In accordance with FAA regulations, all aircraft must be equipped with lavatory smoke detectors and alarm system. The alarm system is located on the lavatory ceiling and has a self-contained alarm.

In the event of an alarm:

1. Treat all lavatory smoke alarm activation as possible fires.
2. One Flight Attendant will contact the Captain and advise him of the location of the alarm.
3. Another Flight Attendant will obtain a fire extinguisher, locate the correct lavatory, and conduct a visual inspection. If a fire exists, the Flight Attendant will attempt to extinguish it.
4. If the visual inspection reveals smoke and/or fire cannot be contained or extinguished, the Captain will be notified immediately. He will determine the nearest suitable airfield in case the source of the smoke cannot be contained and an emergency landing becomes necessary.
5. If the source of the smoke and/or fire cannot be contained or extinguished, the Captain will be notified, and emergency declared, and a landing at the nearest suitable airfield will be made. An emergency evacuation will be accomplished at the Captain's discretion.

If no smoke and/or fire are found and the chime continues to sound, a false activation should be suspected.

Smoke Detector False Activation

Deactivate the alarm as follows:

- Locate the affected smoke detector.
- Deactivate by pushing the Alarm Interrupt switch and hold for five seconds.

If the above procedure is ineffective:

- Pull the circuit breaker (3 3 5 P18-4 A-1 pass & crew call/lav smoke detector) or (7 8 9 P18-3E12 lavatory smoke), and reset after five seconds.
- If the smoke detector reactivates, pull the circuit breaker close and lock the Lavatory doors. There is now no smoke detection capability. The crew should brief an alternate method for crew call.

* * * *

SMOKE / FUMES REMOVAL

This condition is recognized by a persistent or severe accumulation of smoke.

Oxygen Masks & Regulators
(Smoke Goggles, If Required)..ON, 100%

If smoke concentration affects vision, don smoke goggles and use the EMERGENCY position on the oxygen regulator to clear goggles of smoke.

Crew Communications..ESTABLISH

Press crew interphone receiver down and set volume arrow at 12 o'clock or greater. Set MASK/BOOM selector to MASK. Use I/C toggle on audio selector panel or bottom position on YOKE ROCKER switch when speaking to other pilot.

Flight Deck Door... CLOSED

Leave the flight deck door closed to prevent smoke contamination of/from other compartments.

IF Packs ON And Smoke / Fumes Source Confirmed On Flight Deck Or Main Cabin:

L & R Pack Switches ....HIGH

Recirculation Fan Switch(s)...OFF

Pressurization Mode Selector ....(AS INSTALLED) STBY

Cabin Alt Selector (As Installed) .... TO 10,000 FEET MAX

Select higher cabin altitude to increase the ventilation rate.

OR

Cabin Rate Selector (As Installed)..........................MAXIMUM INCR

Digital Controller (As Installed) Land ALT.............................. 10,000’

No. 1 & No. 2 Bleed Air Switches .... VERIFY ON

This assures maximum ventilation.

Engine Thrust (Max Practical) ....ABOVE 45% N_1

During descent / approach, it is desirable to maintain thrust as high as practical to supply maximum bleed air for ventilation.

(Continued)

Flight Deck Air Cond & Gasper Outlets ....OPEN

This assures adequate flow of ventilating air on the flight deck.

Caution: Do not open the flight deck window. Keep the flight deck door closed.

IF Smoke / Fumes Are Uncontrollable:

Aircraft Altitude ....MEA OR 10,000 FEET, WHICHEVER IS HIGHER

At 14,000 feet or below:

Pressurization Mode Selector............................... MAN AC / MAN

Outflow Valve Switch ....OPEN

IF Packs OFF And Smoke / Fumes Source Confirmed On Flight Deck:

Airspeed.. NORMAL HOLDING SPEED

Caution: Window should not be opened unless the source is confirmed to be originating on the flight deck.

Slow aircraft to holding airspeed to minimize the effect of opening a flight deck window.

F/O's Sliding Window..OPEN

Due to resulting high wind noise level, headsets should be on and volume adjusted accordingly.

Land at Nearest Suitable Airport.

* * * *

2.9 – FLIGHT CONTROLS

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FLIGHT CONTROLS

ALL FLAPS-UP LANDING

An All Flaps-Up Landing is required when unable to extend any leading edge or trailing edge flaps.

Before beginning this procedure, consideration should be given to attempting flap extension using the TRAILING FLAPS MALFUNCTION procedure in the QRH and/or in this section of the Flight Manual.

- Burn off fuel to reduce touchdown speed. If tire placard speed (195 knots) is exceeded, tire failure may occur.
- REF Speed = V_{REF} 40 + 55 knots.
- Wind additive is added to the adjusted V_{REF} speed.
- Maintain V_M Flaps 0 speed until on final approach.
- Limit bank angle to 15 degrees when maneuvering below V_M Flaps 0 speed.

Ground Proximity Flap Inhibit Switch..INHIBIT

To avoid a nuisance warning with less than normal landing flaps.

Go-Around Procedure .... REVIEW

Accomplish normal go-around except:

- Limit bank angle to 15 degrees until reaching V_M Flaps 0 speed.
- Accelerate to V_M Flaps 0 speed.

All Flaps-Up Landing Techniques

Prior to intercepting descent profile, decrease airspeed to cursor plus wind correction and maintain this speed until the landing is assured. The normal no-wind rate of descent on final will be approximately 900 FPM due to the higher ground speed. Plan touchdown at the 1000 foot point.

After touchdown, hold forward control column pressure. Without delay, apply reverse thrust and brakes consistent with runway conditions.

* * * *

AUTO SLAT FAIL

The **AUTO SLAT FAIL** light illuminated indicates failure of both auto slat channels.

No crew action required in flight.

* * * *

ELEVATOR TAB LIMIT CYCLE OSCILLATION

An Elevator Tab Limit Cycle Oscillation (LCO) will be characterized by high frequency, possibly severe vibration, originating in the tail of the aircraft and emanating forward through the airframe structure. LCO events have previously occurred at airspeed greater the 275 KIAS, and in an altitude range between 10,000 and 25,000 feet following ground deicing / anti-icing of the horizontal stabilizer. This vibration may, or may not, be felt in the control column. Cabin crews may be able to confirm the source of any airframe vibrations.

IF LCO Is Suspected In Flight:

Immediately reduce airspeed (WITHOUT use of speed brakes, or changing aircraft configuration) to 270 KIAS, or until the vibration ceases, whichever indicated airspeed is lower.

DO NOT USE SPEED BRAKES FOR THE REMAINDER OF THE FLIGHT.

Use of the speed brakes in other emergencies is at the discretion of the flight crew.

Remain at or below the indicated airspeed at which the vibration ceases for the remainder of the flight, but do not exceed 270 KIAS.

Evaluate the need to land at the nearest suitable airport. Landing airport selection should be based upon weather, distance to destination, range available at the reduced airspeed, maximum landing weight, and possible airframe damage.

Use of ground spoilers during landing rollout is permitted.

* * * *

FEEL DIFFERENTIAL PRESSURE

The **FEEL DIFF PRESS** light illuminated indicates the elevator feel computer is sensing a significant pressure differential between hydraulic systems “A” and “B” or one of the elevator feel pitot systems failed.

No crew action required in flight.

* * * *

FLIGHT CONTROL LOW PRESSURE

The **LOW PRESSURE** light illuminated indicates low hydraulic system pressure to ailerons, elevators, and rudder from the associated hydraulic system <u>or</u> ③ 3 5 a flight control low pressure light may indicate that the Rudder Pressure Reducer has failed in the low pressure mode.

Flight Control Switch (Affected Side) ....STBY RUD

> This starts the standby hydraulic pump and arms the standby **LOW PRESSURE** light. The flight control **LOW PRESSURE** light extinguishes indicating the standby rudder shutoff valve has opened.

* * * *

JAMMED OR RESTRICTED ELEVATOR OR AILERON

In the event of a jammed elevator or aileron, do not hesitate to apply additional force to maintain control of the aircraft. Do not turn off any flight control switches unless the faulty control is positively identified. Manual trim may be used to offload control forces (Ref. A.D. 96-26-07).

This procedure is accomplished when use of the Elevator or Aileron is restricted, or reduced.

Autopilot (If Engaged)..........DISENGAGE

Autothrottle (If Engaged)..........DISENGAGE

Symmetrical Thrust..........VERIFY

Jammed or Restricted System..........OVERPOWER

- Use maximum force, including a combined effort of both pilots, if required. A maximum two-pilot effort on the controls will not cause a cable or system failure.

WARNING: Do not turn off any flight control switches unless the faulty control is positively identified.

- If the aileron or spoiler is jammed, force applied to the Captain's and the First Officer's control wheels identifies which lateral control system (aileron or spoiler) is usable and which control wheel (Captain's or First Officer's) provides roll control.
- If the aileron control system is jammed, force applied to the First Officer's control wheel provides roll control from the spoilers. The ailerons and the Captain's control wheel are inoperative.
- If the spoiler system is jammed, force applied to the Captain's control wheel provides roll control from the ailerons. The spoilers and the First Officer's control wheel are inoperative.

IF **Controls Are Normal:**

OR

Accomplish normal IN RANGE, APPROACH and LANDING checklists when appropriate.

IF **Controls Are Not Normal:**

Stabilizer Trim Override Switch..........OVERRIDE

(Continued)

Bank Angle Limit ....15 DEGREES

Plan To Land At Nearest Suitable Airport.

Plan a flaps 15 landing. Flaps 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

REF Speed .... V_{REF} 15

7 8 9 If icing conditions have been experienced or are anticipated prior to landing set $V_{REF} = V_{REF}$ 15 + 10.

Target Speed .... V_{REF} PLUS WIND ADDITIVE

Ground Proximity Flap Inhibit Switch...............................INHIBIT

* * * *

JAMMED STABILIZER

This condition is recognized by failure of the stabilizer to respond to electric trim inputs.

Manual Trim..APPLY

There is no limit on the amount of effort which the Pilots may exert on the manual trim wheels when attempting to free a jammed stabilizer. Force applied to the trim wheels causes a disconnect clutch to disengage. Approximately ½ turn of the stabilizer wheel is necessary to disengage the clutch before trimming can take place. Steady pressure on the manual trim handles is required to prevent engagement before the desired trim is attained.

IF Airload Causes Trim Wheel To Move When Released:

Stabilizer Trim Autopilot Cutout Switch ....CUTOUT

- Autopilot is not available.
- Maintain in-trim airspeed until start of approach. To reduce the force required to move the stabilizer, use an airspeed which results in an in-trim condition.
- Plan a flaps 15 landing. Flaps 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

REF Speed.. V_{REF} 15

7 8 9 If icing conditions have been experienced or are anticipated prior to landing set $V_{REF} = V_{REF}$ 15 + 10.

- Use normal wind additive to V_{REF} for establishing appropriate "target" speed.
- Establish landing configuration early.
- Anticipate higher than normal elevator force during approach and landing.

Ground Proximity Flap Inhibit Switch...INHIBIT

* * * *

LEADING EDGE FLAP TRANSIT LIGHT ON

The **LE FLAPS TRANSIT** amber light illuminated indicates an asymmetry, no leading edge device(s), or leading edge devices not in programmed position with respect to the trailing edge flaps. The leading edge devices annunciator on the aft overhead panel confirms status of leading edge devices.

Airspeed (Max)..230 KTS

Wing Anti-Ice (If TAT Below 10° C)... ON

IF Roll Encountered <u>Or</u> During Flap <u>Extension</u> With No Roll:

Plan a flaps 15 landing.

Ref Speed ....3 3 5 V_{REF} 15 PLUS 5 KNOTS
7 8 9 V_{REF} 15 PLUS 15 KNOTS

7 8 9 V_{REF} 15 PLUS 15 KNOTS additive above is adequate in icing conditions, therefore no additional icing penalty is necessary.

OR

Use normal wind additive to V_{REF} for establishing appropriate "target" speed.

Bank Angle ....LIMIT TO 15 DEGREES WHEN BELOW V_M FLAPS 0 SPEED

Ground Proximity Flap Inhibit Switch............................INHIBIT

<u>Note</u>: If **LE FLAPS TRANSIT** light should extinguish during flap extension, proceed with normal landing.

* * * *

IF During Flap <u>Retraction</u> With No Roll Encountered:

LED Annunciator Panel (Aft Overhead) ....CHECK

Flap Handle (Pilot Option).. RECYCLE

(Continued)

IF LE FLAP TRANSIT Light Extinguishes:

Proceed normally.

OR

* * * *

IF LE FLAP TRANSIT Light Remains Illuminated, Limit Airspeed As Follows:

- If any light(s) for only one leading edge device is illuminated, do not exceed 300 knots (280 kts for turbulent air penetration) or .65 Mach, whichever is lowest.
- If any light(s) for more than one leading edge device is illuminated, do not exceed to 230 knots.

- - - - - PRIOR TO LANDING - - - - -

Plan a flaps 15 landing. Flaps 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

REF Speed .... 3 3 5 **V_{REF} 15 PLUS 5 KNOTS**
7 8 9 **V_{REF} 15 PLUS 15 KNOTS**

7 8 9 V_{REF} 15 PLUS 15 KNOTS additive above is adequate in icing conditions, therefore no additional icing penalty is necessary.

Use normal wind additives to establish an appropriate "target" speed.

Bank Angle .... **LIMIT TO 15 DEGREES WHEN BELOW V_M FLAPS 0 SPEED**

Ground Proximity Flap Inhibit Switch .... **INHIBIT**

Note: If LE FLAPS TRANSIT light should extinguish during flap extension, proceed with normal landing.

* * * *

MACH TRIM FAIL

The **MACH TRIM FAIL** light illuminated indicates the Mach Trim system has failed.

Limit airspeed to 280 KIAS or ③ 3 5 .74 or 7 8 9 .82 Mach, whichever is lower.

* * * *

RUNAWAY STABILIZER

This condition is recognized by continuing rotation of the stabilizer trim wheel in a manner not appropriate for flight conditions.

Maintain normal flight attitude by moving control column smoothly in opposite direction to runaway. Stabilizer brake should engage.

Control Column ....HOLD FIRMLY

Autopilot (If Engaged) ....DISENGAGE

Do not re-engage the autopilot.

IF Runaway Continues:

Stabilizer Trim Cutout Switches ....CUTOUT

Continued trimming opposite to an electric trim runaway may result in overheating and/or stalling of the stabilizer trim motor. In the unlikely event that both stabilizer brake systems have malfunctioned, placing the stabilizer trim cutout switches to cutout will have no effect on the runaway. Control column displacement with no trim input can cause air loads to aggravate the runaway condition.

IF Runaway Continues:

Stabilizer Trim Wheel ....GRASP & HOLD

If positioning the stabilizer trim cutout switches to cutout does not stop the runaway, stabilizer travel can be stopped by grabbing and holding the stabilizer trim wheel.

Stabilizer ....TRIM MANUALLY

Anticipate trim requirements.

Complete IN RANGE, APPROACH, and LANDING CHECKLISTS.

Establish proper airspeed and establish an in-trim airspeed early on final approach.

* * * *

SPEED TRIM FAIL

The **SPEED TRIM FAIL** light illuminated indicates failure of the speed trim system.

No crew action required in flight.

* * * *

SPEEDBRAKE DO NOT ARM

The **SPEEDBRAKE DO NOT ARM** light illuminated indicates a fault in the automatic speedbrake system.

Speedbrake Lever ....FULL FORWARD

Manually deploy the speedbrakes immediately upon touchdown.

* * * *

7 8 9 SPEEDBRAKES EXTENDED

The **SPEEDBRAKES EXTENDED** light illuminated <u>in flight</u> indicates the spoilers are deployed and:

- Speed brake handle is beyond the ARMED position, and
- Trailing edge flaps extended more than 10°, or
- Radio altitude less than 800 feet.

The **SPEEDBRAKES EXTENDED** light illuminated on the <u>ground</u> indicates the speed brake lever is in the DOWN detent and the ground spoilers are deployed.

Speed Brake Lever ....ARMED/DOWN DETENT

IF Light Remains Illuminated After Speed Brake Lever Is Down:

Spoilers may be extended.

OR

IF Light Is Illuminated On The Ground:

Do not take off.

* * * *

STAB OUT OF TRIM

The **STAB OUT OF TRIM** light illuminated, with the autopilot engaged, indicates that the elevator position exceeds a certain value in relation to stabilizer position.

Momentary illumination of the **STAB OUT OF TRIM** light during large changes in trim requirements is normal.

IF The Stabilizer Is Not Trimming:

Control Column...HOLD FIRMLY

The control column should be held steady to prevent undesirable aircraft pitching.

Autopilot..DISENGAGE

The autopilot should be disengaged as soon as practical.

Stabilizer Trim...AS REQUIRED

Return to an in-trim condition.

* * * *

TRAILING EDGE FLAPS MALFUNCTION

Flap Position Indicator CB .... CHECK

IF Flaps Are <u>Asymmetric</u> (Flap Position Needles Are Separated):

<u>Caution</u>: Do not attempt further movement of trailing edge flaps with the alternate flaps switch as there is no asymmetry protection.

Consider burning off fuel to reduce touchdown speed. Max tire speed is 195 knots.

OR

Flap Lever.........MOVE FLAP LEVER TO DETENT NEAREST TO THE SMALLEST ACTUAL FLAP POSITION

Adjusted V_{REF} computation (set V_{REF} Bug as follows):

Flaps Less Than 1 .... V_{REF} 40 + 40 KNOTS

Flaps Between 1 & 15..................................... V_{REF} 40 + 30 KNOTS

Flaps 15 Or More ....SET V_{REF} FOR SMALLEST ACTUAL FLAP POSITION

(Continued)

7 8 9 If using V_{REF} 15 and If icing conditions have been experienced or are anticipated prior to landing set V_{REF} =V_{REF} 15 + 10.

Use normal wind additive to V_{REF} for establishing appropriate “target” speed.

Target Speed .... ADJUSTED V_{REF} PLUS WIND ADDITIVE

- Stick shaker may occur at high gross weights and/or bank angles greater than 15 degrees.

Flaps less than 1:

- Maintain V_M Flaps 0 until on final.
- Limit bank angle to 15 degrees below V_M Flaps 0 speed.

Flaps 1 or greater:

- Maintain at or above V_M for smallest actual flap position until on final.
- Limit bank angle to 15 degrees when below V_M for smallest actual flap position.

- - - - - PRIOR TO FINAL - - - - -

Ground Proximity Flap Inhibit Switch.............................INHIBIT

IF Leading Edge Devices Are Not In FULL EXT Position:

Alternate Flaps Master Switch.. ARM

This arms the alternate flaps switch and starts the standby hydraulic pump for leading edge device extension.

Alternate Flaps Position Switch (230 Knots Max) .... MOMENTARILY DOWN

The flap asymmetry is not adversely affected by holding the switch momentarily down. Verify LED annunciator panel (AFT overhead) indicated FULL EXT.

Amber **LE FLAPS TRANSIT** light (center instrument panel) may remain illuminated if flaps are less than 10 degrees.

Note: If leading edge devices remain retracted and trailing edge devices are less than 1, refer to ALL FLAPS UP LANDING procedure.

(Continued)

Go-Around Procedure .... REVIEW

Limit bank angle to 15 degrees when below V_M for smallest actual flap position.

Do not exceed leading edge or trailing edge flap limit speeds.

* * * *

IF Flaps Are Symmetric (Flap Position Indicator Needles Are Not Separated):

Plan a flaps 15 landing using alternate flap extension.

A flaps 15 landing is recommended because of the time required to retract flaps electrically in event of a go-around.

Flaps 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

REF Speed ....V_{REF} 15

7 8 9 If using V_{REF} 15 and if icing conditions have been experienced or are anticipated prior to landing set $V_{REF} = V_{REF}$ 15 + 10.

Use normal wind additive to V_{REF} for establishing appropriate "target" speed.

- - - - - PRIOR TO FINAL - - - - -

Ground Proximity Flap Inhibit Switch............................INHIBIT

Alternate Flaps Master Switch .... ARM

Arms the alternate flap switch and starts the standby hydraulic pump for LED extension.

During flap extension (230 knots max), set handle to next desired flap position, extend flaps, then slow to respective maneuver speed. Repeat this process until flaps have been lowered to 15.

Note: Asymmetry protection is not provided when the alternate extension system is used. Monitor the flap indicators closely. Alternate extension to flaps 15 takes approximately 2 minutes.

(Continued)

Note: The **LE FLAPS TRANSIT** light will remain illuminated until flaps approach the flaps 10 position.

Note: If the flaps do not move to the selected position, complete the "IF Flaps Are Asymmetric" procedure at the beginning of this checklist.

Go-Around Procedure .... REVIEW

Observe trailing edge flap and leading edge device limit speeds.

Use caution to avoid retracting flaps to less than desired position. If flaps must be retracted, use alternate flap position switch. Switch must be manually positioned to OFF from UP. Use caution to avoid retracting flaps to less than desired position.

With trailing edge flaps retracted and the flap lever positioned to UP, the leading edge devices may be retracted by placing the alternate flap master switch to OFF.

* * * *

UNCOMMANDED YAW OR ROLL

Accomplish this procedure if uncommanded yaw or roll occurs in flight (Ref: A.D. 2000-22-02 R1).

- Maintain control of the aircraft with all available flight controls. If roll is uncontrollable, immediately reduce pitch attitude/angle of attack and increase airspeed. Do not attempt to maintain altitude until control is recovered.

WARNING: The pilot should be prepared prior to Autopilot/ Autothrottle disengagement to make control wheel corrections to return to wings level.

The Autopilot may be attempting to hold the aircraft wings level with a significant control wheel displacement. Allowing the control wheel to return to the neutral position after disengagement may aggravate the rolling tendency.

- If engaged, disconnect Autopilot and Autothrottle.

IMMEDIATE ACTION

Autopilot (If Engaged) ....DISENGAGE

Maintain control of the aircraft with all available flight controls. If roll is uncontrollable, immediately reduce pitch / angle of attack and increase airspeed. Do not attempt to maintain altitude until control is recovered.

Autothrottle (If Engaged)...DISENGAGE

Symmetrical Thrust ....VERIFY

IF Yaw Or Roll Continues:

Yaw Damper Switch .... OFF

The Yaw Damper light illuminates when the yaw damper is disengaged.

If it is confirmed that the Autopilot or Autothrottle is not the cause of the uncommanded yaw or roll, the Autopilot may be re-engaged at the pilot's discretion.

* * * *

UNCOMMANDED RUDDER

Condition: Uncommanded rudder pedal displacement or pedal kicks. (Ref: A.D. 2000-22-02 R1).

IMMEDIATE ACTION

Autopilot (If Engaged) .... DISENGAGE

Maintain control of the aircraft with all available flight controls. If roll is uncontrollable, immediately reduce pitch / angle of attack and increase airspeed. Do not attempt to maintain altitude until control is recovered.

Autothrottle (If Engaged) .... DISENGAGE

Symmetrical Thrust .... VERIFY

IF Yaw Or Roll Continues:

Yaw Damper Switch .... OFF

Rudder Trim .... CENTER

Rudder Pedals .... FREE & CENTER

Use maximum force including a combined effort of both pilots, if required to free and center the rudder pedals.

IF Rudder Pedal Position Or Movement Is Not Normal And The Condition Is Not The Result Of Rudder Trim:

System B Flight Control Switch .... STBY RUD

A slight rudder deflection may remain, but continued rudder pedal pressure may help maintain an in-trim condition.

Sufficient directional control is available on landing using differential braking and nose wheel steering.

OR

Crosswind capability may be reduced.

Do not use autobrakes.

Consider checking rudder freedom of movement at a safe altitude using slow rudder inputs while in the landing configuration and at approach speed.

IF Condition Was The Result Of Rudder Trim Or Environmental Factors:

Yaw Damper Switch .... ON

Accomplish the normal DESCENT – APPROACH and LANDING checklists.

* * * *

YAW DAMPER

The yaw damper is a separate control and provides a limited rudder movement in opposition of the yaw rate of the aircraft. Rudder (yaw damper) indicator displacement indicates yaw damper operation. **YAW DAMPER** light illuminates amber when the yaw damper is not engaged (Ref. A.D. 96-26-07).

Yaw Damper Switch.. OFF, THEN ON

IF Light Remains Illuminated:

Yaw Damper Switch .... OFF

* * * *

2.10 – FLIGHT INSTRUMENTS, DISPLAYS

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FLIGHT INSTRUMENTS, DISPLAYS

AIRSPEED UNRELIABLE

- Pitch attitude not consistent with existing phase of flight, altitude, thrust, and weight, or noise and/or low frequency buffeting.
- Crosscheck ground speed and winds provided by the IRS and FMC to determine airspeed accuracy if indicated airspeed is questionable.
- Reference FLIGHT WITHOUT RELIABLE AIRSPEED chart in section 5 or QRH.

Note: Erroneous or unreliable airspeed indications may be caused by blocked or frozen pitot-static system(s), or a severely damaged or missing radome.

Aircraft Attitude & Thrust .... ADJUST

Pitot / Probe Heat ....CHECK ON

Mach & Airspeed Indicators .... CROSS CHECK

* * * *

7 8 9 ALT DISAGREE

The **ALT DISAGREE** alert indicates the Captain's and First Officer's altitude indications disagree by more than 200 feet for more than 5 continuous seconds.

Altimeter Barometric Settings.. CHECK

Check all altimeters set to proper barometric setting for phase of flight.

IF **ALT DISAGREE** alert extinguishes after resetting barometric settings, operate normally.

OR

* * * *

IF **ALT DISAGREE** alert remains:

Flight not permitted in RVSM airspace.

Transponder altitude received by ATC may be unreliable.

Maintain visual conditions, if possible.

(Continued)

Establish landing configuration early.

Radio altitude reference available below 2,500 feet.

Use electronic and visual glide slope indicators, where available, for approach and landing.

* * * *

7 8 9 CDS FAULT

The **CDS FAULT** annunciation indicates a CDS fault.

Note: The **CDS FAULT** annunciates on the ground only, prior to second engine start.

Do Not Takeoff.

* * * *

7 8 9 CDS MAINT

The **CDS MAINT** annunciation indicates maintenance is required on the CDS system.

Note: The **CDS MAINT** annunciates on the ground only prior to second engine start.

Do Not Takeoff.

* * * *

7 8 9 DISPLAYS CONTROL PANEL

The absence of an altimeter and the DISPLAYS CONTROL PANEL annunciation, in its place, indicates failure of the related EFIS control panel.

Note: The altimeter blanks and an ALT flag illuminates on the side corresponding to the failed control panel. The pressurization system AUTOFAIL will also annunciate if the failure is in the Captain's panel. The Autopilot for the respective control panel may also disengage. The Autopilot of the operating side should continue to function.

Displays Control Panel Select Switch
(On Overhead Panel)................................BOTH ON 1 Or BOTH ON 2

Select side corresponding to the operating control panel. Verify DISPLAYS CONTROL PANEL annunciation and ALT flag extinguish, and altimeter reappears.

Note: Information on all flight instrument DU's is now controlled by the operable Displays Control Panel.

* * * *

7 8 9 DSPLY SOURCE

WARNING: Moving the DISPLAYS SOURCE switch on the overhead panel to the failed side will lead to loss of all flight instruments.

IF Displayed On The Ground:

DO NOT TAKEOFF.

The **DSPLY SOURCE** annunciation indicates only one DEU is supplying display information.

Note: Other indications and considerations:

- Absence of hydraulic pressure indication on failed side
- Speed limit flag visible on failed side
- Minimum maneuver speed and stick shaker band removed from airspeed indicator on failed side
- EEC's revert to Soft Alternate Mode.
- Dual autopilot approach is not available.

* * * *

7 8 9 DISPLAY UNIT FAILURE

IF A Single Display Is Unusable And Automatic Switching Has Occurred:

No crew action required.

* * * *

OR

IF A Single Display Is Unusable And Automatic Switching Has Not Occurred:

MAIN PANEL DUs Selector..................................AS REQUIRED

LOWER DU Selector ....AS REQUIRED

* * * *

ERRONEOUS COMPASS HEADINGS

Determine which system is accurate. Note RDMI HDG and HSI heading flags. Check the standby compass in level flight.

Compass Transfer Switch.................. BOTH ON OPERATING SYSTEM

* * * *

FLIGHT RECORDER

The flight recorder **OFF** light illuminated indicates that the recorder is not operating.

No Crew Action Required.

* * * *

7 8 9 IAS DISAGREE

The **IAS DISAGREE** alert indicates the Captain's and First Officer's airspeed indications disagree by more than 5 knots for 5 continuous seconds.

Accomplish the **AIRSPEED UNRELIABLE** checklist.

* * * *

INSTRUMENT SWITCHING

While this type of failure can be difficult to detect under normal circumstances, instrument switching capabilities can compound the problem considerably. If all navigation information displays are connected to a single VHF navigation receiver, a failure of this type can be extremely difficult to identify. Situations where redundancy of navigation information is lost should be avoided. Instrument switching should be avoided. Instrument switching should only be used in performance of published abnormal procedures. If a failure dictates instrument switching then cross checking from all other available information including ATC radar should be used.

* * * *

3 5 SYMBOL GENERATOR FAIL

The **SG FAIL** annunciation illuminated on the EADI and EHSI, or blanking of both EADI and EHSI displays indicates a failure of the respective symbol generator.

EFI Transfer Switch..AS REQUIRED

Note: Do not engage either autopilot.

* * * *

2.11 – FLIGHT MANAGEMENT, NAVIGATION

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FLIGHT MANAGEMENT, NAVIGATION

CDU FAIL

Note: If FMC annunciation is displayed in the center of the CDU you have had:

7 8 9	DUAL FMC Failure.
③ 3 5	SINGLE FMC Failure.

Refer to the applicable Abnormal above.

IF One CDU Display Is Completely Blank And Other Side Is Operable Check FMCS C/Bs (③ 3 5 P18-2, E6-9) (7 8 9 P6-1, D15 &16; P18-2, A6 & 7, E8).

OR Operable CDU may be used to make all required entries.

* * * *

IF Both CDU Displays Are Completely Blank Check FMCS C/Bs (③ 3 5 P18-2, E6-9) (7 8 9 P6-1, D15 &16; P18-2, A6 & 7, E8).

FMC/CDU, LNAV and VNAV are inoperative. Resume conventional navigation.

7 8 9 Refer to ❶ (in the DUAL FMC FAILURE Non-Normal)

* * * *

7 8 9 DUAL FMC FAILURE

The failure of both FMC's is indicated by:

- FMC ALERT light.
- Failure of MAP information on both sides.
- Blank MCDU except for MENU with ACARS available.

If dual FMC failure occurs the FMC, LNAV and VNAV are inoperative. Resume conventional navigation.

❶ Select VOR or APP as appropriate on the displays control panel. Ensure appropriate NAV frequency has been selected to the active side of the NAV control panel.

Note: When preparing for approach:

- Use SPD REF selector located above upper engine display to set the reference airspeed bugs for V_{REF}. This speed is found in the QRH / Flight Manual Sec. 5 performance section. Set the current WT so the displayed V_M speed bugs will be displayed correctly. Ensure selector is returned to SET after speed entry is made.
- Use the N_1 SET located above upper engine display to set the N_1 bugs for appropriate go around setting.

* * * *

FMC/CDU ADVISORY MESSAGES

These messages relate to incorrect scratch pad entries or to FMC/CDU status. This is a general list: some messages may not apply to all FMC configurations. The white **CDU MSG** light illuminates and the message is displayed in the CDU scratch pad. Some messages will displace an existing scratch pad entry and are displayed immediately when generated. Other messages will not be displayed until the scratch pad has been cleared; however, the **MSG** light will still be illuminated. A new entry in the scratch pad overrides any displayed message. Messages caused by CDU entry errors are displayed only on the associated CDU; other messages are displayed on both CDUs. When multiple messages have been generated, they will be stacked for display in priority sequence, or in the order of their occurrence if of the same priority. As each message is cleared, the next message in the stack is displayed. Most messages are cleared with the CLR key on the CDU, or by correcting the condition. Other messages are cleared by changing the displayed page; this will delete the entry which caused the message. The following tables list all advisory messages, their cause, and the recommended corrective action.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	The aircraft is above its maximum certified altitude.	Descend to an altitude below the maximum certified altitude.
ALT CONSTRAINT XXXXX (altitude value)	Added or modified constraint conflicts with existing downtrack constraint(s).	Clear the message and revise the entry.
APPRCH VREF NOT SELECTED	Aircraft has transitioned into approach environment and Vref has not been selected on APPROACH REF page.	Select Vref on APPROACH REF page.
ARR N/A FOR RUNWAY	Runway or approach does not match the selected arrival procedure.	Go to the ARRIVALS page and modify selection.
BUFFET ALERT	Current conditions result in a maneuver margin less than specified.	Bring the aircraft back within the operating envelope.
CHECK FMC FUEL QUANTITY	The FMC has detected an unexpected drop in the fuel quantity.	Check the fuel system gauges for correctness.
DATA BASE FULL	Entry attempted into a supplemental or temporary navigation data base category which is full.	Go to the NAV DATA pages and delete unneeded waypoints, navaids, or airports from the appropriate data base and re-attempt entry.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
DES PATH UNACHIEVABLE	When in path descent and above the path, the FMC predictions show the profile restrictions at the next waypoint cannot be achieved (LNAV remains engaged).	Modify the restrictions.
DRAG REQUIRED	Airspeed is 10 kts or more above FMC target speed or within 5 kts of Vmo/Vmmo.	Use speedbrakes, trim or reduced thrust, as required, to bring the aircraft within 5 kts of FMC target speed.
INVALID DELETE	DEL key operation was attempted for a data line to which it was not applicable.	Clear the message and select the proper line after the DEL key is pressed.
INVALID ENTRY	Attempted data entry has incorrect format, range, etc. for the selected data line. Entered RTA waypoint is not in the flight plan.	Clear the message and scratch pad entry, and repeat the entry with the correct data.
INVALID OFFSET	Desired offset does not meet FMC offset criteria.	Clear the message and amend the entry.
LOC CAP ACTIVE	The aircraft is approaching its turn onto the localizer course and will maintain an intercept heading.	Clear the message manually, or wait for the AFDS to signal reset status to the FMC.
LOC CAP CANCELLED	Flight plan modifications or the aircraft condition did not facilitate localizer capture.	Clear the message manually, or wait for the AFDS to reset to LOC CAP ACTIVE.
MAX ALT FLXXX (flight level value)	Altitude entry on any page is above the maximum altitude for current selected performance margins.	Clear the message or amend the data entry.
MAX MACH .XXX/MIN MACH .XXX OR MAX CAS .XXX/MIN CAS .XXX	FMC target speed is greater than the maximum or less than the minimum buffet speed for the entered cruise or step climb altitude.	Change the target speed to within the message limits or enter a lower altitude.
NO DES PATH AFTER XXXXX (waypoint)	FMC is unable to construct a PATH DES that satisfies all altitude restrictions after XXXXX.	Modify speed or altitude restrictions on the RTE LEGS pages.
NOT IN DATA BASE	FMC does not contain the required data for the entered identifier.	Clear the message and check data entry, or enter the required information into the supplemental or temporary navigation data base via the NAV DATA pages.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
NOT IN FLIGHT PLAN	RTA waypoint or lateral offset start/end waypoint entry is not in active flight plan.	Clear the message and amend the entry.
NOT ON INTERCEPT HEADING	Aircraft is not within the LNAV capture criteria for the active leg (LNAV disengages).	Manually place the aircraft on an intercept heading and reengage LNAV.
OFFSET DELETED	The entered start waypoint has been deleted from the flight plan.	Clear the message and amend the route.
OFST ENDS ABEAM XXXXXX	An invalid offset leg exists between the end waypoint (XXXXXX) and the start of offset or no end waypoint exists.	Clear the message and amend the route.
PROGRAM PIN ERROR	FMC connector wiring is incorrect.	System unusable; advise maintenance personnel. The CLR key will not clear the message.
RESET MCP ALT	FMC operation cannot take aircraft away from the AFDS MCP altitude.	Select a MCP altitude value in the proper direction (higher for climb, lower for descent).
ROUTE FULL	Entry of more than maximum allowed number of waypoints or holding patterns attempted.	Clear the message and review existing and desired waypoints and holding patterns for possible deletion.
RUNWAY N/A FOR SID	The selected runway is not applicable to the selected departure procedure.	Clear the message and check selections on the DEPARTURES page. Modify as required.
SELECT ACTIVE WPT/LEG	Power–up restart or insertion of a different flight plan while airborne.	EXECute a direct–to or leg intercept to tell the FMC which leg of the route is active.
STEEP DESCENT AFTER XXXXXX	An excessive vertical discontinuity exists after point XXXXXX.	Check routing.
TAI ON ABOVE 10°C	Aircraft is operating with anti-icing with TAT above +10°C.	Clear the message and check the use of anti–icing for engines and/or wings.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE CRZ ALT	FMC predicts that the aircraft cannot reach the new CRZ ALT due to performance limitations. Or FMC predicts that no cruise time is possible at the entered CRZ ALT.	Clear the message and review the CRZ ALT selection.
UNABLE MACH .XXX	The entered cruise mach is unattainable based on present gross weight.	Select a smaller mach number or wait until gross weight is reduced sufficiently.
UNABLE TO OFFSET	A valid offset cannot be constructed due to geometric limitations.	Clear the message and amend the route.
USING RSV FUEL	Predicted fuel remaining at DEST is less than the RESERVES entry on the PERF INIT page. May be the result of an inoperative fuel quantity indicator.	Clear the message and change routing if required. Use manual computations of fuel quantity remaining to determine gross weight.
VERIFY GW AND FUEL	Fuel flow data becomes invalid after engine start and fuel value is replaced with dashes.	Enter fuel weight on PERF INIT page 1/2. Periodic update of fuel weight is required to keep gross weight value current.
VERIFY RNP VALUE	When entering an RNP the underlying RNP value is smaller than the manually entered value or the ANP is greater than the manually entered RNP.	Change or delete the manually entered RNP.
XXXX (airport identifier)	A REF AIRPORT is entered on the POS INIT page and no entry of ORIGIN yet appears on RTE page 1.	Enter the airport identifier on the ORIGIN data line.
XXXXX (MCP altitude value)	In cruise, resetting the AFDS MCP altitude to a value different from the CRZ ALT causes the value to appear in the scratch pad.	Enter the MCP altitude value on the appropriate target altitude data line.

FMC/CDU ALERTING MESSAGES

These messages relate to operationally significant conditions which affect FMC/CDU operation. This is a general list: some messages may not apply to all FMC configurations. The amber **FMC ALERT** light on each pilot's instrument panel illuminates whenever an alerting message is displayed in the CDU scratch pad. The white **CDU MSG** light also illuminates. Some messages will displace an existing scratch pad entry and are displayed immediately when generated. Other messages will not be displayed until the scratch pad has been cleared; however, the **MSG** light will still be illuminated. A new entry in the scratch pad overrides any displayed message. Messages caused by CDU entry errors are displayed only on the associated CDU; other messages are displayed on both CDUs. When multiple messages have been generated, they will be stacked for display in priority sequence, or in the order of their occurrence if of the same priority. As each message is cleared, the next message in the stack is displayed. Most messages are cleared with the CLR key on the CDU, or by correcting the condition. Other messages are cleared by changing the displayed page; this will delete the entry which caused the message. The following tables list all alerting messages, their cause, and the recommended corrective action.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CHECK FLIGHT PLAN	The FMC has found and corrected an error in the nav data base.	Check the flight plan and correct if necessary.
CYCLE IRS OFF–NAV	IRS is unable to complete alignment under current conditions.	Cycle IRS mode selector to "OFF" and back to "NAV".
DATA BASE INVALID	The automatic validity test of the permanent navigation data base has failed.	Advise maintenance personnel to check the FMC and reload the data base, as required. If desired, consider the use of the temporary nav data base.
DISCO INSRTD AFTR XXXXX (waypoint identifier)	A ROUTE DISCONTINUITY has been inserted into the flight plan due to undefined termination of a downpath leg or a double waypoint BYPASS.	Select the RTE or RTE LEGS pages and modify the waypoints for a continuous route.
DISCONTINUITY	Passing the last waypoint in the route prior to a ROUTE DISCONTINUITY (LNAV disengages) or pressing LNAV while in a discontinuity.	Select the RTE LEGS page. Enter the desired active waypoint into the box prompts. Correct any ROUTE DISCONTINUITY and EXECute. Reengage LNAV.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
DUAL FMC OP RESTORED	Dual FMC operation has been successfully restored.	Clear message and set FMC source select switch to NORMAL.
END OF OFFSET	Two minutes prior to passing offset leg termination.	Confirm ATC clearance.
END OF ROUTE	LNAV engaged and passing the last waypoint in the route (LNAV disengages).	Select the RTE LEGS page. Enter the desired active waypoint into the dash prompts and EXECute. Reengage LNAV.
ENTER IRS POSITION	IRS in the alignment mode needs present position to complete alignment. Previous present position entry was not received back from the IRS.	Enter IRS present position into the scratch pad and line select 4R on the POS INIT page of the CDU. If present position was previously entered, overwrite displayed data. If necessary, enter present position directly into the IRS control /display unit.
INSUFFICIENT FUEL	A change in conditions or flight plan route causes predicted fuel at destination to be 900 kilograms/2000 lbs or less. May be the result of a fuel quantity indicator inoperative.	Modify the route plan or cruising altitude, or divert for additional fuel. Use manual computations of fuel quantity remaining to determine gross weight.
IRS MOTION	IRS has automatically restarted the alignment due to detection of excessive motion.	Clear message and attempt to reduce aircraft movement, if practicable.
IRS NAV ONLY	The FMC has downmoded to the IRS-only mode of navigation or (U7.1+) navigation accuracy is not sufficient for present phase of flight.	Refer to FMC navigation check on page xxxx.
MAX ALT FLXXX	Altitude intervention attempt to raise cruise altitude when MCP altitude is above maximum altitude.	Reset MCP altitude.
MISSED CAPTURE	Proper localizer capture maneuver was performed, but the AFDS did not capture.	Clear the message manually.
NAV DATA OUT OF DATE	Effectivity dates of nav data base do not agree with date input from clock.	Check the IDENT page and reverse the dates for ACTIVE NAV DATA if required.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
NAV INVALID–TUNE XXXXX (navaid identifier)	FMC is unable to auto–tune or receive the navaid for a RNAV or VOR approach procedure.	Cross-check radios and manually tune the desired navaid.
OFP MISCOMPARE	Primary FMC has detected a discrepancy between its software and that of the secondary FMC.	Contact maintenance personnel.
OVERSPEED DISCONNECT	During path descent and below the speed restriction altitude, VNAV disengages when airspeed exceeds FMC speed restriction by more than 15 knots.	Manually reduce speed and reengage VNAV.
PATH DES NOT AVAILABLE	Within 5 NM of advisory top–of–descent, a path descent is planned, and a computed path is not available.	EXECute a SPD DES if desired, or construct an adequate path (must include an “at” altitude restriction for the E/D waypoint and not have a ROUTE DISCONTINUITY).
PERF DEFAULTS INVALID	Validity check of performance defaults data base has failed.	Contact maintenance personnel.
PROGRAM PIN MISCOMPARE	Primary FMC has detected a discrepancy between its program pin configuration and that of the secondary FMC.	Contact maintenance personnel.
RESET MCP ALT	Within 5 NM of the top–of–descent point without selecting a lower altitude on the AFDS MCP.	Select lower MCP altitude values as clearances permit.
RTA UNACHIEVABLE	The RTA is not in the computed RTA window under current parameters.	Enter an achievable RTA or discontinue the RTA mode of navigation. Adjust parameters to meet the RTA.
SW OPTIONS INVALID	The validity check of the software options data base has failed.	Contact maintenance personnel.
SCANNING DME FAIL	Inputs from the frequency scanning DME radio have failed.	Clear the message and check position. Radio updating of FMC position is not available.
SELECT MODE AFTER RTA	RTA mode has been discontinued due to sequencing of RTA waypoint or RTA waypoint has been removed from the flight plan.	Select desired navigation mode. (ECON, manual speed, etc.)

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
SINGLE FMC OPERATION	The primary FMC has determined that the secondary FMC is not available.	Move FMC source selector switch to “BOTH ON L” or “BOTH ON R”.
SINGLE IRS NAV	Navigation environment is OCEANIC and one IRS is invalid.	NONE
UNABLE NEXT ALTITUDE	(Prior to U5) Due to undershoot, the next climb constraint cannot be achieved (VNAV engaged). (U5 and on) Unable to meet the next flight plan altitude constraint in a VNAV SPD climb or descent. The message appears only with VNAV engaged.	Clear the message and review the prediction. Consider selection of MAX RATE CLB or MAX ANGLE CLB, or a different N1 limit as appropriate.
UNABLE REQUIRED NAV PERFORMANCE – RNP	FMC actual navigation performance is not sufficient for the current special RNP (crew entered or leg specified).	Revert to raw data if able. Check updating status. Go-Around if required.
VERIFY OFFSET	A flight plan change has resulted in a conflict in reference to an offset start or end waypoint.	Confirm ATC clearance and make appropriate adjustments to RTE.
VERIFY POSITION	Position information is contradictory.	Refer to POS SHIFT 3/3 for FMC sensor comparisons.
VERIFY RNP	Underlying RNP value is less than manually entered value or a GPS approach has been selected and the default RNP is active.	Enter appropriate RNP.
VERIFY TAKEOFF SPEEDS	A PERF INIT change has been made after takeoff speeds were specified.	Enter new takeoff speeds.
VNAV DISCONNECT	The criteria for VNAV engagement is not satisfied (VNAV disengages).	Manually control the vertical path.

③ 3 5 FMC FAILURE WITH SINGLE FMC

The failure of the FMC is indicated by:

- FMC **ALERT** light.
- **FAIL** light on the CDU.
- FMC displayed in center of CDU.

If an FMC failure occurs the FMC / CDU, LNAV and VNAV are inoperative. Resume conventional navigation.

* * * *

7 8 9 GPS

The **GPS** light illuminated indicates GPS failure.

Note: The FMC will operate using only IRS or radio inputs.

No crew action required during domestic operations. On other than domestic, refer to navigation equipment requirements for your operating area.

* * * *

IRS ALIGN LIGHT FLASHING

When an **ALIGN** light is flashing either before or after present position has been entered:

The entered latitude or longitude does not agree with the LAST POS stored during the last shutdown, or the alignment process is complete but present position entry was not accepted by the IRS (*CDU message: **ENTER IRS POSITION**):

Re-enter the correct position into the CDU scratch pad and again line select the SET IRS POS line (4R). Just pressing line select key 4R without first re-entering present position into the CDU scratch pad, will not send the present position to the IRS. If repeated attempts to enter the correct present position through the CDU result in a continued flashing of the **ALIGN** light, attempt to enter the position directly into the IRS display unit.

If the above steps was not successful, or the aircraft was moved during the alignment phase (*CDU message: **IRS MOTION**):

Re-entering present position may not cause the flashing **ALIGN** lights to extinguish. Select OFF and wait for the **ALIGN** lights to extinguish, then initiate a full alignment.

IF The **ALIGN** Light Continues To Flash:

Check the MEL; Maintenance action is required.

*CDU message may not be active on some aircraft.

* * * *

IRS DC FAIL

The **IRS DC FAIL** light illuminated indicates the related IRS DC power has failed.

If all other IRS lights are extinguished, operate normally. IRS DC power is inoperative.

Note: If both **IRS DC FAIL** lights are illuminated, check Battery / DC system for possible malfunctions.

* * * *

③ IRS FAILURE (IN FLIGHT)

With one IRS operating normally:

Malfunctioning IRS Mode SEL .... OFF

Compass Switch (Overhead Panel).. BOTH ON OPERATING SYSTEM

Attitude Switch (Overhead Panel) .... BOTH ON OPERATING SYSTEM

Crosscheck and verify heading and attitude.

* * * *

IRS FAULT

Note: Placing the MASTER DIM & TEST switch to TEST for 10 seconds may preclude this fault when associated with first alignment of the day.

IRS Mode Selector (Affected Side) .... ATT

Maintain wings level, constant airspeed flight until attitude displays recover (approximately 30 seconds).

IF The **FAULT** Light Extinguishes:

Magnetic Heading .... ENTER

Use the POS INIT page or the overhead IRS display in HDG/STS. Update heading periodically.

Do not use autopilot APPROACH mode.

* * * *

OR

IF The **FAULT** Light Remains Illuminated:

Instrument Transfer Switches .... AS REQUIRED

Do not engage either autopilot.

* * * *

IRS MODE SELECTOR PLACED IN ATTITUDE (ATT) MODE PRIOR TO TAKEOFF

If the IRS mode selector is inadvertently placed in ATT prior to takeoff, the IRS loses its navigation capability and the ability to automatically produce magnetic heading. These capabilities can only be recovered by turning the system off and performing a normal ten-minute IRS alignment cycle with the aircraft parked.

To ensure that takeoffs are not accomplished in the ATT mode, flight crews should be aware of the following IRS attitude mode indications:

1. When an IRS enters the attitude mode, ATT and HDG flags appear on the using flight instruments. The **IRS ALIGN** light illuminates steady. After approximately 30 seconds, the light extinguishes and the ATT flag retracts out of view. The heading flags remain in view unless magnetic heading has been manually entered into the IRS.
2. Since all navigation parameters are lost for the system in ATT, the IRS display unit/data displays are blank when either present position, wind, or track/ground speed displays are selected.
3. Prompts indicating that heading needs to be entered appear on the POS INIT page of the FMC/CDU.

   Note: If heading is entered, HDG flags retract.
4. If both IRS's are in the attitude mode, the following indications are present:
   A. Heading flag in view on both HSI's and RDMI's.
   B. FMC position is blank on the POS REF page of the FMC/CDU.
   C. Course, distance, and ETA information based on present position are blank on the PROGRESS and LEGS pages of the FMC/CDU.
   D. HSI Nav flags are in view if NAV position is selected on the HSI switch.
5. If only one IRS is in the ATT mode, the following indications are present:
   A. Set IRS HDG prompt is displayed at the bottom of the POS INIT page.
   B. IRS display unit/data displays for present position, wind, and track/ground speed are blank for the IRS in the ATT mode.

(Continued)

If an IRS is in ATT mode, perform the following steps to regain the navigation mode:

Determine which IRS is in the ATT mode by selecting PPOS on the IRS display unit/display selector and switching between left and right IRS's to find the blank data display.

Place the appropriate IRS mode selector OFF. Wait until the **ALIGN** light extinguishes (approximately 30 seconds).

Place the IRS mode selector to NAV and insert present position to restart the ten-minute alignment procedure. Be sure that aircraft is not moved during alignment.

* * * *

IRS ON DC

The IRS is operating from the switched hot battery bus (power to the right IRS is removed automatically after 5 minutes).

* * * *

LOSS OF ALIGNMENT (INFLIGHT)

Note: Refer to IRS FAILURE (Inflight) procedure, if applicable.

If an IRS loses both AC and DC power, the alignment is lost. Alignment can also be lost if the mode selector is moved out of the NAV position.

If alignment is lost in flight, the navigation mode (including present position and ground speed outputs) is inoperative for the remainder of the flight. However, selecting ATT allows the attitude mode to be used to re-level the system and provide ADI attitude. The attitude mode requires approximately thirty seconds of straight and level unaccelerated flight to complete the re-leveling. Some attitude errors may occur during acceleration, but will be slowly removed after acceleration.

The attitude mode can also provide heading information. However, to establish compass synchronization, the crew must manually enter the initial magnetic heading. Thereafter, drift of the IRS heading will occur (up to 15° per hour). Therefore, when in the ATT mode, an operating compass system must be periodically cross-checked and an updated magnetic heading entered in the IRS, as required.

Manual IRS entry of MAG heading on the IRS display unit:

- Mode selector(s) is ATT.
- Press H (heading) key (located on #5).
- Enter compass heading on numeric keys.
- Press ENTER key.
- Cross-check and verify heading. Heading flags should be retracted from view.
- The IRS heading will precess (drift) and must be updated periodically.

* * * *

7 8 9 SINGLE FMC FAILURE WITH DUAL FMC'S

Failure of a single FMC is indicated by:

- FMC **ALERT** light.
- Failure of MAP information on the failed side.
- Line selection of FMC on the MCDU is deleted on failed side.
- Scratch pad message **SINGLE FMC OPERATION**

FMC navigation is still available from the remaining FMC. Select the operable FMC to return MAP information to the failed side.

FMC Selector ....AS REQUIRED

Note: This abnormal can be caused by a software mis-compare between the FMCs.

IF FMC/CDU Alert Message **DUAL FMC OP RESTORED** Appears:

FMC Selector ....NORMAL

* * * *

VHF NAV FAILURE

In the event of a failure of the number one or the number two VHF NAV radio as indicated by the various warnings and flags, select the functioning VHF NAV radio with the VHF NAV Transfer Switch.

* * * *

VOR/ILS NAVIGATION SYSTEM FAILURE

Certain Non-EFIS VOR/ILS navigation systems can be susceptible to failures which will not be reflected on the display instrument (HSI, RDMI). This type of internal fault is in the signal sent by the receiver to the display. Since no "feedback loop" exists between the instrument and the receiver no failure flag will be displayed and the course deviation indicator will be "centered." This will give the pilot an "on course" and/or "on glideslope" indication regardless of the aircraft's actual position.

This type of failure will normally be revealed by a cross check of alternate navigation information (FMS position, the other VHF NAV, ADF, DME, etc.) A suspect system can be checked by tuning to a local VOR and rotating the course selector and observing accurate deflection of the course deviation bar. If no deflection is observed, the receiver should not be used. Suspect glideslope information can be verified by checking crossing altitudes from the approach chart and by reference to another glide slope receiver. If necessary, coordinate alternate approach procedures with ATC (non-precision, ASR etc.).

* * * *

2.12 – FUEL

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FUEL

7 8 9 CONFIG

The fuel **CONFIG** annunciation indicates fuel quantity in the center tank exceeds 1600 lbs. and both center tank pumps are producing low or no pressure with either engine running.

Center Tank Fuel Pump Switches..ON

* * * *

CROSSFEED SELECTOR INOPERATIVE

The valve failed in the CLOSE position is indicated by the crossfeed **VALVE OPEN** light illuminated bright with the crossfeed selector in the OPEN position.

The valve failed in the OPEN position is indicated by the crossfeed **VALVE OPEN** light illuminated bright with the crossfeed selector in the CLOSE position.

IF Valve CLOSED:

Flight conditions permitting, vary thrust to maintain fuel balance. If unable to maintain acceptable balance, land as soon as possible.

* * * *

OR

IF Valve OPEN:

Maintain fuel balance with selective use of fuel pumps.

* * * *

③❸❺ DIGITAL FUEL QUANTITY ERROR CODES

Hard Error

A hard error is indicated by an ERR symbol and the absence of the analog quantity arc around the circumference of the gauge. Instead of indicating a quantity in lbs, it shows a fuel quantity of 0 lbs.

Any quantity indicator displaying a hard error indication is unusable. Refer to the MEL and follow established procedures for operation with an inoperative fuel gauge. Enter the error code and condition of flight in the logbook. Do not attempt to clear the error codes without concurrence of Maintenance.

Soft Error

A soft error indication is characterized by the ERR symbol but the indicator will continue to present the analog arc and the fuel quantity in lbs. This is because whenever a soft error is displayed, the fuel quantity is still valid within an accuracy of ± 3%. Enter a soft error message error code and the condition of flight in the logbook for maintenance action.

* * * *

FUEL FILTER BYPASS

A fuel **FILTER BYPASS** light illuminated indicates impending fuel filter bypass due to a contaminated filter.

Erratic engine operation and flame out may occur due to fuel contamination.

* * * *

FUEL PUMP LOW PRESSURE

Fuel pump **LOW PRESSURE** lights may flicker when tank quantity is low and the aircraft is in turbulent air or during climb or descent.

IF One Main Tank **LOW PRESSURE** Light Is Illuminated:

Main Tank Fuel Pump Switch (Affected Side)................................ OFF

Sufficient fuel pressure is available for normal operation.

* * * *

IF Both Main Tank **LOW PRESSURE** Lights Are Illuminated:

Above 30,000 feet, a thrust deterioration or engine flameout may occur.

* * * *

IF One Center Tank **LOW PRESSURE** Light Is Illuminated:

Crossfeed Selector .... OPEN

This prevents fuel unbalance.

Center Tank Fuel Pump Switch (Affected Side)............................. OFF

When the center tank fuel is depleted:

Crossfeed Selector ....CLOSE

Remaining Center Tank Fuel Pump Switch.................................... OFF

* * * *

IF Both Center Tank **LOW PRESSURE** Lights Are Illuminated:

Both Center Tank Fuel Pump Switches.................................... OFF

Center tank fuel is unusable.

Main tank fuel may not be sufficient for the planned flight.

* * * *

(Continued)

IF One Auxiliary Tank **LOW PRESSURE** Light Is Illuminated:

Sufficient fuel pressure is available for normal operation.

* * * *

IF Both Auxiliary Tank **LOW PRESSURE** Lights Are Illuminated:

Auxiliary Tank Fuel Is Unusable.

Use only main tank fuel for remainder of flight to avoid exceeding aft C.G. limits. Check fuel required to destination or suitable alternate. Remaining main tank fuel may not be sufficient for the planned flight.

Center Tank Fuel Pump Switches .... OFF

* * * *

FUEL QUANTITY INDICATOR INOPERATIVE

If a fuel quantity indicator fails:

IF ③ 3 5:

VNAV .... DISENGAGE

FMC gross weight calculations may be inaccurate with an inoperative fuel quantity indicator.

If fuel quantity in the FMC is not correct:

- Do not use FMC speed and altitude information.
- Use manually calculated gross weight and performance information from the QRH.
- On speed tape equipped aircraft, do not use minimum maneuver speeds or buffet margin information.

* * * *

OR

IF 7 8 9:

FMC Fuel Weight .... ENTER

Enter and periodically update manually calculated fuel on the FMC PERF INIT page. This will be done at no less than 30 minute intervals for the remainder of the flight. VNAV is available for use.

* * * *

7 8 9 IMBAL

The fuel **IMBAL** annunciation indicates main fuel tank quantities differ by more than 1000 lbs.

Fuel .... BALANCE

* * * *

INADVERTENT TRANSFER OF FUEL INTO CENTER TANK

An inadvertent increase in fuel quantity in the center tank and a decrease in fuel quantity in either the No. 1 or No. 2 main tank, can result in excessive fuel imbalance between the main tanks. This condition can result from a check valve failure in the center tank. With this failure, the main tank pumps are pumping fuel into the center tank. Because the fuel is entering from the wrong direction, the center boost pump is probably turning backwards. This procedure stops this reverse pump operation and can prevent or reduce an excessive lateral imbalance condition

Fuel Pump Switches (Decreasing Main Tank) .... OFF

Turning off FUEL PUMP switches stops back pressure against center tank pump.

Note: Above 30,000 feet, thrust deterioration or engine flameout may occur.

When The Main Tank Fuel Pump **LOW PRESSURE** Light Is Illuminated:

Center Tank Fuel Pump Switch (Affected Side) .... ON

Leave affected center tank fuel pump switch ON and crossfeed selector closed for the remainder of the flight.

The center tank fuel pump remains ON, even after the **LOW PRESSURE** light illuminates. This prevents fuel from being pumped through the failed center tank check valve and again entering the center tank.

When Center Tank Fuel Pump **LOW PRESSURE** Light Is Extinguished:

Main Tank Fuel Pump Switch .... ON

Note: Leave affected center tank fuel pump switch ON and crossfeed selector closed for remainder of the flight.

* * * *

INFLIGHT ENGINE FUEL LEAK

An inflight engine fuel leak is suspected or confirmed by one or more of the following:

- Visual observation of fuel spray from strut/engine
- Excessive engine fuel flow or fuel imbalance indication
- Total fuel quantity decreasing at an abnormal rate
- 7 8 9 **IMBAL** indication
- **USING RSV FUEL** message
- **INSUFFICIENT FUEL** message

Center Fuel Pump Switches .... OFF

7 8 9 Fuel **CONFIG** indication may be displayed with fuel in center tank.

Crossfeed Selector ....CLOSE

Identify affected engine by observing one wing fuel tank quantity decreasing faster than the other. An increasing fuel imbalance of approximately 500 lbs. in 30 minutes should be considered a fuel leak. Conditions permitting, visually check for engine fuel leak.

IF It Is Determined That No Leak Exists:

Normal Fuel Management ....RESUME

Progress Page 1 .... SELECT

Note: Confirm FMC Route is correct.

OR

Destination Fuel Estimate.. CHECK

Verify adequate fuel available to complete the flight.

* * * *

IF Fuel Leak Is Confirmed:

Flight conditions permitting, accomplish the **ENGINE FAILURE/FIRE/SHUTDOWN/SEVERE DAMAGE/SEPARATION CHECKLIST** procedure to stop the leak.

* * * *

7 8 9 LOW FUEL

A LOW FUEL indicator indicates fuel quantity in the related main tank is less than 2,000 pounds. Initiate this procedure to provide remaining fuel to all engines and to maintain a proper body attitude to prevent uncovering the fuel pumps.

Main Tank Fuel Pump Switches..ALL ON

Crossfeed Selector..OPEN

Makes remaining fuel available to both engines.

- Slow and smooth thrust changes minimizes the possibility of uncovering the fuel pumps.
- Maintain the minimum pitch attitude required for a safe climb and avoid any sustained high nose up attitudes. This minimizes to possibility of uncovering the fuel pumps.

* * * *

3 3 5 MINIMUM FUEL OPERATION

A minimum fuel condition exists when the indicated fuel quantity in any main tank is 1,000 pounds or less. Initiate this procedure to provide remaining fuel to all engines and to maintain a proper body attitude to prevent uncovering the fuel pumps.

Main Tank Fuel Pump Switches..ALL ON

Crossfeed Selector..OPEN

Makes remaining fuel available to both engines.

- Slow and smooth thrust changes minimizes the possibility of uncovering the fuel pumps.
- Maintain the minimum pitch attitude required for a safe climb and avoid any sustained high nose up attitudes. This minimizes to possibility of uncovering the fuel pumps.

* * * *

REFUELING WITH BATTERY ONLY

When the APU is inoperative and no external power source is available, refueling can be accomplished as follows:

Battery Switch...ON

Standby Power Switch ....BAT

This procedure will operate the static inverter and supply the necessary AC voltage to operate the entire fueling system normally, including the gauges and fuel shut-off system. The only limitation during this type operation is the battery life. No cooling limitation has been imposed on the inverter. Therefore, this procedure would be the most desirable to use when no APU or external power is available, since the entire fueling system will operate normally.

* * * *

REFUELING WITH NO AC OR DC POWER SOURCE AVAILABLE

With the APU inoperative, the aircraft battery depleted, and no external power source available, refueling can still be accomplished.

Fueling Hose Nozzle ....ATTACHED TO THE REFUELING RECEPTACLE

Fueling Valves...OPEN FOR THE TANKS TO BE REFUELED

Note: The No. 1, No. 2, and center tank refueling valves each have a red override button that must be pressed and held while fuel is being pumped into the tank. Releasing the override button allows the spring in the valve to close the valve. A tool may be required to hold the spring in the valve to the OPEN position.

Caution must be observed not to overfill a tank, since there is no automatic fuel shut-off during manual operation. When the desired amount of fuel has been pumped into the tanks, the refueling valves for the respective tanks can be released. Tanks No. 1 and No. 2 may also be refueled through filler ports over the wing. It is not possible to refuel the center tank externally using overwing ports.

* * * *

TANK TO TANK FUEL TRANSFER
GROUND OPERATION ONLY

Caution: Observe fuel quantity limits for each tank.

Fuel can be transferred from one tank to another tank by using the appropriate fuel pumps, the defueling valve, and the crossfeed valve. Electrical AC power must be available to transfer fuel from the wing tanks to the center and/or auxiliary tank.

Main Tank Fuel Pump Switches.. ON

Crossfeed Selector.. OPEN

Note: When the AUXILIARY TANK FUELING valve switch in the fueling bay is OPEN, the crossfeed valve is open regardless of the position of the crossfeed selector on the flight deck.

Manual Defueling Valve.. OPEN

Center Tank Fueling Valve Switch In The Fueling Bay (If Fuel Transfer Into Center Tank Is Desired)........................... OPEN

Auxiliary Tank Fueling Valve Switch (If Fuel Transfer Into AUX Tank Is Desired)............................. OPEN

Fuel Transfer... MONITOR

The Center and Aux tank fuel quantity indicator will show an increase in fuel. The main tanks will show a decrease in fuel.

Center And Aux Tank Fueling Valve Switch In Fueling Bay .... CLOSE

When the required amount of fuel has been transferred, the switch is closed at the fueling panel.

Manual Defueling Valve... CLOSE

Crossfeed Selector... CLOSE

Main Tank Fuel Pump Switches... OFF

Main Tanks .... REFILL

External Fueling Panel Access Door .... CLOSE

* * * *

2.13 – HYDRAULICS

TABLE OF CONTENTS

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HYDRAULICS

HYDRAULIC PUMP LOW PRESSURE OR OVERHEAT

A hydraulic pump **LOW PRESSURE** light illuminated indicates low pump output pressure. The hydraulic pump **OVERHEAT** light illuminated indicates fluid or pump overheat.

Pump Switch..OFF

If the action was in response to an **OVERHEAT** light, positioning the pump switch OFF will cause a **LOW PRESSURE** light to illuminate. One pump provides adequate pressure for normal system operation.

* * * *

LOSS OF SYSTEM A

Loss of System A pressure is indicated by the System A pressure at zero and illumination of:

- **MASTER CAUTION** lights.
- **FLT CONT** and **HYD** annunciator lights.
- System A **LOW PRESSURE** lights.
- System A Flight Control **LOW PRESSURE** light.
- **FEEL DIFF PRESS** light.

System A Flight Control Switch ....STBY RUD

This activates the standby pump; supplies pressure to the rudder power control unit, arms the standby **LOW PRESSURE** light, and switches the flight control **LOW PRESSURE** light to monitor standby rudder valve position.

(Continued)

System A Hydraulic Pumps .... OFF

- Ground spoilers, inboard flight spoilers, Autopilot A and alternate brakes are inoperative. The No. 1 engine thrust reverser has standby pressure.
- 3 Nose wheel steering is inoperative.
- 3 5 7 8 9 Normal nose wheel steering is inoperative.
- Plan for manual gear extension.
- When the gear has been lowered manually, it cannot be retracted.
- The drag penalty with gear extended may make it impossible to reach an alternate field.

- - - - - PRIOR TO FINAL - - - - -

Landing Gear Lever .... OFF

Manual Gear Extension Handles .... PULL

The uplock is released when the handle is pulled to its limit, approximately 18 inches for the main gear and 8 inches for nose gear. The respective red gear light should illuminate, indicating uplock release. The gear free-falls to the LOCKED position and the green gear light illuminates as each gear is locked DOWN .

Wait 15 Seconds After The Last Manual Gear Extension Handle Is Pulled:

Landing Gear Lever .... DOWN

The red gear lights extinguish.

3 5 7 8 9 **Nose Wheel Steering Switch........................ ALT**

Landing Checklist .... COMPLETE

* * * *

LOSS OF SYSTEM B

Loss of System B is indicated by the System B pressure at zero and illumination of:

- **MASTER CAUTION** lights.
- **FLT CONT** and **HYD** annunciator lights.
- System B **LOW PRESSURE** lights.
- System B flight control **LOW PRESSURE** light.
- **FEEL DIF PRESS** light.

System B Flight Control Switch..STBY RUD

This activates the standby pump, supplies pressure to the rudder power control unit, arms the standby **LOW PRESSURE** light, and switches the flight control **LOW PRESSURE** light to monitor standby rudder valve position. The yaw damper switch also moves to the OFF position.

System B Hydraulic Pumps .... OFF

Outboard flight spoilers, autopilot B and yaw damper are inoperative. The No. 2 engine thrust reverser and leading edge flaps and slats have standby pressure. Trailing edge flaps have alternate electrical power. Normal brakes are inoperative. Alternate brakes are available.

Ref Speed ....V_{REF} 15

7 8 9 If using V_{REF} 15 and If icing conditions have been experienced or are anticipated prior to landing set V_{REF} =V_{REF} 15 + 10.

Use normal wind additive to V_{REF} for establishing appropriate "target" speed.

Target .... V_{REF} 15 + WIND ADDITIVE

3 3 5 If ice formations are observed on the aircraft surfaces, (wings, windshield wipers, window frames, etc.) add 10 knots to V_{REF} for establishing Target speed to ensure maneuvering capability.

Plan a flaps 15 landing using alternate extension. (A flaps 15 landing is recommended because of the time required to retract flaps electrically in the event of a go-around.)

(Continued)

Flaps 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

When the leading edge devices have been extended by the alternate system, they cannot be retracted. Update weather information prior to extension because the drag penalty/speed restriction with the leading edge devices fully extended may make it impossible to reach an alternate airport.

Autobrake..OFF

- - - - - PRIOR TO FINAL - - - - -

Allow approximately 2 minutes to extend flaps from 0 to 15 degrees using alternate extension system.

Ground Proximity Flap Inhibit Switch...INHIBIT

Alternate Flaps Master Switch .... ARM

During flap extension (230 knots max), set handle to next desired flap position, extend flaps, then slow to respective maneuver speed. Repeat this process until flaps have been lowered to 15.

Note: Asymmetry protection is not provided when the alternate extension is used. Monitor the flap indicators closely. Alternate extension to flaps 15 takes approximately 2 minutes.

Note: The **LE FLAPS TRANSIT** light will remain illuminated until flaps approach the flaps 10 position.

Go-Around Procedure .... REVIEW

- Observe trailing edge flap and leading edge device speed limits.
- To avoid nuisance warning horn with the gear retracted and throttles below go-around thrust position, the flaps may be retracted to 10 degrees or less or the gear may be extended at level off at the Captain's discretion.
- Alternate flaps position switch must be manually positioned to OFF from UP position. Use caution to avoid retracting flaps to less than the desired position.

* * * *

LOSS OF SYSTEM "A" & "B" (MANUAL REVERSION)

Loss of System A and B pressure is indicated by the System A and B pressure at zero and illumination of:

- **MASTER CAUTION** lights.
- **FLT CONT** and **HYD** annunciator lights.
- System A & B **LOW PRESSURE** lights.
- System A & B flight control **LOW PRESSURE** light.

System A and B Flight Control Switches ....STBY RUD

This activates the standby pump, supplies pressure to the rudder power control unit, arms the standby **LOW PRESSURE** light, and switches the flight control **LOW PRESSURE** lights to monitor standby rudder valve position. The yaw damper switch also moves to the OFF position.

7 8 9 Yaw Damper Switch... ON

The standby yaw damper will work only if **both** flight control switches are in STBY RUD.

System A and B Hydraulic Pumps.. OFF

Ground spoilers, inboard and outboard flight spoilers, nose wheel steering, and autopilot are inoperative. Thrust reversers have standby system pressure. Inboard and outboard brakes have accumulator pressure only.

With the loss of both hydraulic systems A and B, the ailerons are controlled manually. High control forces are required for turns and the control wheel must be forcibly returned to the aileron neutral position. Bank angle should be limited to 20 degrees maximum. Because the rudder is powered by the standby hydraulic system, it is still very effective, and care must be used to prevent overcontrol. The elevator is controlled manually; a noticeable dead band exists. To minimize the effect of the dead band, the aircraft may be trimmed slightly nose up and a light forward pressure held on the control column.

(Continued)

The crosswind capability of the aircraft will be greatly reduced. Fly large landing patterns, with a long straight-in final approach. Keep thrust changes small or slow to allow for pitch trim changes. Landing configuration and approach airspeed should be established in-trim on a level flight path and on the runway centerline so that only a slight reduction in thrust is required to establish the landing profile. Fly a normal landing profile. Do not make a flat approach.

For go-around, apply thrust smoothly and in coordination with stabilizer trim. Rapid thrust application results in maximum nose up pitch forces. Keep thrust and flight control movements smooth and moderate.

On touchdown, thrust reverser operation will be slow. Apply steady brake pressure. Do not modulate the brakes. Because of inoperative nose wheel steering and limited capacity of brake accumulators, do not attempt to taxi the aircraft after stopping.

Ref Speed .... V_{REF} 15

7 8 9 If using V_{REF} 15 and if icing conditions have been experienced or are anticipated prior to landing set V_{REF} =V_{REF} 15 + 10.

Use normal wind additive to V_{REF} for establishing appropriate "target" speed.

Target .... V_{REF} 15 + WIND ADDITIVE

3 3 5 If ice formations are observed on the aircraft surfaces, (wings, windshield wipers, window frames, etc.) add 10 knots to V_{REF} for establishing Target speed to ensure maneuvering capability.

Plan a flaps 15 landing using alternate extension. (This is recommended because of the time required to retract flaps electrically in the event of a go-around.)

Flaps 15 configuration results in a higher than normal pitch attitude. There is a tendency to push the nose down to obtain a normal visual sight picture. Use caution to avoid going below the normal glide path.

Review the weather prior to extension of gear and leading edge devices, because the drag penalty / speed restriction may make it impossible to reach an alternate.

(Continued)

Autobrake...OFF

In Range and Approach Checklists ....ACCOMPLISH

Go-Around Procedure ....REVIEW

Advance thrust to go-around smoothly and slowly to avoid excessive pitch-up.

Observe trailing edge flap and leading edge device limit speeds.

Landing gear cannot be retracted.

Limit bank angle to 15 degrees until reaching flaps 15 maneuver speed.

Alternate flaps position switch must be manually positioned to OFF from UP. Use caution to avoid retracting flaps to less than the desired position.

- - - - - PRIOR TO FINAL - - - - -

Allow approximately two minutes to extend flaps from 0 to 15 degrees using alternate extension system.

Plan for manual gear extension. When the gear has been lowered manually, it cannot be retracted. When the leading edge devices have been extended by the alternate system, they cannot be retracted.

Ground Proximity Flap Inhibit Switch...INHIBIT

Alternate Flaps Master Switch ....ARM

During flap extension (230 knots max), set handle to next desired flap position, extend flaps, then slow to respective maneuver speed. Repeat this process until flaps have been lowered to 15.

Note: Asymmetry protection is not provided when the alternate extension is used. Monitor the flap indicators closely. Alternate extension to flaps 15 takes approximately 2 minutes.

Note: The **LE FLAPS TRANSIT** light will remain illuminated until flaps approach the flaps 10 position.

Landing Gear Lever...OFF

(Continued)

Manual Gear Extension Handles .... PULL

The uplock is released when the handle is pulled to its limit, approximately 18 inches for the main gear and 8 inches for nose gear. The respective red gear light illuminates, indicating uplock release. The gear free-falls to the locked position, and the green gear lights illuminate as each gear is locked DOWN.

Wait 15 seconds after the last manual gear extension handle is pulled:

Landing Gear Lever .... DOWN

The red gear lights extinguish.

Landing Checklist .... ACCOMPLISH

* * * *

STANDBY HYDRAULIC LOW PRESSURE

Illumination of the standby hydraulic **LOW PRESSURE** light indicates low output pressure from the electric motor-driven standby pump. The standby hydraulic system may be totally inoperative.

Stby Hyd Pump Normal Circuit Breaker
(3 3 5 P6-11, A-8,
7 8 9 E & E Compartment) ....CHECK, RESET

IF Standby Pump Was Started By A Flight Control Switch:

Flight Control Switch... OFF, THEN RESET TO STBY RUDDER

Caution: Rudder control may be affected while recycling the switch.

The following standby hydraulic components are inoperative with the loss of another hydraulic system:

- Loss of A and B (manual reversion): Rudder, LED's, and thrust reversers.
- Loss of A: #1 Thrust Reverser.
- Loss of B: L.E. devices and #2 thrust reverser.

* * * *

STANDBY HYDRAULIC LOW QUANTITY

The Standby Hydraulic **LOW QUANTITY** light illuminated indicates low fluid level in the Standby Hydraulic System.

The Standby Hydraulic System may be inoperative.

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2.14 – LANDING GEAR

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LANDING GEAR

ANTI-SKID INOPERATIVE

The **ANTI-SKID INOP** light illuminated indicates a system fault is detected by the automatic anti-skid monitoring system.

IF On The Ground:

Check MEL for restrictions. For takeoff, turn autobrake switch OFF.

OR

* * * *

IF In Flight:

Autobrakes .... **OFF**

Auto speedbrake is not available. Use manual speedbrakes on landing.

Brake with caution.

Reference Actual Landing Distances (Unfactored) chart in Section 5.

* * * *

AUTOBRAKE DISARM

IF On Ground:

Autobrakes .... **OFF**

If the light remains illuminated, DO NOT attempt takeoff.

OR

* * * *

IF In Flight:

Autobrakes .... **OFF THEN RESELECT**

IF The **AUTOBRAKE DISARM** Light Re-Illuminates:

Autobrakes .... **OFF**

Use manual brakes.

* * * *

BRAKE PRESSURE INDICATOR ZERO PSI

This indicates the nitrogen precharge in the brake accumulator has leaked out, and accumulator braking is not available.

With hydraulic systems indications normal, brake operation is unaffected. There is no leak on the hydraulic side of the brakes.

* * * *

EMERGENCY LANDING TECHNIQUES

General

Consideration should be given to the best suitable airport with adequate fire-fighting capability.

Coordinate with all ground emergency facilities. For example, the fire trucks normally operate on a common VHF frequency with the aircraft and can advise the crew of aircraft condition during landing.

Consideration should be given to landing with as many gear down as possible. Circumstances will influence the pilot's decision as to whether a partial gear-up landing should be made. If a choice of configuration is available, the decision will be determined by the amount of landing gear available, the conditions at the landing field, time of landing, available facilities, aircraft load distribution, and controllability. In all cases, reduce weight as much as practicable by burning off fuel to provide the slowest possible touchdown speed.

Fuel pressure to the engines should be shut off before the engines contact the ground to reduce the possibility of fire. If the APU is running, it also should be shut down prior to landing.

Landing Runway

Consideration should be given to the best suitable airport with adequate runway and firefighting capability. Foaming the runway is not recommended. Tests have shown that foaming provides minimal benefit and it takes approximately 30 minutes to replenish the fire truck’s foam supply.

Landing Techniques

Plan a normal approach, extending maximum (for configuration) flaps as for a normal landing and normal rate of descent. Use the normal V_{REF} speed plus wind velocity and gust factor corrections.

The landing should be made with all available gear down and every effort should be made to keep the aircraft on the hard surfaced runway. This will minimize damage to the aircraft and facilitate passenger evacuation. Deployment of speed brakes at touchdown with one main landing gear retracted is <u>not</u> recommended unless stopping distance is critical.

Both Main Gear Down (Nose Gear Up)

If possible, move C.G. aft by relocating passengers.

Stabilize V_{REF} speed early and maintain normal rate of descent. With touchdown at the normal 1,000 feet point, check the speed brakes deployed. Use normal reverse. Hold nose up as long as possible after touchdown but lower the nose gently before losing elevator effectiveness. Normal braking can be used to minimize structural damage. When the aircraft is stopped, place start levers to cutoff, pull the engine and APU fire warning switches and discharge fire bottles (if necessary), at the Captain's command.

Nose Gear Only Extended

Establish a normal approach with flaps maximum for condition. Land in the center of the runway. Use normal approach and flare attitude maintaining back pressure on the control column until ground contact.

The engines will contact the ground prior to the nose gear. Move the speed brake lever to up after touchdown. Select fuel pumps to OFF, speed brake lever down, and the start levers to CUTOFF. Pull the engine and APU fire handles and discharge the fire bottles (if necessary) at the Captain's command.

All Gear Up Or Partially Extended

Use a normal approach and flare attitude. The engines will contact the ground first. After touchdown, move speed brake lever to up. There is adequate rudder available to maintain directional control during initial ground slide. Select fuel pumps to OFF, speed brake lever down, and the start levers to CUTOFF. Pull the engine and APU fire handles and discharge fire bottles (if necessary) at Captain's command.

One Main Gear Only Extended

Establish a normal approach with flaps maximum for condition.

Land the aircraft on the side of the runway that corresponds to the available gear down. Deployment of speed brakes at touchdown with one main landing gear retracted is <u>not</u> recommended unless stopping distance is critical. The auto speed brakes are deactivated by pulling the **AUTO SPEED BRAKE** circuit breaker (P6-2). Maintain wings level as long as possible. Use braking as required to keep aircraft rolling straight. Reverse thrust is available on the gear extended side if desired .

Select fuel pumps to OFF, speed brake lever down, and the start levers to cut off prior to the engine touching the ground. Pull engine and APU fire handles and discharge fire bottles (if necessary) at Captain's command.

One Main Gear Down And Nose Gear Extended

Establish a normal approach and flare profile with flaps maximum for condition. Deployment of speed brakes at touchdown with one main landing gear retracted is "not" recommended unless stopping distance is critical. The auto speed brakes are deactivated by pulling the **AUTO SPEED BRAKE** circuit breaker (P6-2). The landing gear will absorb the initial shock and delay touchdown of the engine. At touchdown, position the speed brake lever to the flight detent only for maximum lateral control. Braking and reverse thrust on the engine opposite the unsupported wing should be used as required to keep the aircraft rolling straight. Maintain the wings level as long as possible. Place the start levers to CUTOFF prior to the engine contacting the ground. Pull the engine and APU fire handles and discharge fire bottles (if necessary) at Captain's command.

After Stop

Initiate the passenger evacuation procedure, if required.

* * * *

FAILURE OF AIR/GROUND SENSING LOGIC

In the event the ground sensing logic reverts to the air mode while the aircraft is on the ground or vice versa, the following system malfunctions may occur:

- - - - - AFTER TAKEOFF - - - - -

The landing gear lever will not go above the OFF position.

- - - - - AFTER LANDING - - - - -

- The landing warning horn sounds intermittently and may not be silenced.
- The landing gear unsafe lights flicker.
- The aircraft may not depressurize.
- The APU generator will only power one bus.
- When the brakes are applied with the anti-skid system ON, feedback is felt in the pedals. Braking is normal with the anti-skid OFF.

Investigation has revealed that the printed circuit (PC) cards located in lower E and E compartment have had moisture contamination resulting from spilled fluids leaking through the floor. If one or more cards revert to the air mode when the aircraft is on the ground, it may result in full or partial loss of braking at taxi speeds below 15 knots with the anti-skid ON. Braking should be normal with the anti-skid OFF.

* * * *

GEAR LEVER WILL NOT MOVE ABOVE OFF AFTER TAKEOFF

This condition is recognized by the inability to position the landing gear lever UP in the normal manner. The probable cause is:

- Failure of the air-ground system.
- Failure of the landing gear lever latch solenoid.
- Failure of the ground spoiler bypass valve to close.
- 7 8 9 Manual Gear Extension Door is not closed and/or not connected to solenoid.
- 7 8 9 Failure or contamination of solenoid inside of Manual Gear Extension Door.

Land Gear Lever .... DOWN

IF Takeoff Configuration Warning Is SILENT After The Flaps Are Fully Retracted:

Note: This condition indicates a failure of the landing gear latch solenoid.

Landing Gear Override Trigger .... PULL

This bypasses the solenoid lever lock.

Landing Gear Lever .... UP & OFF

* * * *

OR

IF Takeoff Configuration Warning SOUNDS After The Flaps Are Fully Retracted:

Note: This condition indicates a failure of either the air/ground system or failure of the ground spoiler bypass to close.

Aural Warning C/B (P6-3, D18) .... PULL

IF Practical, Leave Gear Extended And Return To Departure Airport.

A landing at the nearest suitable airport is recommended.

Caution: Do not operate the Speedbrake inflight. A high sink rate could develop due to ground and flight spoiler deployment.

* * * *

OR

IF The Flight Must Be Continued:

(Continued)

Landing Gear Override Trigger..PULL

This bypasses the solenoid lever lock.

Landing Gear Lever... UP & OFF

Landing Gear Air/Gnd Relay And Lights C/B
(3 3 5 P6-3, C-18)(7 8 9 P6-3, D15)............PULL

Caution: Do not operate the speedbrakes inflight. A high sink rate could develop due to ground and flight spoiler deployment.

- - - - - PRIOR TO LANDING - - - - -

Caution: Do not arm speedbrakes

After landing gear extension:

Landing Gear Air/Gnd Relay And Lights C/B
(3 3 5 P6-3, C-18)(7 8 9 P6-3, D15).........RESET

Landing Gear.. DOWN, 3 GREEN

Landing Gear Air/Gnd Relay And Lights C/B
(3 3 5 P6-3, C-18)(7 8 9 P6-3, D15)............PULL

Pulling the C/B will prevent the takeoff warning horn from sounding after selecting flaps beyond the takeoff range.

Manually deploy speed brakes upon touchdown.

After landing with the C/B pulled, aircraft systems will be in the AIR mode. Some of the abnormal system reactions are: locked wheel protection will not be available and inboard wheel brakes are inoperative at taxi speeds, the stall warning system may activate continuously, and the pressurization system will maintain a small positive pressure.

See **FAILURE OF AIR / GROUND SENSING LOGIC**, this section.

* * * *

MANUAL GEAR EXTENSION

Use this procedure if the landing gear lever is placed in the DOWN position and a green gear light does not illuminate. Observe landing gear extend speed of 270 knots / .82 M maximum.

7 8 9 If a green landing gear indicator light is illuminated on either the center main panel or the overhead panel, the related landing gear indicates DOWN and locked.

Landing Gear C/B (3 3 5 P6-3, C-17 & 18)
(7 8 9 P6-3, C15 & B17) .... CHECK

Landing Gear Lever .... OFF

This removes hydraulic pressure to the actuator.

Manual Gear Extension Handles ....PULL

The uplock is released when the handle is pulled to its limit, approximately 18 inches for the main gear and 8 inches for the nose gear. The respective red gear light illuminates, indicating uplock release. The gear free-falls to the locked position, and the green gear lights illuminate as each gear is locked DOWN.

Wait 15 seconds after the last manual gear extension handle is pulled:

Landing Gear Lever .... DOWN

The red gear lights extinguish.

IF All Green Lights Illuminate:

Landing Checklist... COMPLETE

OR

* * * *

IF Any Green Gear Light Fails To Illuminate:

3 3 5 **Wheel Well Light Switch .... ON**

3 3 5 **Gear Down-Lock Visual Indicator(s) .... CHECK**

Verify that the mechanical down-lock indicator(s) (red markings) are aligned.

The Main Gear Viewers are located opposite the 3rd window aft of the overwing exit, and one foot left of center. Pull up the carpet to sight through viewer.

(Continued)

The Nose Gear Viewer is located just forward of flight deck door. Pull up the access door to sight through viewer.

Note: There are not view ports installed on the 7 8 9.

Autobrake.. OFF

IF All Landing Gear Are Not Verified DOWN And LOCKED:

Refer to Sec. 2 and accomplish the **PARTIAL OR GEAR-UP LANDING CHECKLIST**.

* * * *

PARTIAL OR GEAR UP LANDING

- Plan on MANUAL GEAR EXTENSION, this section. (As Required).
- Burn off fuel to reduce touchdown speed.
- Plan a Flaps 40 landing.
- Set V_{REF} 40.

Brief crew and passengers on emergency landing and evacuation procedures.

- - - - - PRIOR TO APPROACH - - - - -

Aural Warn C/B (P 6-3, D-18)... PULL

Pull circuit breaker marked **AURAL WARN** or **WARN HORN** to inhibit warning when landing flaps are selected.

Grd Prox Warn C/B (3 3 5 P18-1, A-7)
(7 8 9 P18-1, B7).. PULL

Prevents GPWS warning due to one or more landing gear being in an unsafe position.

Autobrake..OFF

Normal braking can be used to aid in directional control.

Auto Speedbrake C/B (P6-2, B-9) .... PULL

The auto speedbrake C/B should only be pulled if either main gear cannot be extended.

Standby Power Switch ....BAT

Ensures that the standby bus is powered after landing.

Emergency Exit Lights.. ON

(Continued)

Available Gear ....EXTEND IF DESIRED

If a choice of configuration, (i.e., all-gear up landing or partial-gear landing is available,) the decision is based on the amount of landing gear available, the conditions at the landing field, time of landing, available facilities, aircraft load distribution, and controllability.

Minimum damage occurs if the aircraft is kept on a surfaced landing area. A decision to land with partial main gear should consider the ability to keep the aircraft on a hard surfaced runway. Normal braking can be used to aid in directional control.

Engine Bleed Air Switches..OFF

This ensures the aircraft is depressurized at touchdown.

APU Switch...OFF

Landing Procedure...REVIEW

- Position fuel pump switches OFF just prior to flare. Fuel pressure to the engines should be shut OFF prior to landing to reduce the possibility of fire.
- Raise speed brake lever at touchdown if both main landing gears are fully extended or if stopping distance is critical.
- After stop, accomplish the **EMERGENCY EVACUATION (LAND) CHECKLIST**, if required.

* * * *

PARTIAL OR GEAR UP LANDING TECHNIQUES

General

Consideration should be given to the best suitable airport with adequate fire-fighting capability.

Coordinate with all ground emergency facilities. For example, the fire trucks normally operate on a common VHF frequency with the aircraft and can advise the crew of aircraft condition during landing.

Consideration should be given to landing with as many gear down as possible. Circumstances will influence the pilot's decision as to whether a partial gear-up landing should be made. If a choice of configuration is available, the decision will be determined by the amount of landing gear available, the conditions at the landing field, time of landing, available facilities, aircraft load distribution, and controllability. In all cases, reduce weight as much as practicable by burning off fuel to provide the slowest possible touchdown speed.

Fuel pressure to the engines should be shut off before the engines contact the ground to reduce the possibility of fire. If the APU is running, it also should be shut down prior to landing.

Landing Runway

Consideration should be given to the best suitable airport with adequate runway and fire fighting capability. Foaming the runway is not recommended. Tests have shown that foaming provides minimal benefit and it takes approximately 30 minutes to replenish the fire truck's foam supply.

Landing Techniques

Plan a normal approach, extending maximum (for configuration) flaps as for a normal landing and normal rate of descent. Use the normal V_{REF} speed plus wind velocity and gust factor corrections.

The landing should be made with all available gear down and every effort should be made to keep the aircraft on the hard surfaced runway. This will minimize damage to the aircraft and facilitate passenger evacuation. Deployment of speedbrakes at touchdown with one main landing gear retracted is <u>not</u> recommended unless stopping distance is critical.

③ TIRE SCREEN

The TIRE SCREEN light monitors the screen locking pins in the wheel well.

Caution: If the TIRE SCREEN light is illuminated and the cause is a tire burst screen not secure, equipment damage could result when the gear is retracted.

Note: The screens are not installed in A/C 329 and subsequent.

* * * *

WHEEL WELL FIRE

Landing Gear (270 Kts. Max) ....DOWN

Do not retract landing gear until at least 20 minutes after WHEEL WELL fire warning light extinguishes.

No fire extinguishing equipment is installed in the wheel wells. The primary source of overheat or fire is in the wheel brake system. If a warning sound should occur, the wheels may be extended removing the heat or fire from the wheel wells.

IF The Landing Gear Must Be Retracted For Aircraft Performance:

Landing Gear (235 Kts. Max) ....UP

Do not retract landing gear until airspeed is reduced to retract limit of 235 knots.

Land At Nearest Suitable Airport.

* * * *

2.15 – WARNING SYSTEMS

TABLE OF CONTENTS

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WARNING SYSTEMS

CONFIGURATION WARNING

Condition: An intermittent warning horn sounds when advancing thrust levers to takeoff, or a steady warning horn sounds inflight.

Assure proper aircraft configuration.

* * * *

GROUND PROXIMITY ALERT

Condition: The GPWS provides warnings and/or alerts for any of the following potentially hazardous flight conditions:

- Excessive descent rate
- Excessive terrain closure rate
- Altitude loss after takeoff or go-around
- Unsafe terrain clearance when not in landing configuration
- Excessive deviation below an ILS glideslope
- Bank angles and descent below the selected minimum altitudes
- Windshear

Correct the flight path or the aircraft configuration.

Note: If an alert occurs above 500 feet AGL, when flying under daylight VFR conditions, and positive visual verification is made that no hazard exists, the alert may be regarded as cautionary and the approach may be continued.

* * * *

7 8 9 PSEU

Condition: The **PSEU** light illuminated indicates a PSEU fault has been detected.

Do Not Takeoff.

Note: The **PSEU** light illuminates on the ground only.

* * * *

LIST OF EFFECTIVE PAGES

PAGE	DATE
SEC 2	
* TOC-1	11/15/02
* TOC-2	11/15/02
SEC 2.0	
* TOC-1	11/15/02
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SEC 2.3	
* TOC-1	11/15/02
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* 1	11/15/02

FAA APPROVED
12 NOV 2002

Don R. Klos
Principal Operations Inspector

* Asterisk indicates page(s) revised or added by the current revision.

NORMALS

INTRODUCTION

GENERAL

Normal procedures are used by the flight crew to ensure the aircraft condition is acceptable for flight and to properly operate the aircraft and its systems for each phase of flight. These procedures assume that all systems are operating normally and that automated features are utilized, when appropriate. For ground operation, flight crewmember duties have been organized in accordance with an "area of responsibility" concept. The panel scan diagram describes the crewmember's area of responsibility and scan flow pattern for each panel. A normal scan flow is encouraged; however, certain items may be handled in the most logical sequence for existing conditions (e.g., air conditioning, etc.). Actions outside the crewmember's area of responsibility are initiated at the direction of the Captain.

One of the most important items in good flight deck management is the proper utilization of the checklist. The success attained by flight crews in the execution of the various normal and emergency procedures is attributable in a large extent to the dual reliability of the challenge and response checklist system. A high degree of standardization should result, which makes possible repeated interchange of crewmembers without jeopardy to operational safety.

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STANDARD CALLOUTS

The following chart identifies the standard callouts required during flight, both instrument (IMC) and visual (VMC). Altitude callouts above 100 feet AGL are made with reference to the barometric altimeters. Callouts at or below 100 feet AGL are made with reference to radio altimeters. During the final approach segment, the PM will monitor the instruments and call out significant deviations from the intended target airspeed, approach course, glideslope and sink rate. The PM will also monitor instruments for warning flags and call out any flag in view. If the designated crewmember is distracted at the time a standard callout is required, the other pilot will make the call.

Note: For specific calls relating to flight guidance, see the applicable procedure.

CONDITION / LOCATION		CALLOUT
Takeoff	Takeoff Power Set	**PF:** "CHECK POWER" **PM:** "POWER SET ____%"
	100 Knots	**PM:** "100 KNOTS"
	V1	**PM:** "V1" (Call approximately 5 knots prior to V1)
	VR	**PM:** "ROTATE
	Positive Rate Of Climb	**PF or PM:** "POSITIVE RATE" **PF:** "GEAR UP"
Climb And Descent	Passing Transition Altitude	**PM:** "____FEET ____SET"
	1000 Feet Above or Below Assigned Altitude	**PM:** State actual altitude for assigned altitude, i.e., "SIX THOUSAND FOR SEVEN THOUSAND."
Approach	1000 Ft ATDZ	**PM:** "1000"
	500 Ft ATDZ	**PM:** "500"
	400 Ft ATDZ	**PM:** "400"
	300 Ft ATDZ	**PM:** "300"
	200 Ft ATDZ	**PM:** "200"
	100 Ft ATDZ	**PM:** "100"
IMC (Except Monitored)	100 Ft Prior To Minimums	**PM:** "APPROACHING MINIMUMS"
	Reaching Minimums	**PM:** "MINIMUMS"
	Approach Lights or Runway In Sight	**PM:** "APPROACH LIGHTS IN SIGHT" "RUNWAY IN SIGHT"
Monitored Approach	100 Ft Prior To Minimums	**Captain:** "APPROACHING MINIMUMS, I'M GOING HEADS UP"
	Landing OR Go-Around	**Captain:** "I HAVE THE AIRCRAFT" OR **F/O:** "MINIMUMS, GOING AROUND"
All IMC Approaches *Visual Approaches At Captain's Discretion*	100 Feet	**PM:** "100" * *
	50 Feet	**PM:** "50" * *
	30 Feet	**PM:** "30" * *
	20 Feet	**PM:** "20" * *
	10 Feet	**PM:** "10" * * * * Not Called if Announced By EGPWS
Autoland Approaches	500 Feet ATDZ	**PM:** "500" **PF:** "FLARE ARMED"
Missed Approach (Go-Arounds Or Rejected Landings)	Missed Approach Point DA(H), MAP	**PF:** "GOING AROUND" **PF:** "FLAPS 15" **PF:** "CHECK POWER" **PF or PM:** "POSITIVE RATE" **PF:** "GEAR UP" **PF:** "CHECKED MISSED APPROACH ALTITUDE"
Non-Precision	MAP	**PM:** "MISSED APPROACH POINT"
Landing Roll	80 Knots	**PM:** "80 KNOTS"
	Transition To Manual Braking	**PF/PM:** "MANUAL BRAKES"

FMS / MCP FLIGHT

GENERAL

The Autopilot Flight Director System (AFDS) and Flight Management Computer (FMC) systems are designed to provide increased flight precision and reduced pilot / crew workload. Pilots must be well versed in flying the B737 using all levels of automation from raw data hand flying through auto flight guidance using the full LNAV and VNAV capabilities of the FMC. When an automated function improves precision or reduces workload, its use may be desirable. However, if an automated function does not complement a given situation, good judgment supports use of a more basic mode. FMC LNAV and VNAV automated flight guidance functions are tools to be used by the pilot when and if they are appropriate. Continental expects B737 pilots to match the level of automation used with the flight dynamics of the situation. The pilot's assessment of the situation, and his judgment, determine that level.

Below 10,000 feet MSL, due to the increased need to clear for visual traffic, it is highly desirable to use the mode control panel functions in order to limit heads-down time. Maximum emphasis should be placed on programming the FMC with all known departure and climb information while on the ground, and all known descent and landing information prior to descending below 10,000 feet MSL. While one pilot programs, the other pilot assumes total responsibility for clearing whenever the aircraft is in motion.

Closely monitor altitude during all altitude changes to ensure that the flight guidance system acquires and/or commands levels off at the correct altitude. Use standard callouts, crew coordination, and crosscheck MCP settings with flight instruments to detect any uncommanded changes.

PHILOSOPHY OF AUTOMATION

Continental's goal for automation is to increase safety, efficiency, and improve situational awareness, while reducing pilot workload. Pilots must be proficient in all capabilities of their aircraft, including the automated systems, and must use their judgment as to how and when those systems are employed.

LEVELS OF AUTOMATION		
I	Hand Flown	Raw Data
II	Hand Flown	Flight Guidance
III	Autopilot / Autothrottle	Flight Guidance
IV	LNAV / VNAV	Flight Guidance

Use automation at the level that it best improves situational awareness, reduces workload, and provides for most efficient flight performance. The level of automation used is dynamic – change the level (up or down) if the current level employed is detracting from the situation (i.e., increasing workload).

Pilots must be aware that consistent use and reliance on automation levels III and IV throughout the flight regime will degrade basic flying skills. Therefore, pilots must continue to maintain proficiency by using all levels of automation on a regular basis.

CREW RESOURCE MANAGEMENT

Automated aircraft, by the nature of the equipment employed, <u>require</u> well-developed crew coordination.

Effective resource management recognizes that human error is likely. The goal is to reduce the probability that serious errors will occur, and to promptly detect and correct mistakes when they do happen.

As always, the captain is the final decision making authority on the aircraft; however, it is the responsibility of all crewmembers to contribute to the decision making process to help ensure that the best decisions are made.

Captains set the tone on the flight deck. Their initial crew introduction and briefing is an important leadership opportunity and they should encourage all crewmembers to provide information about operational issues. All flight deck crewmembers must bring any information that has any impact on operational safety to the attention of the captain.

If any crewmember has *any* doubts about the flight's safety, they must speak up with appropriate persistence until there is some resolution. All crewmembers should balance assertiveness with tact. The issue must always be w*hat* is right, not *who* is right.

The following specific automation-related CRM skills will be trained and developed to be employed as an integral part of routine flight deck procedures:

- Plan and brief automation modes and configurations.
- Establish guidelines for PF and PM duties for the operation of automated systems.
- Plan workload and allow sufficient time for programming tasks. Limit programming during critical phases or conditions of flight.
- Verbalize entries and changes to automated systems.
- Maintain an awareness of the automation modes selected by crew or initiated by FMS.
- Change level of automated systems (up or down) to increase situational awareness and avoid work overload.

AUTOMATION EMPLOYMENT

FMC Lateral Navigation Accuracy

[7][8][9] The FMC is only certified for sole-source navigation when it is operating in the radio-updating / GPS mode. The aircraft use GPS as the priority-updating source of the FMC. If the GPS is inoperative, radio updating is provided automatically. The FMC will radio update primarily from DME/DME comparisons. However, updates from LOC or VOR facilities can occur.

③[3][5] The FMC is only certified for sole-source navigation when it is operating in the radio-updating mode. To provide for the best accuracy when operating the FMC for sole-source navigation, it is desirable that both radios be in AUTO mode. In the AUTO radio-updating mode, the FMC selects the best VOR/LOC/DME sources for radio updating and tunes both VHF navigation radios. If one of the Nav radios is in the AUTO mode with the other Nav radio in MANUAL mode, accuracy is slightly degraded. In this case, the FMC will agility tune the Nav radio in the AUTO mode to multiple stations for more accurate updating. With both Nav radios in MANUAL, the FMC will use the manually tuned navaids for updating, provided updating of the tuned facility is within reception range and meets update criteria.

In an aircraft with only radio updating capability, if the radio updating is intermittent or erroneous, the FMC position can shift. This is commonly termed “map” shift, as it is seen as shifting the magenta line on the map display.

Inconsistent or erroneous updating will be reflected in the ACTUAL nav performance value. The FMC will display the message **UNABLE REQUIRED NAV PERF-RNP** when the ACTUAL (ANP) exceeds the REQUIRED (RNP). If ANP exceeds RNP, or if FMC navigation is ever uncertain, revert to ground-based navigation aides and/or solicit the help of ATC.

The **VERIFY POSITION** message indicates a position disagreement between the IRS, updating sensors, or FMC positions. When this message is displayed, the flight crew should determine the aircraft’s actual position using ground-based navaids, if available. The positions that are in disagreement may be seen on the POS SHIFT page.

If the **UNABLE REQUIRED NAV PERF-RNP** or **VERIFY POSITION** messages are displayed in the CDU scratch pad, the flight crew should perform the following procedures as necessary to ensure navigation accuracy:

1. Ensure that the navigation radios are operating in the auto-tuning mode so that the FMC can update its position if navaids are available. Check the PROGRESS page to ensure that radio updating is occurring.
2. Determine the actual aircraft position using raw data from the VOR navigation or if available, ADF radios and compare that position with the FMC position. (Use the FIX page.)
3. If radio navaids are unavailable, compare the FMC position with the IRS position using the POS REF page of the FMC CDU. If the two IRS positions are in agreement and the FMC position is significantly different, the FMC position is probably unreliable. On Dual FMC equipped aircraft also compare the relative position of FMC-L and FMC-R for accuracy.

   Note: The FMC position can be updated on the POS SHIFT page to the most accurate source from the IRS-L, IRS-R, or a VOR/DME position from a selected navaid.
4. Confirm actual position with ATC radar or visual reference points if available.
5. Navigate using the most accurate information available. The possibilities are:
   - LNAV (continue to monitor FMC position using VOR/ADF raw data).

Caution: Navigation in the LNAV mode with an unreliable FMC position will probably result in significant navigation errors.

- Conventional VOR/ADF procedures.
- Radar vectors from ATC.
- Dead reckoning from last known position.
- Use of visual reference.

MCP / CDU Inputs

It is imperative that changes on the Mode Control Panel (MCP) and on the Control Display Unit (CDU) of the Flight Management Computer (FMC) be accomplished accurately. Flight deck workload, Autopilot status, communications requirements, etc. can all influence which pilot should perform certain functions at any given time. The guidelines set forth below establish the preferred procedures. If the pilot normally expected to accomplish a given task is distracted by other duties, or flight deck workload / convenience so dictates, it is permissible for the other pilot to make the appropriate changes. In this event, the pilot making the changes must verbally state the changes made. Regardless of which pilot make the inputs, all changes to routings, reroutings and restrictions must be confirmed by both pilots at the time they are entered in the MCP / CDU.

Autopilot On

While the autopilot is ON, all MCP and CDU operations that affect the aircraft's flight path are normally done by the PF. If desired, the PF can request these steps be done by the PM.

Autopilot Off

While the Autopilot is OFF, all MCP and CDU operations should be called for by the PF and executed by the PM.

Altitude Alerting

The Altitude Alerting system shall be used during all phases of flight to assist the flight crew in altitude awareness, and to prevent deviation from assigned clearances. During climb and descent, the flight crew shall set the next clearance altitude in the Altitude Selector Window. In those situations where a clearance is received containing multiple crossing restrictions and VNAV is not engaged, the Altitude Selector shall be set at the next altitude restriction, and then reset for each subsequent restriction. On FMS arrivals or published arrivals (STARS) stored in the navigation data base, the clearance limit on the arrival (the lowest altitude) may be set in the MCP altitude window provided VNAV is engaged to assure compliance on the arrival.

While the autopilot is ON, the PF will set new clearance altitudes in the Altitude Selector Window. While the autopilot is OFF, the PM will select the cleared altitude in the Altitude Selector Window. Both pilots will verbally and visually acknowledge the cleared altitude set in the MCP.

PREFLIGHT INSPECTIONS

GENERAL

Before accepting an aircraft, a thorough exterior and flight deck inspection shall be made. The responsibility for these checks rests with the Captain. The Captain may delegate the duty to the First Officer (or IRO).

To avoid passenger inconvenience, the cabin check is not required when crew changes are scheduled on a through flight. This cabin inspection may be accomplished by the flight attendants and status reported to the Captain.

A complete EXTERIOR INSPECTION and FLIGHT DECK INSPECTION will be accomplished on each originating flight or crew change. Subsequent inspections are to be performed at each station in accordance with the EXTERIOR INSPECTION - THROUGH FLIGHT procedure.

Upon arrival at the aircraft, the following procedures are normally accomplished in the designated order:

- **Safety Inspection - Exterior**
- **Safety Inspection - Flight Deck (if required)**
- **Establish Electrical Power And Air Conditioning (if required)**
- **Flight Deck Inspection**
- **Exterior Inspection**
- **Cabin Inspection**
- **Receiving Aircraft Procedure/Checklist**

When operationally efficient during crew changes, the exterior inspection may be accomplished while waiting for passengers and crew to deplane.

SAFETY INSPECTION - EXTERIOR

Either the Captain, First Officer or IRO will conduct an Exterior Safety Inspection on all originating flights and crew changes.

Surfaces and Chocks .... CHECK

Visually check that all movable surfaces are clear and the chocks are in place.

Maintenance Status .... CHECK

If maintenance is in progress, confer with maintenance personnel to determine if the work will prevent activation of any aircraft systems.

SAFETY INSPECTION – FLIGHT DECK

Either the Captain, First Officer or IRO will conduct the Flight Deck Safety Inspection from memory when there is neither APU nor External electrical power on the busses.

Logbook (Aircraft & Cabin) .... CHECK

Verify maintenance status is acceptable for flight and ensure agreement with authorized dispatch deviations, if required.

The remaining items from Flight Deck Safety Inspection may be omitted if both AC and DC Electrical systems are already powered when the crew arrives at the aircraft.

Battery Switch .... ON

Verify guard down.

DC Meter Selector .... BAT

Check voltmeter at least 23V DC and ammeter zero.

Electric Hydraulic Pump Switches .... OFF

Landing Gear Lever .... DOWN

Verify three green gear lights illuminated.

Radar Switch .... OFF / TEST

ESTABLISH ELECTRICAL POWER AND AIR CONDITIONING (IF REQUIRED)

APU ELECTRIC AND PNEUMATIC POWER

Starting

If first flight of the day, complete the "Fire / Ovht / Extinguisher Test" described in the RECEIVING AIRCRAFT expanded checklist procedures in this section.

Battery Condition .... CHECKED

A minimum of 23V is required for APU start.

APU Bleed Air Switch .... OFF

APU Switch............................MOMENTARY START, RELEASE TO ON

Check the LOW OIL PRESSURE light illuminated and ③ 3 5 check a full scale negative deflection on the DC ammeter.

Check the LOW OIL PRESSURE light extinguished. Monitor EGT.

APU Generator ....ON BUSSES

When the APU GEN OFF BUS light illuminates, move the APU Generator Bus switches to ON. Verify ③ 3 5 BUS OFF 7 8 9 SOURCE OFF lights extinguish.

Note: The APU must be operated one minute before using a pneumatic source.

Note: Provide positive fuel pressure to the APU by selecting a left (forward recommended) main tank boost pump ON or a right (forward recommended) main tank boost pump ON with crossfeed open.

Note: If extended APU operation is required on the ground and fuel is loaded in the center tank, leave the left center tank fuel pump switch ON. This will preclude a fuel imbalance before takeoff.

Caution: Center tank fuel pumps must be OFF unless personnel are available on the flight deck to monitor LOW PRESSURE lights.

Note: The APU ③ LOW OIL QUANTITY 3 5 7 8 9 MAINT light indicates that the oil quantity is low. Advise maintenance that the tank should be serviced. The APU may be operated while the APU LOW OIL QUANTITY/MAINT light is illuminated.

Using APU For Air Conditioning

APU .... **ON BUSSES**

APU generator connected to busses.

Cabin Temperature Selectors .... **AUTO**

Set for desired temperature.

Isolation Valve Switch .... **3 3 5 AUTO**
7 8 9 OPEN

APU Bleed Air Switch .... **ON**

3 3 5 Left or Right Air Conditioning
Pack Switch .... **AUTO or HIGH**

7 8 9 Air Conditioning Pack Switch(es) .... **AUTO or HIGH**

Heating

One-pack operation from the APU is satisfactory for normal heating on the ground. Under extremely cold conditions, both packs may be used for more rapid heating.

During right pack operation only, under cold conditions, if the left **PACK TRIP OFF** light illuminates, position the recirculation fan OFF until the cabin temperature stabilizes.

Cooling

3 3 5 When cooling the aircraft on the ground with the APU as the only source of pneumatic air, use one pack only. Set cabin temperature selector at AUTO NORMAL (straight up). Open all flight deck vents.

Operating With APU Generator and/or Pneumatics Inoperative

Caution: If an external air cart is used, the air cart should be placed on the opposite side of the aircraft from the engine being started. After one engine has been started, the air cart should be removed from the vicinity of the aircraft.

With the APU Generator Inoperative, but APU Pneumatics Available:

Engine Start: Use external electrical power or **BATTERY START** checklist.

Start No. 1 engine first.

Start No. 2 engine using normal procedures.

Refueling: Use normal procedures with external electrical power or refer to **REFUELING WITH BATTERY ONLY** checklist.

With APU Pneumatics Inoperative, but APU Generator Available:

Engine Start: Use external air cart or air bottle to start either engine. Start the other engine using **ENGINE CROSSBLEED START** checklist.

Refueling: Normal Procedures.

With APU Generator and Pneumatics Inoperative (External Electric Power Not Available):

Dispatch: Do not dispatch to an airport that does not have the required engine starting equipment. Because of safety considerations, an engine should not be left running during a turnaround.

Engine Start: Use **BATTERY START** checklist with the external air cart or air bottle.

Start No. 1 engine first.

Start No. 2 engine using **ENGINE CROSSBLEED START** checklist.

During Battery Start, if the isolation valve does not open, start No. 2 engine using external air only after ensuring safety of ground personnel. It is preferred to wait for external electrical power rather than to start No. 2 engine with external air and battery.

Takeoff: If takeoff will be made in the engine bleeds OFF configuration, refer to **UNPRESSURIZED TAKEOFF** checklist.

Refueling: Refer to **REFUELING WITH BATTERY ONLY** checklist.

Using Ground Preconditioned Air

The passenger cabin and flight deck may be air conditioned by attaching a preconditioned air source to the ground service connection on the underside of the fuselage. This air goes directly into the supply duct manifold for distribution throughout the aircraft.

Caution: Possible supply duct manifold damage may occur when APU air and ground preconditioned air are being supplied to the aircraft simultaneously.

To avert possible damage to the ducting system(s) the following procedures will be followed:

- When arriving at an aircraft with preconditioned air being supplied, the APU Bleed Air Switch and Air Conditioning Pack Switch **will not** be opened or turned on until the preconditioned air has been removed.
- If the APU is supplying air to a Pack at the gate and then preconditioned air is applied, the APU Bleed Air Switch and Air Conditioning Pack Switch(es) **must** be turned OFF.

Using Pneumatic Air Cart

Caution: The battery switch should always be ON when using the aircraft air conditioning system since the protective circuits are DC. This will ensure protection in the event of loss of AC power.

Cabin Temperature Selectors .... AUTO

Set for desired temperature.

Recirculation Fan Switch(es) .... AUTO

Isolation Valve Switch...OPEN

APU Bleed Air Switch...OFF

Left and/or Right Air Conditioning Pack Switch(es)..............................ON

Position the pack switch(es) as desired to AUTO or HIGH.

Operation of two packs from one air source is permitted provided the external air cart can maintain 20-25 PSI with both packs operating.

Pneumatic Duct Pressure Indicator .... 20 – 25 PSI

IF External Air Cart Cannot Maintain 20 - 25 PSI:

Isolation Valve Switch ....AUTO

APU Bleed Air Switch .... ON

APU bleed air will service the left pack and external air will service the right pack.

FLIGHT DECK INSPECTION

The following flight deck items should be checked:

3 5 7 8 9 ACARS .... AUTO INITIALIZE

Position Lights.. ON

Spare Bulbs .... CHECK

Escape Rope (Right).. CHECK

Smoke Goggles (Right) .... CHECK

Portable Oxygen and Mask (As Installed)... CHECK

Fire Extinguisher.. CHECK

③ 3 5 Crew Oxygen Valve.. ON

Circuit Breakers .... CHECK

Crew / ACM Life Vests... CHECK

Headsets and Microphones .... CHECK

ACM Smoke Goggles.. CHECK

ACM Oxygen Mask (Test Not Required) .... CHECK

Crash Ax.. CHECK

Emergency Medical Kit.. CHECK

Smoke Goggles (Left)... CHECK

Escape Rope (Left) .... CHECK

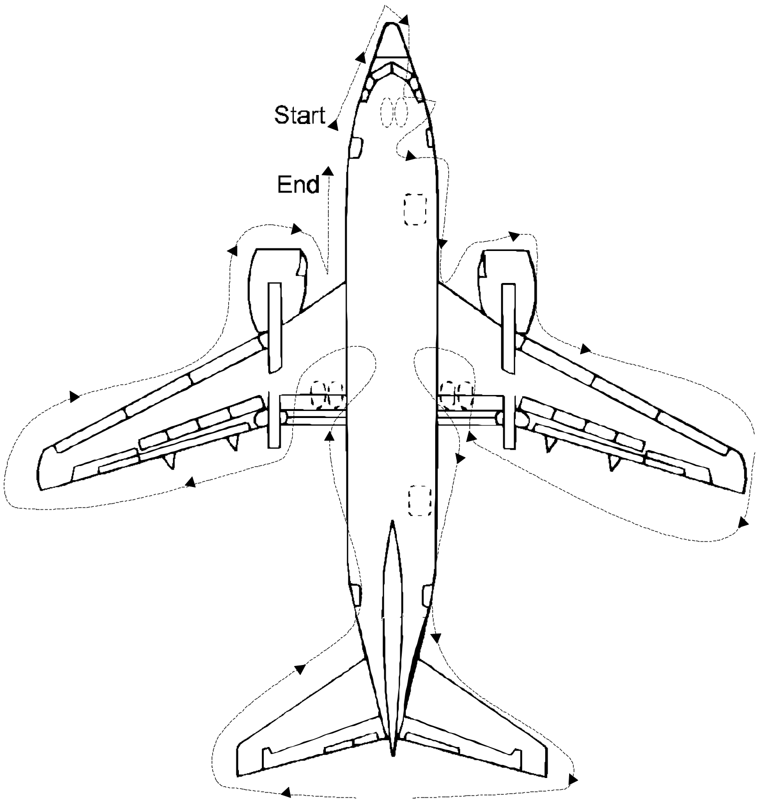
Publications (Checklists, Manuals, etc.)... CHECK

Crew Baggage (Under 2nd ACM Seat).. STOWED

Protective Breathing Equipment (PBE).. CHECK

For operational convenience, tests and checks required by the RECEIVING AIRCRAFT procedure applicable to modules located on the aft overhead instrument panel (P5 aft) may be accomplished concurrently with the FLIGHT DECK INSPECTION.

EXTERIOR INSPECTION



Either the Captain, First Officer or IRO will conduct the Exterior Inspection.

The recommended sequence is to start at the left forward fuselage and proceed in a clockwise direction. During the walk around, observe the general condition of all surfaces, fuselage, empennage, wings, windows, antennas, flight controls, engines, and cowlings. Check particularly for damage, fluid leakage, proper position, and security of access panels. Also verify that crew, passengers, and cargo doors, which are not in use, are closed and the door handles recessed. Check all external lights are clean, with undamaged lenses. Check operation of navigation / position lights.

Check potable water and lavatory fill and drain areas for leakage. If evidence of leakage is found, notify maintenance.

Note: If evidence of fluid leakage or stains is noted at the forward and/or aft lavatory service panel, ground personnel must verify if a leak exists before departure. If a leak is present, repairs must be made, or the affected lavatory must be drained and placarded inoperative.

Prior to conducting the exterior inspection, the aircraft will be configured as follows:

- Parking brake set.
- Fuel system pressurized.
- Caution: Center tank fuel pumps must be OFF unless personnel are available on the flight deck to monitor **LOW PRESSURE** lights.
- Hydraulic systems pressurized.
- Wheel well lights **ON**.
- Position lights **ON**.

When operationally efficient during crew changes, the exterior inspection may be accomplished while waiting for passengers and crew to deplane. When this is done, the requirements of the exterior inspection preamble still apply except that the parking brake may be off, and the hydraulic systems may be unpressurized.

WARNING: If thrust reverser levers are not in the stowed position, check with Maintenance prior to pressurizing hydraulic systems.

WARNING: Check flap handle in agreement with position indicator prior to pressurizing hydraulics.

- Total Air Temperature Probe
  - Check for damage and that dust cover is removed.
- Angle Airflow Sensor
  - Check for damage.
- Left Pitot Static Probes
  - Check pitot probes for damage, security of attachment, and dust covers removed.
- Radome and Conductor Strips
  - Check for damage and security.
- Lower Nose Compartment
  - Check that lower nose door is closed, latched handle flush.

- Taxi Light
- Nose Doors
  - Check doors for security of attachment.
- Tires And Wheels
  - Check tires and wheels for condition. Be alert for foreign material adhering to rim which could cause an out of balance condition.
- Shock Strut
  - Check not fully compressed.
- Ground Locking Gear Pin
  - If any ground locking gear pin is not removed, contact Maintenance.
- Nose Gear Steering Lockout Pin
  - Check pin installed if tow out is to be accomplished.
- Nose Gear Down Indicators
  - Check that red arrows on locking braces are aligned and clean.
- 3 3 5 Gear View Window
  - Check window cleanliness.
- Nose Wheel Well
  - Check all hydraulic components for visible leaks and verify that the brake pads are installed. Verify aft wheel well light is operational.
  - Inspect closely for foreign objects such as chocks, tools, and any other items which may have been improperly placed in this area.
- External Power Receptacle
  - Open receptacle door, check light switch NORMAL, and close and latch access door.
- 3 3 5 Toilet Service Panel
  - Check free of leakage. Evidence of leakage should be reported to Maintenance.
- Right Pitot Static Probes
  - Check both pitot probes for damage, security of attachment, and dust covers removed.
- Angle Airflow Sensor
  - Check for damage.

- Sliding Window Handle
  - Check that handle is flush with surface.
- E & E Access Door
  - Check door closed and handle flush.
- ③ 3 5 8 9 E & E Flow Control Valve Outlet
  - Check that outlet is clear of all obstructions and that air is being exhausted from outlet opening.
- 7 Overboard Exhaust Valve
  - Check that outlet is clear of all obstructions and that air is being exhausted from outlet opening.
- Oxygen Pressure Relief Green Disc
  - Check that disc is in place.
- Alternate Static Port
  - Check that no obstructions are covering static port.
- Ram Air Deflector and Air Inlet Door
  - Check that deflector door is extended and air inlet is open.
- Right Air Conditioning Access Doors
  - Check that all latches are secure and doors closed.
- 7 8 9 Retractable Landing Light
  - Check for damage and that lens is clean and flush with surface.
- Right Wing Illumination Light
  - Check for damage and that lens is clean.
- Inboard Landing Light & Turnoff Light
  - Check for damage and that lens is clean.
- Leading Edge Flaps
  - Check condition of flaps for damage.
- Engine
  - Check cowling for damage and latches secure.
  - Check inlets for cleanliness and obvious obstructions.
  - Check fan blades for damage.
  - Check thrust reverser faired with engine cowling when closed.

- Leading Edge Slats
  - Check condition of slats for damage.
- Defueling Panel Access Door
  - Check that door is closed and latched.
- Fuel Panel Access Door
  - Check that door is closed and latched.
- ③ 3 5 Dripsticks (5)
  - Check that alignment marks and dripsticks agree.
- 7 8 9 Dripsticks (6)
  - Check that alignment marks and dripsticks agree. (Four dripsticks are also installed in center tank.)
- Ram Air Vent Scoop
  - Check fuel surge tank vent opening clear.
- Position Lights (Green)
  - Check illuminated and undamaged.
- ③ 3 5 Logo Light (White)
  - Check illuminated and undamaged.
- Static Dischargers
  - Check undamaged.
- Right Aileron and Tab
  - Check aileron and tab undamaged.
- Outboard Flap
  - Check condition of flaps for damage.
- Lower Wing Surfaces
  - 7 8 9 If there is frost or ice on the lower surface outboard of the engine, there may also be frost or ice on the upper surface.
- ③ 3 5 Retractable Landing Light
  - Check for damage and that lens is clean and flush with surface.
- Landing Gear Doors and Seal
  - Check that strut doors are fastened to strut and lower strut door seal is secure.

- Strut, Tires, and Wheels
  - Check strut for leaks. Check cable, wheels and tires for general condition. Check hub cap fairing assembly secured.
- Brake Wear Indicators
  - Check wear indicator pins for length remaining. If pin is recessed or flush with brake flange with brakes set, check with Maintenance.
- Strut Extension
  - Check that strut is not fully compressed.
- Ground Locking Pin

  Note: If any ground locking pin is not removed, contact Maintenance.
- ③ [3] [5] Gear Down Indicators
  - Check that red marks on locking brace are aligned and clean.
- ③ [3] [5] Ram Air Exhaust Louvers
  - Check that exhaust louvers are fully open.
- Wheel Well Area
  - Check wheel well area for general condition, hydraulic leaks and main gear viewer clean. Check wheel well light is **ON**.
  - Inspect closely for foreign objects such as chocks, tools, and any other items which may have been improperly placed in this area.
- Tire Burst Screens
  - Check that tire screen is properly secured and locked. The screens are not installed in A/C 329 and subsequent.
- System A and B Reservoir Quantities
  - Check that indicators on reservoir are RFL or above.
- Brake Accumulator Indicator
  - Check accumulator for brake pressure reading of 2800 PSI minimum pressure (if pressurized). A minimum of 1000 PSI if unpressurized.
- APU Fire Control Panel
  - Check that fire handle is UP.
- Inboard Flaps
  - Check flap surface undamaged.
- Negative Pressure Relief Door
  - Check that door is flush with surface.

- Main Pressure Outflow Valve
  - Check that outflow valve is fully open.
- $\boxed{8}\boxed{9}$ Tail Skid
  - Replace shoe if worn to wear dimple.
  - Replace cartridge assembly if warning decal is red.
- Pressure Safety Relief Ports (2)
  - Check that valve openings are free of dirt or obstruction.
- APU Air Inlet Door
  - Check that door opening is clear.
- ③$\boxed{3}\boxed{5}$ APU Fire Discharge Indicators
  - Check red (thermal) and yellow (pressure) discharge indicators are in place.
- APU Access Door
  - Check door closed and latched.
- APU Exhaust
  - Check for any obstructions or damage.
- $\boxed{7}\boxed{8}\boxed{9}$ APU Cooling Air Inlet
  - Check for any obstructions or damage.
- Horizontal and Vertical Stabilizers
  - Check undamaged.
- $\boxed{7}\boxed{8}\boxed{9}$ Logo Lights (White)
  - Check illuminated and undamaged.
- Elevator Pitot Probes
- Static Dischargers
  - Check right side of horizontal stabilizer, top of vertical stabilizer, rudder and left side of horizontal stabilizer are undamaged.
- Elevator and Tabs
  - Check elevator balance tab faired with elevator and undamaged.
- Rudder
  - Check rudder faired with vertical stabilizer and undamaged.

- Tail Cone Strobe Light
- Water Service Door
  - Check door closed and latched.
- Aft Water Drain Mast
  - Check for damage.
- Toilet Service Panel
  - Check for leakage. Evidence of leakage should be reported to Maintenance.
- Inboard Flap
  - Check flap surface undamaged.
- Fuel Shroud Drain Mast
  - Check drain mast for leakage. If fuel is dripping from mast, check with Maintenance.
- Strut, Tires, & Wheels
  - Check strut for leaks. Check wheels and tires for general condition. Check hub cap or hub cap fairing secured.
- Landing Gear Doors & Seal
  - Check that strut doors are fastened to strut and lower strut door seal is secure.
- Brake Wear Indicators
  - Check wear indicator pins for length remaining. If the pin is recessed or flush with the brake flange with brakes set, check with Maintenance.
- Strut Extension
  - Check that strut is not fully compressed.
- Ground Locking Pin

  Note: If any ground locking pin is not removed, contact Maintenance.
- 3 3 5 Gear Down Indicators
  - Verify that red marks on locking brace are aligned and clean.
- Fire Extinguisher Bottle Pressures

- Wheel Well Area
  - Check wheel well area for general condition, hydraulic leaks and main gear viewer clean. Check wheel well light is ON.
  - Inspect closely for foreign objects such as chocks, tools, and any other items which may have been improperly placed in this area.
- ③ Tire Burst Screens
  - Check that tire screen is properly secured and locked. The screens are not installed in A/C 329 and subsequent.
- Wheel Well Light Switch
  - Check wheel well light switch OFF.
- ③ 3 5 Ram Air Exhaust Louvers
  - Check that exhaust louvers are fully open.
- Left Air Conditioning Access Doors
  - Check all latches secure and door closed.
- Outboard Flap
  - Check condition of flaps for damage.
- Lower Wing Surfaces
  - 7 8 9 If there is frost or ice on the lower surface outboard of the engine, there may also be frost or ice on the upper surface.
- ③ 3 5 Retractable Landing Light
  - Check for damage and that lens is clean and flush with surface.
- Left Aileron and Tab
  - Check aileron and tab undamaged.
- Ram Air Vent Scoop
  - Check fuel surge tank vent opening clear.
- Static Dischargers
  - Check undamaged.
- ③ 3 5 Logo Light (White)
  - Check illuminated and undamaged.
- Position Lights (Red)
  - Check illuminated and undamaged.

- Leading Edge Slats
  - Check condition of slats.
- 3 3 5 Dripsticks (5)
  - Check that alignment marks on lower wing surface and dripsticks agree.
- 7 8 9 Dripsticks (6)
  - Check that alignment marks and dripsticks agree. (Four dripsticks are also installed in the center tank.)
- Engine
  - Check cowling for damage and latches secure.
  - Check inlets for cleanliness and obstructions.
  - Check fan blades for damage.
  - Check thrust reverser faired with engine cowling when closed.
- Leading Edge Flaps
  - Check condition of flaps for damage.
- Inboard Landing Light & Turnoff Light
  - Check for damage and that lens is clean.
- Left Wing Illumination Light
  - Check for damage and that lens is clean.
- 7 8 9 Retractable Landing Light
  - Check for damage and that lens is clean and flush with surface.
- Ram Air Deflector and Air Inlet Door
  - Check that deflector door is extended and air inlet is open.
- Alternate Static Port
  - Check that no obstructions are covering static port.
- 3 3 5 8 9 Forward Outflow Valve
  - Check that the outflow valve opening is clear.
- Forward Water Drain Mast
  - Check for damage.

EXTERIOR INSPECTION - THROUGH FLIGHT

Make an exterior inspection with emphasis on tire condition and engines. Parking brake and hydraulic systems may be off.

- Nose Gear, Wheels, and Tires
- ③ 3 5 Forward Toilet Service Panel
- Right Engine and Cowl
- Right Main Gear, Wheels, and Tires
- Aft Toilet Service Panel
- Left Main Gear, Wheels, and Tires
- Left Engine and Cowl
- Flight Controls
- General Structural Integrity (Visual)

CABIN INSPECTION

Lavatories

- Lavatory Fire Extinguishers

  Open door to the sink cabinet and check temperature indicator. If any of the 4 indicator patches have changed from gray to black, notify Maintenance.

- General Condition and Water Heater

Emergency Equipment

- Megaphones
  - Check in place.
- First Aid Kits
  - The use of shrink-wrapping will be the normal method of sealing first aid kits.
  - If a first aid kit is used enroute to a station that does not have shrink-wrapping capabilities, the first aid kit may be inspected and inventoried. It then will be sealed with a lead and wire seal or replaced with another kit by Maintenance so that the aircraft may depart that station. Kits with lead and wire seals will be removed and replaced by Maintenance with kits sealed with shrink-wrap during normal maintenance activities.
- Portable Fire Extinguishers
  - Properly stowed, handle safety wired and pressure indicator normal.
- Portable Oxygen Bottle
  - Masks installed properly and clean, pressure within limits (1500 PSI minimum), and properly stowed. Hose should be attached to 4 liter (hi) outlet.
- Life Rafts and Vests (If Installed)
  - Checked properly stowed.
- Escape Slide
  - Bottle pressure checked in the green band and properly stowed. The girt bar retainer straps, if installed, must not be wrapped around girt bar when in the disarmed position and the straps must not be frayed or tied in knots and must be properly attached to their velcro pads.

- Passenger Service Units

Cabin Furnishing

- Potable Water
- Windows, Doors and Exits
  - 7 8 9 Installation of handle covers on the overwing exits must be verified prior to departure whenever passenger are carried.
- Emergency Exits Secure, Handles Properly Stowed
- Flashlight Adjacent To Each Flight Attendant Seat

Continental Airlines

737 Normal Checklist

RECEIVING AIRCRAFT

F/O Challenge	Captain Respond
Circuit Brkrs. & Emerg. Equip.	CHECKED
Oxygen	CHECKED, SET, 100% (F, C)
IRS Selectors	NAV
Hydraulics	CHECKED, ON
Air Conditioning & Pressurization	SET
Mode Control Panel	SET
Altimeters & Flt Instruments	SET, CHECKED (F, C)
Ground Proximity	CHECKED
Throttles & T/O Warning	FREE, CLOSED, CHECKED
Start Levers	CUTOFF
Transponder	STANDBY
Log Book/ETOPS/Gear Pins/MEL	CHECKED, ON BOARD
Parking Brake	SET

BEFORE START

F/O Challenge	Captain Respond
Flight Deck Windows	LOCKED (F, C)
Seat Belt Sign	ON
Door Lights	OUT
Beacon	ON
Fuel	____ REL, ____ ON BOARD, PUMPS ON

AFTER START

F/O Challenge	Captain Respond
Generator(s)	ON
Pitot Heat	ON
Anti-Ice	(AS REQUIRED)
Flight Deck Door	CLOSED AND LOCKED

TAXI

F/O Challenge	F/O Respond
Takeoff Briefing	COMPLETED
Flight Controls	CHECKED
Speedbrake Lever	DOWN DETENT (F, C)
Flaps	SET ____ GREEN LIGHT (F, C)
Autobrake	RTO
CDU / Airspeed Bugs	SET (F, C)
Trim	SET, ZERO

DELAYED ENGINE START

F/O Challenge	F/O Respond
Generator(s)	ON
Anti-Ice	(AS REQUIRED)

BEFORE TAKEOFF

F/O Challenge	F/O Respond
Recall	CHECKED
Takeoff Announcement	COMPLETED
Air Conditioning & Pressurization	SET
Start Switches	CONTINUOUS
Takeoff Config. Switch (If Installed)	CHECKED (F, C)
Transponder	TA/RA

AFTER TAKEOFF

PM Challenge	PM Respond
Air Conditioning & Pressurization	SET
Gear	OFF, LIGHTS OUT
Flaps	UP, LIGHTS OUT

IN RANGE

PM Challenge	PM Respond
Air Conditioning & Pressurization	SET
Seat Belt Sign	ON
Recall	CHECKED
Altimeters & Flt. Insts.	SET, CHECKED (PM, PF)
Airspeed Bugs	SET (PM, PF)
Autobrake	SET
Approach Briefing	COMPLETED

APPROACH

PM Challenge	PM Respond
Start Switches	CONTINUOUS
Altimeters / Bugs	SET (PM, PF)
Radios	IDENTIFIED
Nav Displays	SET
Course Arrow	AS REQUIRED
Landing Announcement	COMPLETED

LANDING

PM Challenge	PM Respond
Speedbrake	ARMED
Gear	DOWN, 3 GREEN (PM, PF)
Flaps	____ GREEN LIGHT

AFTER LANDING

F/O Challenge	(Silent)	F/O Respond
Anti-Ice		(AS REQUIRED)
Trim Air Switch (If Installed)		OFF
Pressurization		(AS REQUIRED)
Start Switches		OFF
APU		(AS REQUIRED)
Exterior Lights		(AS REQUIRED)
Autobrake		OFF
Speedbrake		DOWN DETENT
Flaps		UP
Radar		OFF
Transponder		STBY

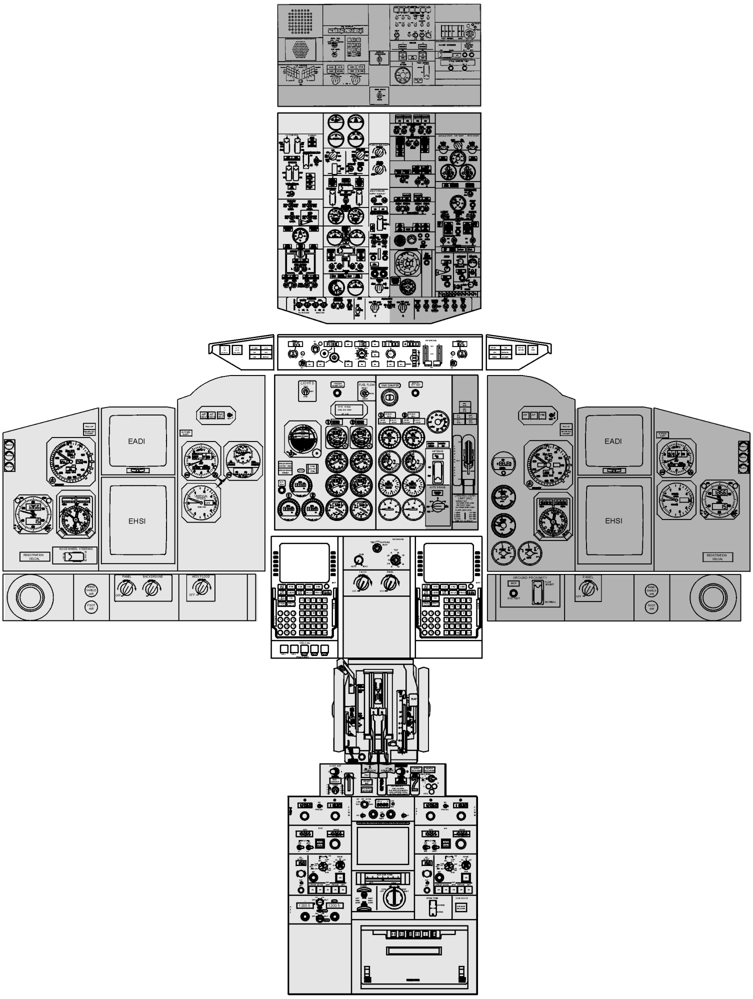
PARKING

F/O Challenge	Captain Respond
Parking Brake	(AS REQUIRED)
Start Levers	CUTOFF
Pitot Heat / Anti-Ice	OFF
Hydraulic System	SET
Beacon	OFF
Log book / ACARS	COMPLETED
IRS Selectors	OFF

TERMINATION

Either Pilot Challenge	Either Pilot Respond
Fuel Pumps	OFF
Galley Or Cab / Util	OFF
IFE / Pass Seat (If Installed)	OFF
Emergency Exit Lights	OFF
Window Heat	OFF
Packs	OFF
APU Bleed	OFF
Lights	OFF
APU / EXT Power	(AS REQUIRED)
Battery Switch	(AS REQUIRED)

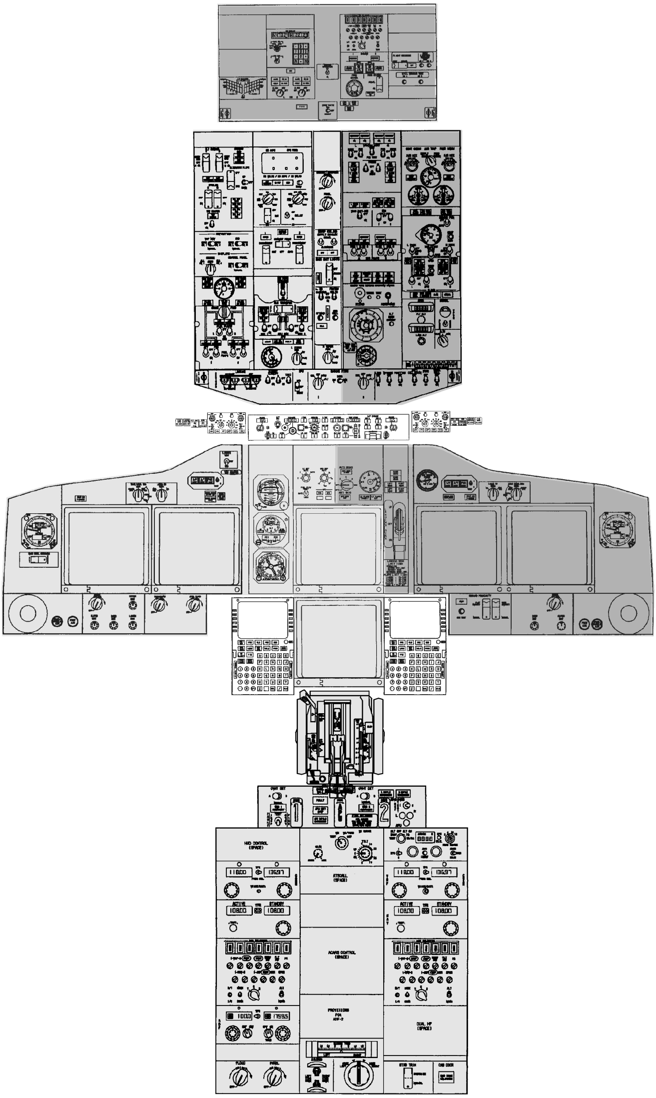
③ 3 5 RECEIVING AIRCRAFT FLOW



Captain First Officer

MCP and CDU's (Both Pilot's)
Both Captain and First Officer are responsible for Verification of flight deck setup

7 8 9 RECEIVING AIRCRAFT FLOW



Captain First Officer

MCP and CDU's (Both Pilot's)
Both Captain and First Officer are responsible for Verification of flight deck setup

RECEIVING AIRCRAFT

The following RECEIVING AIRCRAFT checklist defines the procedure to be conducted before each flight. Division of responsibility between the Captain and First Officer is also defined. The procedure is normally conducted in the designated order; however, variations in order are acceptable.

Each pilot's RECEIVING AIRCRAFT flow may be initiated once their departure from the flight deck is no longer anticipated.

The Captain shall then call for the RECEIVING AIRCRAFT checklist when there are no distractions on the flight deck.

F/O CHALLENGE	RECEIVING AIRCRAFT	CAPT. RESPOND
Circuit Brkrs. & Emerg. Equip.		**CHECKED**
Oxygen		**CHECKED, SET 100% (F, C)**
IRS Selectors		**NAV**
Hydraulics		**CHECKED, ON**
Air Conditioning & Pressurization		**SET**
Mode Control Panel		**SET**
Altimeters & Flt Instruments		**SET, CHECKED (F, C)**
Ground Proximity		**CHECKED**
Throttles & T/O Warning		**FREE, CLOSED, CHECKED**
Start Levers		**CUTOFF**
Transponder		**STANDBY**
Log Book / ETOPS / Gear Pins		**CHECKED, ON BOARD**
Parking Brake		**SET**

INTENTIONALLY LEFT BLANK

<u>F/O Challenge</u> **<u>Capt. Respond</u>**

Gear Lever & Lights (Flow) .... DOWN, 3 GREEN

Check that the gear handle is in the down detent and that ③ [3] [5] three [7] [8] [9] six green lights and no red lights are displayed.

Circuit Breakers & Emergency Equipment ....CHECKED

Verify C/B's are in or collared in compliance with dispatch requirements. Ensure that required flight deck emergency equipment was checked during the FLIGHT DECK INSPECTION.

Flight Recorder (Flow) ....CHECKED, SET

Set trip number and local date as installed. Move flight recorder test switch to the TEST position. Verify **OFF** light extinguishes, indicating power to tape monitor. Return flight recorder test switch to NORMAL position.

Mach & Stall Warning (Flow) ....CHECKED

Press Mach airspeed warning test button and verify the clacker sounds.

Press stall warning test buttons until control column shaker activation. [7] [8] [9] The stall warning test requires that the AC transfer busses are powered for up to 4 minutes.

With hydraulic power off, the leading edge flaps may droop enough to cause an asymmetry signal, resulting in a failure of the stall warning system to test. Should this occur, place the B system electric pump on to retract the flaps. When flaps are retracted, repeat the test.

Reverser Lights (Flow) .... EXTINGUISHED

Verify **REVERSER** lights extinguished.

③ [3] [5] PMC Switches (Flow) .... ON

Verify **INOP** lights extinguished.

[7] [8] [9] EEC Switches (Flow) .... ON

Verify **ALTN** and **ENGINE CONTROL** lights extinguished.

Oxygen .... CHECKED, SET 100% (F, C)

Check that crew oxygen quantity is sufficient for dispatch and that passenger oxygen switch is capped. **PASS OXY ON** light must be extinguished. Check the condition of the flight deck PBE.

Conduct an oxygen mask test (first flight of day and after crew change):

Audio Selector Panel .... SET

Press INT or FLT transmitter selector (as installed). Select receiver switch and adjust volume controls on the audio selector panel and overhead speaker. Position microphone selector to MASKS.

Oxygen Panel .... SET

Check that mask is properly stowed and Normal/100% switch is in the 100% position.

Reset / Test Slide Lever .... PUSH DOWN AND HOLD

Observe momentary yellow cross in flow indicator.

Emergency / Test Selector .... PUSH AND HOLD

While holding reset / test slide lever down and pushing emergency / test selector, simultaneously key microphone and listen for oxygen flow sound through the overhead speaker. Then release all switches. Position microphone selector to **BOOM**.

IRS Selectors .... NAV

<u>System Startup</u>:

IRS Mode Selector .... NAV

Move IRS mode selector from OFF through ALIGN to NAV. Observe the **ON DC** lights momentarily illuminate during self test. Observe the white IRS **ALIGN** lights illuminate after ten seconds indicating start of alignment. After ten minutes of successful alignment, the IRS automatically enters NAV mode.

IDENT Page ....SELECT

Verify that current NAV DATA is selected. If both primary and alternate NAV DATA are out of date, operations may be continued using conventional VOR / Airways navigation. Notify Dispatch that the aircraft is no longer area navigation capable. Enter a discrepancy in the maintenance log.

Present Position .... ENTER

Ensure that IRS's are in NAV and both **ALIGN** lights are illuminated.

Verify that **SET IRS HDG** prompt is not displayed.

Select POS INIT on a CDU; observe box prompts on line 4.

Enter the ICAO airport identifier into REF AIRPORT (2L).

Enter a gate identifier (example: C17), on the GATE (3L) line.

Note: Gate coordinates are not available for all airports.

③③⑤ Compare REF AIRPORT coordinates and GATE coordinates (if available) to LAST POS to ensure accuracy. Line select GATE (if available), or REF AIRPORT coordinate to the scratchpad and transfer to SET IRS POS box prompts (4R).

⑦⑧⑨ Line select either GPS position coordinates to the scratch pad from POS REF (2/3). Return to POS INIT (1/3) and compare scratchpad coordinates to GATE (if available), REF AIRPORT and LAST POS coordinates to ensure accuracy. Enter GPS coordinates into SET IRS POS box prompts (4R).

If GPS coordinates are not available, if available utilize GATE or REF AIRPORT coordinates for alignment.

If an IRS does not accept the initialization latitude / longitude the FMC message **ENTER IRS POS** will appear and one or both **ALIGN** lights will flash. Recheck accuracy of the initialization coordinates before re-entering. Re-enter the correct initialization position into the scratchpad and line select SET IRS POS (4R).

To Enter Present Position Direct To IRS:

IRS Display Selector... PPOS

Latitude... ENTER

Key-in latitude in the data display, beginning with N or S, then press the ENT key (the cue lights extinguish).

Longitude.. ENTER

Key-in longitude in the data display, beginning with E or W, then press the ENT key (the cue lights extinguish). Observe that proper latitude and longitude are displayed and that the **ALIGN** light is not flashing.

Fast Re-Alignment - Ground:

A fast re-alignment (30 seconds) zeros the ground speed, but does not correct heading errors. While this method may be required in certain circumstances, the full ten minute alignment is the preferred method.

Mode Selectors...ALIGN

Ensure that both white **ALIGN** lights illuminate.

Present Position..ENTER

Insert present position in CDU box prompts as described under system startup.

Mode Selectors... NAV

7 8 9 GPS Light (Flow).. EXTINGUISHED

7 8 9 PSEU Light (Flow) .... EXTINGUISHED

Flight Control Panel (Flow)...CHECKED

Verify switches capped, standby **LOW QUANTITY** light extinguished, yaw damper switch ON, yaw damper light extinguished, **LOW PRESSURE** lights appropriate to hydraulic status and failure lights extinguished.

Standby Hydraulic System Test (Crew Option):

System A or B Flight Control Switch ....OFF

The **LOW PRESSURE** light will illuminate.

System A or B Flight Control Switch...................................... STBY RUD

The associated flight control **LOW PRESSURE** light extinguishes. The standby hydraulic **LOW PRESSURE** light will remain extinguished or will illuminate momentarily depending on residual standby pressure.

System A or B Flight Control Switch.....................ON (RECAP SWITCH)

7 8 9 Navigation & Display Switches (Flow) ....NORMAL

③ 3 5 Instrument & Nav Switches (Flow) ....NORMAL

3 5 7 8 9: NAV, IRS, EFI, FMC switches (as installed)

Some aircraft with dual FMC capability may have one FMC removed. The FMC switch will be placarded DEACTIVATED.

③: NAV, COMPASS, ATTITUDE switches

If these switches are other than normal, suspect a failure on previous flight, and investigate prior to dispatch.

Fuel System (Flow) .... CHECKED

Verify that fueling is underway or completed.

③35 Verify **FUEL VALVE CLOSED** lights are on dim, and the **FILTER BYPASS** lights are extinguished.

789 Verify **ENG VALVE CLOSED** lights are on dim, **SPAR VALVE CLOSED** lights are on dim and the **FILTER BYPASS** lights are extinguished.

Verify the crossfeed selector is closed and the **VALVE OPEN** light is extinguished.

Caution: If a pump **LOW PRESSURE** light does not extinguish when the fuel pump switch is turned ON, this may indicate a locked fuel pump rotor. Place the switch to OFF to prevent possible damage to pump.

Main Tank Fuel Pumps:

Verify main tank fuel pump switches are ON, and their respective pump **LOW PRESSURE** lights are extinguished.

Center Tank Fuel Pumps:

If fuel quantity exceeds 1,000 lbs., verify center tank fuel pump switches are ON, and their respective pump **LOW PRESSURE** lights are extinguished.

For ground operation, center tank fuel pump switches must not be positioned to ON unless the center tank fuel quantity exceeds 1,000 lbs., except when defueling or transferring fuel.

Center tank fuel pump switches must be positioned to OFF when both center tank fuel pump **LOW PRESSURE** lights illuminate.

Center tank fuel pumps must be OFF unless personnel are available on the flight deck to monitor **LOW PRESSURE** lights.

Galley Power (Flow) .... ON

Position galley power switch ON.

789 Cab / Util (Flow) .... ON

Position CAB/UTIL power switch ON (if installed).

789 IFE / Pass Seat (Flow) .... ON

Position IFE/PASS SEAT power switch ON (if installed).

Electrical System (Flow) ....CHECKED

Battery Switch .... ON
Standby Power Switch ....AUTO
Generator Drive Disconnect Switches ....SAFETIED
③35 CSD Drive Temp Switch...IN
Bus Transfer Switch...AUTO

<u>Standby Power Check</u>:

<u>Caution</u>: ③35 The Standby Power check is to be accomplished on the first flight of the day.
789 The Standby Power check is not to be accomplished.

IRS Alignment..COMPLETE

Battery Switch .... ON

AC-DC Meters Selectors ....STBY PWR

APU Generator Bus No. 2 Switch
or Ground Power Switch ....OFF

Turn appropriate switch OFF depending on power source in use, removing power from TR-3. If left generator bus is still powered, verify that automatic transfer bus switching occurred.

Standby Power Switch...OFF

Check **STANDBY PWR OFF** light illuminated, and AC/DC voltmeters indicate zero.

③: Captain ADI **ATT** flag in view.

35: Captain RMI **HDG** flag in view.

Standby Power Switch... BAT

Check **STANDBY PWR OFF** light extinguished, and AC/DC voltmeters indicate normal.

Verify that the AC standby bus is powered by the inverter.

③: Captain ADI **ATT** flag out of view.

35: Captain RMI **HDG** flag out of view.

Standby Power Switch..AUTO

Select the standby power switch to AUTO, momentarily hesitating in the OFF position to ensure the standby relays are restored to their normal position. Do not rely on the switch cap to re-select the AUTO position. Verify proper switch action by reference to the DC meter.

DC Meter Selector..BAT

APU Generator Bus No. 2 Switch or
Ground Power Switch...ON

Check voltage reads in excess of 24 volts as an indication that the battery charger is operating.

Equipment Cooling Switches (Flow) .... NORMAL

Verify switch(es) is/are in the NORMAL position.

Verify **OFF** light extinguished. If this light is **ON**, there is danger of equipment overheating.

Emergency Exit Lights (Flow) ....CAPPED

Verify guard down and **NOT ARMED** light extinguished.

No Smoking Sign (Flow) .... ON

The no smoking sign will remain **ON** for all non-smoking flights.

Seat Belt Sign (Flow) ....OFF

Window Heat (Flow) .... ON

Turn all window heat switches ON. Observe green **ON** lights illuminate. In hot weather, the green **ON** light may not illuminate due to windows that are already at or above operating temperature. This may be verified (crew option) by conducting a power test.

Window heat must be on at least 10 minutes prior to takeoff. Window heat should normally remain ON during Through-Flight stops. Continual heating and cooling cycles may accelerate window delamination; however, the flight crew may elect to turn window heat OFF during very long ground times or in very hot weather.

Selecting PWR Test provides a confidence test when any of the green window heat **ON** lights are extinguished when the respective window heat switches are ON. The controller is forced to full power, bypassing normal temperature control. However, overheat protection is still available. If any green **ON** light remains extinguished during the power test, the heat system is inoperative.

Do not power test when all green **ON** lights are illuminated. Window heat switches must be ON.

③⑶⑸ Pitot Heat (Flow) .... OFF

⑺⑻⑼ Probe Heat (Flow) .... OFF

Anti-Ice (Flow) .... OFF

Verify **VALVE OPEN** lights extinguished.

Hydraulics .... CHECKED, ON

Position System A and B hydraulic pump switches to the ON position.

Verify electric pump **LOW PRESSURE** lights extinguished. Brake pressure, System A pressure, and System B pressure should be 2800 psi minimum.
③⑶⑸ Hydraulic quantities must be above the RFL lines.
⑺⑻⑼ No RF annunciation displayed.

Voice Recorder (Flow)..CHECKED

Push test button and hold for 5 seconds. Observe meter needle remains in green band entire time test button is depressed. With headset on and plugged into voice recorder test monitor jack, speak in a conversational tone and listen for the same words played back.

Note: This check is to be accomplished on the first flight of the day.

Air Conditioning & Pressurization ....SET

Move the air temperature selector to SUPPLY DUCT(S) and review temperature indicated in relation to air conditioning mode. Leave the selector in the SUPPLY position for periodic review of cabin temperature.

⑻⑼ Verify TRIM AIR switch is OFF. Verify **ZONE TEMP** lights are extinguished.

Note: B737-800/900 aircraft have had nuisance illuminations of one, two or all three air conditioning system **ZONE TEMP** lights on the forward overhead panel during master caution recall. Resetting the master caution system typically extinguishes the **ZONE TEMP** lights under this situation.

This problem occurs when the TRIM AIR switch is ON during any aircraft power transfer (ground power to APU generators, APU generators to engine generators, etc.). If the TRIM AIR switch is OFF during power transfer, the temperature control system Built In Test Equipment (BITE) does not test the three zone trim valves.

This procedure will result in a slight degradation in heating performance, especially when starting from a cold soaked aircraft at very cold temperatures.

Place the control and passenger cabin temperature controls to AUTO. Observe air mix valve and/or duct temperature. **RAM DOOR FULL OPEN** lights should be illuminated.

Press to test the WING-BODY OVERHEAT switch. Observe both **WING BODY OVERHEAT** lights, the **MASTER CAUTION** lights and **AIR COND** system annunciator lights illuminate, and then extinguish when the test button is released.

Note: Wing body overheat test not required on Through-Flights.

Verify that RECIRC FAN switch(es) are ON.

If air conditioning has not already been established, evaluate air conditioning requirements. 7 8 9 The APU can supply adequate pressure for dual pack operation. 3 3 5 Normally operate one pack in the AUTO or HIGH position. Two pack operation using the APU is allowed for maximum heating only. Check the isolation valve switch in the AUTO position, both engine bleed air switches on, APU bleed air switch ON unless external air is in use for air conditioning or will be used for start, and recirculating fan switch in AUTO.

The proposed cruise altitude should be set into the FLT ALT selector.

Destination field elevation should be set into the LAND ALT selector.

Two hundred feet below destination field elevation should be set into the CABIN ALT selector (if installed).

Set the standby rate knob on the index and verify that the FLT/GRD switch is in the GRD position (if installed).

Verify the pressurization mode selector is in the AUTO position, and the **AUTO FAIL** light is extinguished.

Check that the pressurization indicators read zero differential pressure, zero rate of climb, and field elevation.

Exterior Lights (Flow)..(AS REQUIRED)

Position lights are to be ON any time there is electrical power on the aircraft. Logo lights should be operated at night below 18,000 feet.

Ignition Select Switches (Flow) .... IGN L or R

The right ignitor will be selected for the first flight of the day. Alternating the ignition select switch on subsequent starts should be accomplished.

7 8 9 EFIS Control Panel (Flow)...SET

MINS Reference Selector..AS DESIRED

Select RADIO or BARO. Adjust decision height or altitude reference, as appropriate. BARO reference bug should be set at field elevation.

METERS Switch ....AS DESIRED

BARO Reference Selector ....SET

Select IN or HPA. Set local altimeter setting.

VOR Switches ....AS DESIRED

<u>WARNING</u>: In mountainous terrain below FL 250 at least one pilot will monitor raw data to ensure navigational accuracy.

MODE SELECTOR..AS DESIRED

The MAP mode is recommended for departure.

CENTER Switch ....AS DESIRED

The use of CENTER MAP allows fixes behind the aircraft to be viewed if the departure runway is not aligned with the route of flight.

RANGE Selector ....AS DESIRED

TRAFFIC Switch..AS DESIRED

MAP Switches ....AS DESIRED

WXR Radar Switches...OFF

Mode Control Panel ....SET

Ensure the autopilots are OFF; that courses, altitude, heading, and speed are set for the anticipated departure; that the bank limiter is set on 25 degrees; that flight director switches are ON with the correct **MA** light illuminated.

③ Select VOR/ILS or NAV as appropriate for the type of departure anticipated.

When selecting a value on the MCP, ensure the corresponding display on the instrument also changes.

Flight Mode Annunciator (Flow)..CHECKED

Check the Flight Mode Annunciator (FMA) for proper indications.

Altimeters & Flight Instruments............................ SET, CHECKED (F, C)

Note: IRS's must be aligned for proper indications.

Verify that airspeed indicates ③ 3 5 zero or 7 8 9 60, digital readout indicates 45, and that no flags are in view. ③ 3 5 Verify airspeed cursor control IN for automatic operation. Check ADI for proper attitude and warning flags out of view. Check compass warning flags out of view, cross-check heading of RMIs with (E) HSIs. Check vertical speed indicator at zero with no flags.

Check Standby Horizon for proper attitude and warning flag out of view. On 3 5 7 8 9 ensure that the ILS selector on the Standby Horizon is ON. Check Standby altimeter / airspeed indicator. On 7 8 9 check standby RMI for proper heading and Bearing Pointer switch in appropriate position.

③ 3 5 Set barometric pressure in all altimeters. Set altimeter bugs at field elevation. Verify proper altitude and no flags.

③ 3 5 Press to test the **MARKER BEACON** lights and adjust the intensity by turning the light cap as required. Check GMT with ACARS.

The following instrument checks are required first flight of the day:

③ INSTRUMENT COMPARATOR TEST:

Press the instrument comparator test switch. Observe the instrument comparator lights illuminate. Release the instrument comparator test switch and observe the instrument comparator lights extinguished. The **MON PWR** light will not illuminate but may be tested by pulling the PWR circuit breaker (ensure circuit breaker is reset P6-1, A-9).

③ RADIO ALTIMETER TEST:

Press and hold the altimeter test button. Observe the altitude display moves to 40 ± 5 feet. The **DH** light will illuminate when the test altitude is indicated. Release the test button. Observe the altitude display returns to zero and the **DH** light extinguishes.

On the 3 5 7 8 9 aircraft there is no Instrument Comparator / Radio Altimeter Test.

The following tests are optional:

HSI/ILS TEST

Tune VHF navigation radio to an ILS frequency. Move UP/LEFT DOWN/RIGHT test switch to the UP/LEFT position. Observe the glideslope pointer is up one dot and the course deviation bar is left one dot. Check navigation and glideslope failure flags are out of view. Release switch. Move UP/LEFT DOWN/RIGHT test switch to the DOWN/RIGHT position. Observe the glideslope pointer is down one dot and the course deviation bar is right one dot. Check navigation and glideslope failure flags are out of view. Release switch.

DME TEST

Tune VHF navigation radio to a VOR frequency.

Move VOR/DME test switch to DME. Check that both indicators for the DME being tested are covered for two seconds; then display four dashes for three seconds; then display 000.0 ± 0.5 until the test switch is released.

ADF AND RMI TEST

Position the ADF/VOR pointer switch on the RMI to ADF. On EFIS aircraft to check the ADF pointers on the EHSI, select FULL NAV with the EHSI Mode Selector.

Move the function selector to TEST and the ADF pointer on the RMI should point to 45 degrees left of the lubber line. Place function selector to desired mode.

HSI VOR RMI TEST

Select VOR/ILS on the HSI switch.

Tune in a VOR test station (VOT), if available, or any receivable VOR frequency. Set course selector to 000. Select VOR on VOR/ADF switch (on RMI).

Move VOR/DME test switch to VOR. Check that the course deviation bar is centered; the to/from flag indicates **FROM** and the VOR pointer indicates 180 degrees. Release the test switch.

Note: The maximum permissible error is ±4°.

3 5 7 8 9 Nosewheel Steering Switch (Flow) .... NORM

7 8 9 Display Select Panel (Flow) .... AS REQUIRED

Warning & Operating Lights (Flow) ....CHECKED

Ensure warning lights are checked.

Set lights to **BRIGHT** or **DIM** as appropriate.

Fuel Quantity Indicators (Flow) ....CHECKED

[7][8][9] Verify the fuel **CONFIG** indication extinguished.

③[3][5] **Qty Test Switch (Flow) ....PRESS**

Note: Do not test while aircraft is being refueled.

Press and hold until the fuel quantity indicators drive to zero and **ERR** is displayed.

Releasing the test switch initiates a self-test. The fuel quantity indicators should display the following:

- Error code for approximately two seconds.
- 8s for approximately two seconds.
- Maximum fuel tank capacity for up to two seconds.
- Actual fuel quantity.

Fuel Flow Switch (Flow) ....RESET

Engine Instruments (Flow) .... CHECKED

③[3][5] Press engine oil quantity test button and verify both indicators move toward zero and return to the original setting when the switch is released.

Verify the oil quantity is sufficient for dispatch.

Scan RPM, EGT, fuel flow, oil pressure and oil temperature gauges for normal indications. Press N_1 reference knobs in to permit FMC control of N_1 bugs.

[7][8][9] Check N_1 and N_2 zero, EGT, F/F, oil pressure, and oil temperature pointers and digital readouts are not displayed until the start switch is moved to GRD.

[7][8][9] **Engine Display Control Panel (Flow) ....SET**

N_1 SET selector ....AUTO

Permits FMC control of N_1 bugs.

Speed Reference selector ....AUTO

Permits FMC control of reference speed bugs.

③ 3 5 Anti-Skid Control Switch (Flow) .... CAPPED

Verify that the anti-skid switch is capped and the warning light is extinguished.

7 8 9 Anti-Skid INOP Light (Flow) .... EXTINGUISHED

Autobrake (Flow)... RTO

Verify **AUTOBRAKE DISARM** light illuminates and then extinguishes after 2 seconds.

Radar (Flow) .... CHECKED, OFF

Prior to Weather Radar Test Procedures, the IRS alignment must be complete.

Weather Radar Test Procedures:

On ③ with the Bendix RDR-4B-2457 Radar:

Set the radar system control as follows:
Mode selector .... TEST
Antenna stab .... ON
Gain.. AUTO
Range Control.. ANY RANGE
Brightness .... AS DESIRED

Check the display for:

- The presence of green, yellow, and red bands with three pie-shaped magenta areas.
- Appearance of alphanumeric legends (cues).

If there is any fault in the system, there will be no test pattern.

Note: If the MSG button is depressed, the screen will display **NO AUX DATA**. Depressing the MSG button again will restore the previous display.

On Non-EFIS -300 with the Bendix RDR-4B-3459 Radar:

- Mode Selector .... TEST
- Gain .... AUTO
- Range.. 40
- Brightness.. AS DESIRED

Note: In addition to the normal Test Pattern display check for the Caution, W/S Fail, W/S Warning and the Aural annunciations.

On 3 5 7 8 9 aircraft test the radar as follows:

Either EHSI any expanded scale mode except PLAN

- Select any mode except TEST on the WXR control panel.
- Turn the WXR on using the EFIS WXR on button
- Select TEST on the WXR control panel and observe results. Verify no fault messages present.
- Select Mode selector (WXR switch) OFF at the end of the test.

Note: The WXR will radiate following step 2 until the WXR is selected step 4 (at most a few seconds). The safe distance is 15 feet from the antenna for personnel. Furthermore, if concerned, the tilt knob could be used to tilt the antenna up.

Predictive Windshear Test:

On aircraft with an operational predictive windshear system. When the Mode Selector Switch is placed in TEST, the predictive windshear system automatically begins a two stage check as follows:

VISUAL AND AURAL TEST TIMING	**FIRST 2 SECONDS**	**10 SECONDS**		
Presentation	**Initial Indications**	**Normal Indications**	**Failure**	
Caution Lamp	ON	OFF	OFF	
W/S Fail Lamp	ON	OFF	ON	
W/S Warning Lamp	OFF	ON	Internal	External
Aural	Chime or "Monitor Radar Display" *	"GO AROUND, WINDSHEAR AHEAD" (pause) "WINDSHEAR AHEAD, WINDSHEAR AHEAD"	None	"GO AROUND, WINDSHEAR AHEAD" (pause) "WINDSHEAR AHEAD, WINDSHEAR AHEAD"
Display	Test Pattern	Test Pattern	Test pattern with label EXT W/S FAULT (unless radar failure)	

TEST MODE

* Additional "Monitor Radar Display" aural if installed.

WARNING: Failure to return the transponder to STBY after landing or selecting any mode except STBY prior to leaving the ramp area allows the radar to operate in the windshear mode creating a radiation hazard to personnel on the ground. This hazard exists even if the radar mode is selected OFF or TEST.

Ground Proximity ....CHECKED

Verify switch guards down.

③❸❺

③ Verify Terrain System INHIBIT switch is in normal. (If EGPWS Installed)

③ Position Weather Radar indicator to TEST position. (If EGPWS Installed)

Hold test switch for at least 2 seconds.

- Verify the **INOP** light, the **PULL UP** lights and the **BELOW G/S** lights illuminate.
- ③ The **GPWS** lights, the TERRAIN SYSTEM **INOP** light and the Green Terrain Display **ON** light illuminate (If EGPWS Installed).
- The aural warning sounds for one cycle: "GLIDESLOPE, WHOOP WHOOP - PULL UP."
- On aircraft with reactive windshear warning capability, the red **WINDSHEAR** light on the Captain's and F/O's instrument panels will illuminate, and the aural warning "WINDSHEAR, WINDSHEAR" will sound.
- Aural warning: "TERRAIN TERRAIN PULL UP."
- ③ Terrain self-test pattern displayed on WXR indicator (If EGPWS Installed).

❼❽❾ (EGPWS) Push momentarily.

- **BELOW G/S** and GPWS **INOP** lights illuminate.
- **TERR FAIL** and **TERR TEST** show on navigation displays.
- **PULL UP** and **WINDSHEAR** alerts illuminate.
- "GLIDESLOPE," "PULL UP," and "WINDSHEAR" aurals sound.
- Terrain display test pattern shows on navigation displays.
- "TERRAIN CAUTION" aural sounds and **TERRAIN CAUTION** message shows on navigation displays.

Note: If the test switch is held for at least 10 seconds, the above indications and additional GPWS aural warnings are tested.

Hold the test switch at least ten seconds to test the above indications and any additional GPWS aural warnings.

Speedbrake (Flow) .... DOWN DETENT

Verify speed brake lever is full forward, in the down detent, and the SPEEDBRAKE ARMED light is extinguished.

Note: The Captain should physically check that the speedbrake lever is seated in the down detent. The speedbrake lever may visually appear to be in the down detent, but may not be completely stowed. This will cause a takeoff warning when throttles are advanced for takeoff.

Throttles & T/O Warning ....FREE, CLOSED, CHECKED

Advance the throttles full travel individually to ensure freedom of movement and that the takeoff warning horn is operating.

Flaps & Slats (Flow) ....WITH GAUGE

WARNING: If flap lever is in any position other than UP, contact ground crew prior to moving the handle.

Stabilizer Trim (Flow)...CHECKED, NORMAL

Operate and hold either pilot's trim switch, observe trim wheel movement, then move main electric stabilizer trim cutout switch to CUTOUT. Trim wheel movement should cease. Release the trim switch.

Move the cutout switch back to NORMAL, operate, and hold the stabilizer trim switch in the opposite direction. Observe trim wheel movement, then move the cutout switch to CUTOUT. Trim wheel movement should cease. Release the stabilizer trim switch. Move the cutout switch back to NORMAL (ON).

Start Levers..CUTOFF

Ensure start levers are in the CUTOFF position.

Fire Control Panel(s) (Flow)...CHECKED

Note: The Engine / APU and Cargo (if installed) checks are to be accomplished on the first flight of the day only.

Engine / APU System Check:

OVHT DET Switches ....NORMAL

TEST Switch ....FAULT/INOP

Verify the MASTER CAUTION lights, OVHT/DET anunciator, FAULT light, and APU DETECTOR INOP light illuminate.

If the FAULT light fails to illuminate, the fault monitoring system is inoperative.

TEST Switch .... OVHT/FIRE

Verify warning bell sounds and MASTER FIRE WARN, MASTER CAUTION lights and OVHT/DET annunciator are illuminated.

FIRE WARN light - press. Verify WARN lights and alarm bell cancel.

Verify ENG 1, APU, and ENG 2 Fire Warning Switch and ENG 1 and ENG 2 OVERHEAT lights are illuminated.

If AC busses are powered, verify WHEEL WELL light is illuminated.

If the FAULT light illuminates during the OVHT/FIRE test, it denotes a fault on the “A” or “B” loop on one or both engines.

To determine which loop is good, if any, perform the following procedures:

OVHT DET Switches .... BOTH ON A

TEST Switch .... OVHT/FIRE

If the FAULT light remains extinguished and both engine OVERHEAT lights and engine fire warning switch illuminate, Loop “A” is good.

If the FAULT light illuminates and one of the engine OVERHEAT lights and corresponding engine fire warning switches remain extinguished, there is a fault in Loop “A” of the detection system of that engine.

OVHT DET Switches ....BOTH ON B

TEST Switch .... OVHT/FIRE

If the FAULT light remains extinguished and both engine OVERHEAT lights and engine fire warning switches illuminate, Loop “B” is good.

If the FAULT light illuminates and one of the engine OVERHEAT lights and corresponding engine fire warning switch remain extinguished, there is a fault in Loop “B” of the detection system of that engine.

Select the good loop for each engine (NORMAL if both loops tested good) and place the test switch to OVHT/FIRE. If the test is successful, leave the fire panel in this configuration for flight.

Check the Fire Extinguisher System:

Position test switch to position 1. The extinguisher test lights will illuminate. Release the switch, and lights will extinguish.

Repeat for extinguisher test 2 position.

This completes the Fire/Ovht/Ext test for ALL systems.

Cargo System Check:

③ 3 5

ARM SELECTOR Switch .... AUTO

TEST Switch .... PUSH

Verify fire warning bell sounds with master **FIRE WARN** lights and master **CAUTION** lights illuminated.

Master **FIRE WARN** Light .... PUSH

Verify master **FIRE WARN** lights and fire bell cancel.

Verify cargo **FIRE** warning light is illuminated.

Verify **DET** and **FAIL** LED's (**FWD, AFT**) are illuminated.

Verify **FWD**, **AFT**, **1st BTL** and **2nd BTL** squib indicators are illuminated.

Note: The **DISCH** lights will not illuminate during the test. They will illuminate when the aircraft's LIGHT TEST switch is placed to the ON position along with the remainder of the cargo fire panel lights.

Master **CAUTION** Light .... PUSH

Verify master **CAUTION** lights extinguish.

7 8 9

DETECTOR SELECT Switches .... NORMAL

TEST Switch .... PUSH

Verify fire warning bell sounds and master **FIRE WARN** lights illuminate.

Master FIRE WARN Light...PUSH

Verify master FIRE WARN lights and fire warning bell cancel.

Verify CARGO FIRE (FWD, AFT) WARNING lights are illuminated.

Verify DETECTOR FAULT light remains extinguished.

Note: If a CARGO FIRE WARNING light does not illuminate and the DETECTOR FAULT light illuminates, a detection loop is inoperative.

Verify the green EXTINGUISHER test lights are illuminated.

Verify the cargo fire bottle DISCH light is illuminated.

Radios (Flow) ....SET

NAV and COMM radios should be set as desired for departure. NAV / Auto-tuning would be appropriate if position verification has been completed.

B737 aircraft are equipped to record the uninterrupted audio signals received by a boom or a mask microphone. Flight crewmembers are required to use the boom microphone below 18,000 feet MSL.

WARNING: 7 8 9 Do not key HF radio while aircraft is being fueled. Injury to personnel or fire may result.

3 5 **EFIS Control Panel (Flow) ....SET**

HSI Range Selector...AS DESIRED

Traffic Switch...AS DESIRED

HSI Mode Selector...MAP/CTR MAP

The MAP mode, is recommended for departure. The use of CENTER MAP allows fixes behind the aircraft to be viewed if the departure runway is not aligned with the route of flight.

WARNING: In mountainous terrain below FL 250 at least one pilot will monitor raw data to ensure navigational accuracy.

Weather Radar Switch ....OFF

Map Switches..AS DESIRED

Transponder...STANDBY

Prior to the TCAS system check, the IRS alignment must be complete.

The TCAS system is checked by rotating the spring loaded function selector switch counter clockwise to the test position for 1 second and then releasing it.

7 8 9 The TEST button is located on the top of the transponder switch.

③ The RA/VSI indicator red and green circumference lights illuminate sequentially and the TCAS flag is in view throughout the test period.

3 5 7 8 9 The red TCAS RA pitch command symbol appears on the EADI.

On all radar PPIs a test pattern appears on the radar display allowing verification of each type of intruder symbol.

WARNING: When an engine is operating on an aircraft with predictive windshear, having the transponder switch in any position except STBY will cause a radiation hazard to personnel. This hazard exists even if the radar mode is selected to OFF or TEST.

At the conclusion of a successful self-test, a synthesized voice announces: "TCAS SYSTEM TEST OK." Should a failure be detected during self-test, the display fault annunciator will indicate the fail system component, and the audio message says, "TCAS SYSTEM TEST FAIL."

- A Resolution Advisory (red square) will appear at the 3 o'clock, range of two miles, 1,000 feet below and flying level.
- A Traffic Advisory (yellow circle) will appear at 9 o'clock, range of two miles, 200 feet below and climbing.
- Proximity Traffic (solid white diamond) will appear at 1 o'clock, range 3.6 miles, 200 feet above and descending.
- Non-Threat Traffic (open white diamond) will appear at 11 o'clock, range of 3.6 miles flying level 1,000 feet above.

ACARS (Flow) .... CHECKED, INITIALIZED

Initialization:

③

A check of the ACARS Link Test is required first flight of the day. The ACARS will be initialized on the 597 ACARS on the center pedestal as follows:

- Push the INTL button. The window will display **FTL 0000**.
- Type in the flight number, and push the ENT button.
- Type in BF (boarded fuel) in gallons. Push ENT key.
- Type in FOB (fuel on board) in pounds. Push ENT key.
- Use toggle keys and enter three letter DEP (departure airport). Push ENT key.
- Use toggle keys and enter three letter DES (destination airport). Push ENT key.
- Type in month and day. Push ENT key.

3 **5**

The automatic initialization of the DFDMU suffices for this link test. During a Link Test, all alphanumeric, station display, function selector keyboard and annunciator lights illuminate. GMT clock updates if the aircraft is at the gate. The ACARS will be initialized on the Interactive Display Unit (IDU) on the center pedestal as follows:

- Select the MAIN SYSTEM MENU, touch ACARS, PRE FLIGHT, INITITALIZATION. Touching AUTO sends the request message.
- Upon receipt of the uplink message, the INIT advisory is activated. Touch INIT> and the data pages will display the data contained in the uplink.

- To manually enter the data not supplied by the uplink, touch the appropriate fields and enter the data.
- The Management Unit (MU) will calculate FOB using the BD FUEL and DENSITY fields as follows: Previous flight arrival fuel + (boarded fuel x density) = FOB. This calculated FOB is compared to the value displayed in the FOB field.

Note: If **FIELD LOCKED** appears during FLT NO entry, the last post flight report has not been sent. Send it.

7 8 9

The ACARS will be initialized on the MCDU as follows:

Press the MENU key on the CDU. Line select <ACARS.

- Select <PRE-FLIGHT. If first flight of day, select GMT>; then select <AUTO UPDATE. Wait for AUTO UPDATE COMPLETE; then select <MENU. This returns the PRE-FLIGHT menu.
- Select <INITIALIZATION. Then select <AUTO.
- The FLT NO, DEP, DES and day after DES fields will be completed via ground uplink. If uplink is not available, manually enter this data. Enter the FLT TIME at 5R from the flight plan in the format hhmm; example: 4 hours and 55 minutes would be 0455.

  Fuel Verifications:

  Fields 1, 2 and 3R are FOB LBS, BD FUEL, and DENSITY respectively. These entries are completed from the fuel slip. Fuel density default value is 6.7 lbs/gal and is amendable. GALS may be changed to LTRS by pressing the line select key. The density value may be changed by entering the desired value in this space. The word **FUEL** appears under the advisory in 6R, if a calculated fuel error greater than ±5% has been detected. This is based on the calculation of inbound fuel plus fuel uplift. In this case, line select 6R and review the CALCULATED FUEL ERROR page. This page is for viewing only; no changes are allowed. Return to the INITIALIZATION page via the **INIT** prompt at 5R, and modify the fuel entries, or investigate further as necessary to ensure verification of the correct FOB.

  Note: A FOB entry must have been made on the inbound leg at block in or no entries will be possible.

Aileron & Rudder Trim (Flow)..CHECKED, ZERO

Check aileron trim switches centered. Exercise the rudder trim in each direction. Ensure that the rudder trim indicator moves freely and correctly in conjunction with the trimming action. Observe the rudder pedal deflection as an additional indication that rudder trim is operating. Ensure that the RUDDER TRIM switch returns freely to its spring loaded center position from both directions of movement.

Flight Deck Door Control / Status Panel (Flow)..............................CHECK

With the door open, illumination of the **OPEN** light alone indicates the door control system is functional. Failure of the **OPEN** light to illuminate, or illumination of any other light on the control panel or forward instrument panel **FLIGHT DECK DOOR** red light, indicates a fault with the door system.

Log Book / ETOPS / Gear Pins / MEL .... CHECKED, ON BOARD

Review the aircraft logbook. Ensure all discrepancies, the airworthiness release, the ETOPS service check (when applicable), and the first flight of the calendar day checks are signed off. The first flight of the day checks are:

- Fire Control Panel(s) Check
- ③ Instrument Check
  Instrument Comparator
  Radio Altimeter
- ③ 3 5 Standby Electrical Power Check
- ACARS GMT Auto Update (If available)
- CVR

Visually confirm that all gear pins are on board and properly stowed.

Visually confirm MEL is on the flight deck. In the event that the MEL is missing, or is damaged/has pages missing the following procedures apply:

1) The aircraft is parked at the gate and released <u>without</u> MEL/CDL items affecting the flight:

   a) If at a Hub (IAH, EWR, CLE) contact operations and request MEL be delivered to aircraft.

   b) If at an out station:

      - Contact Maintenance Control and advise of missing MEL.

      - Logbook entry is not required.

- The flight may depart and continue to the next hub facility where a replacement MEL will be obtained.

2) The aircraft is at an out station, parked at the gate and released <u>with</u> a MEL/CDL placard, or malfunction occurs prior to closing aircraft door:

   a) Contact Maintenance Control and advise of missing MEL.

   b) Prior to departure, the appropriate MEL/CDL information/procedure must be in your possession, via ACARS printer (if available), fax, TELEX or photocopy.

   c) Reference MEL Introduction and Preamble.

3) The aircraft is at an out station, has left the gate and an equipment malfunction has occurred prior to takeoff:

   a) Return to the gate and make appropriate Logbook entry.

   b) Contact Maintenance Control and they will evaluate the discrepancy and coordinate the required maintenance action.

   c) Maintenance Control will then issue the placard number for the discrepancy if the item is to be deferred.

   d) Maintenance Control will insure the appropriate MEL/CDL information / procedure is forwarded to flight crew as described in example #2.

   e) Contact Dispatch for a re-release if required.

Parking Brake..SET

Set parking brake in anticipation of removal of chocks.

FMC/CDU (Flow) ....SET

Although verification of FMC loading is accomplished with the TAXI checklist, every effort should be made to load as much information as possible as soon as such information is available. Normally, all data except zero fuel weight and assumed temperature is available prior to weight and balance close-out.

RTE...SELECT

Enter route by entering origin and destination airports, and the company route identifier, if applicable, then waypoints and/or airways.

DEP ARR ....SELECT

Select departure / transition procedures if required.

LEGS ....SELECT

Verify selected departure and route. Correct discontinuities.
On 3 5 7 8 9 the CTR STEP (6R) prompt may be used with the EHSI mode selector in PLAN to check the flight plan.

RTE...SELECT

ACTIVATE and EXECUTE.

INIT REF...SELECT

Verify fuel quantity on CDU agrees with fuel quantity indicators.

Enter fuel RESERVES. The RESERVES field should include the sum of ALTN plus RESV. For international flights the RSV10 and RSV30 should be included.

Enter actual ZFW.

Note: The ZFW should be either uplinked or entered from the ACCULOAD – PILOT WEIGHT MANIFEST. DO NOT enter the planned ZFW from the Flight Plan.

Note: If unusable fuel is required by the MEL (i.e., fuel boost pump inop), the ACCULOAD sheet may show the unusable fuel as part of the ZFW. In this case, subtract the unusable fuel from ZFW for entry into the FMC. (FMC fuel on board considers all fuel as usable when it calculates actual aircraft gross weight.)

Enter the COST INDEX. Enter the CRZ ALT.

Enter the CRZ WIND. (TOC winds located in the Flight Monitoring Information section of the computer flight plan.)

Enter the T/C OAT. (AVG OAT located in the Flight Information section of the computer flight plan.)

Verify TRANS ALT.

Note: 7 8 9 All entries except RESERVES and T/C OAT will uplink if ACARS is operational.

EXECUTE.

Note: If ATC metering for arrival is in effect, an RTA (Required Time of Arrival) may be entered on the RTA page.

CLB..SELECT

If VNAV is the planned pitch mode for departure the following techniques may be used:

L2 Climb:

- On line L2 TGT SPD enter V_M Flaps 0 as the target speed.
- Upon reaching an altitude where the pilot wishes to accelerate to 250 knots (normally 3,000 AFE) select ECON.

L3 Climb:

- On line L3 SPD REST enter (V_M Flaps 0 / 3000 feet AFE).
- On line L2 TGT SPD enter 250 knots.
- Upon reaching an altitude where the pilot wishes to accelerate to the scheduled climb speed select ECON (normally 10,000 MSL).

Note: You will be unable to make an entry on line L2 until all required entries are made to the PERF INIT page.

TAKEOFF (Line 6R of INIT REF)..SELECT

Enter OAT from the current ATIS.

If reduced thrust takeoff is planned, enter SEL TEMP (assumed temperature).

Note: 7 8 9 OAT and SEL TEMP will uplink if ACARS is operational.

Verify N_1 indicator bugs reflect the full rated thrust value.

Verify **PREFLIGHT COMPLETE.**

Thrust Mode Display...CHECK

Verify dashes are displayed.

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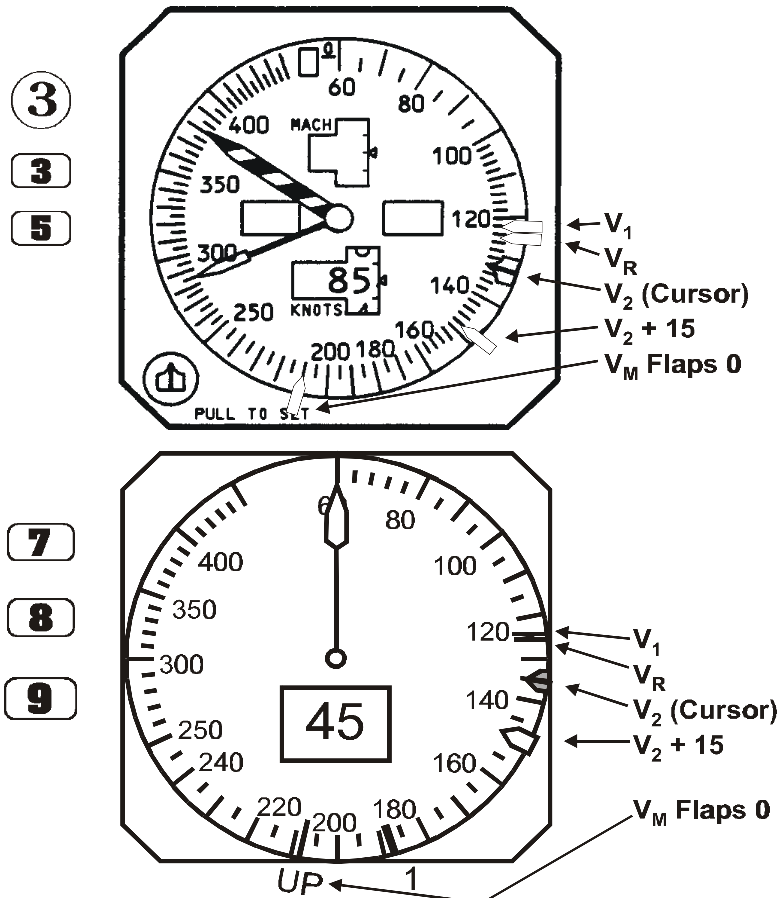
TAKEOFF REFERENCE BUGS SETTINGS



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Reference Bugs

The illustration describes the positioning of the reference bugs on the Mach / Airspeed Indicator for takeoff. The V-speeds will be normally provided on line 10 of the ACCULOAD sheet. If adjustments are required or the V-speeds are not available on the ACCULOAD sheet they can be computed from the chart in the QRH.

Note: For improved climb takeoffs, the reference bugs will be set the same as for normal takeoffs.

③ 3 5 External (White) Airspeed Bugs

Position the white movable reference bugs at V_1, V_R, $V_2 + 15$ and V_M Flaps 0.

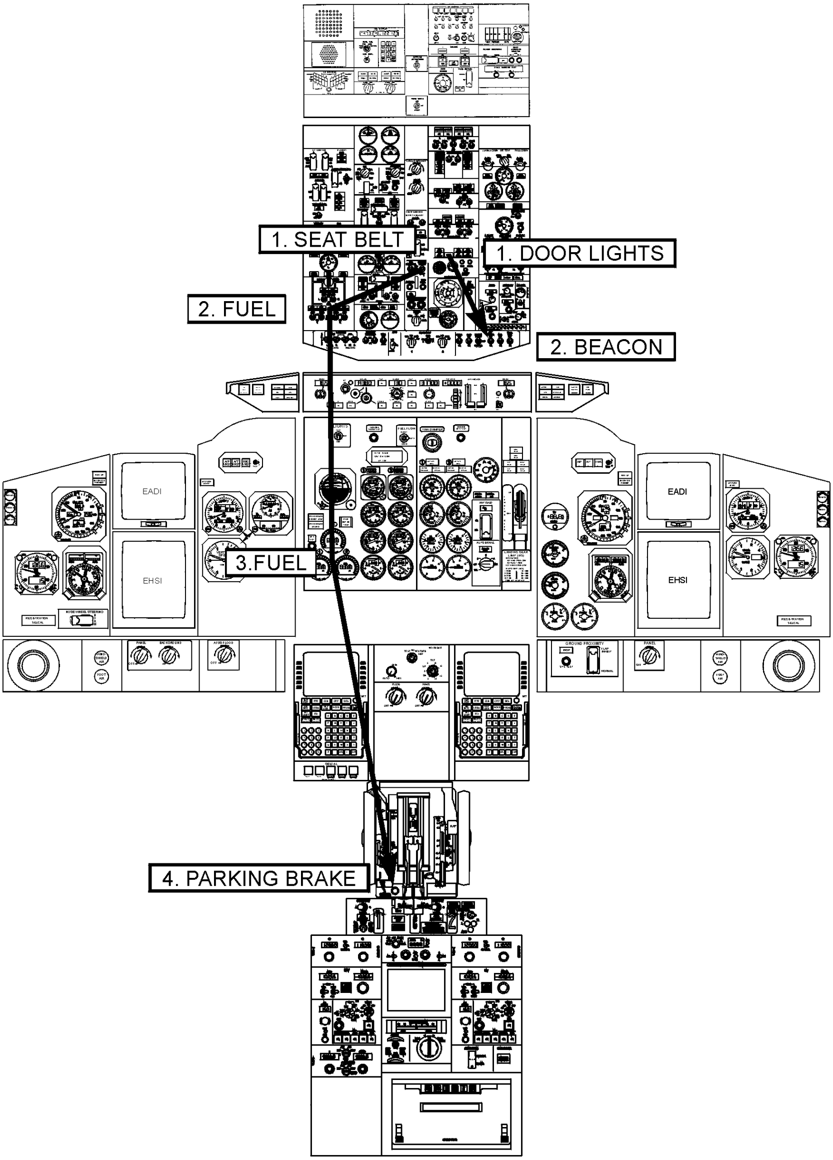
7 8 9 Reference Speed Bugs

Select AUTO on the speed reference selector. When zero fuel weight and V-speed entries are made on the CDU V_1, V_R, $V_2 + 15$, and V_M Flaps 0 speed bugs will be displayed. If the FMC is inoperative, enter the V-speeds manually using the speed reference selector. The ZFW and V-speeds associated with the Gross weight will uplink if ACARS is operational.

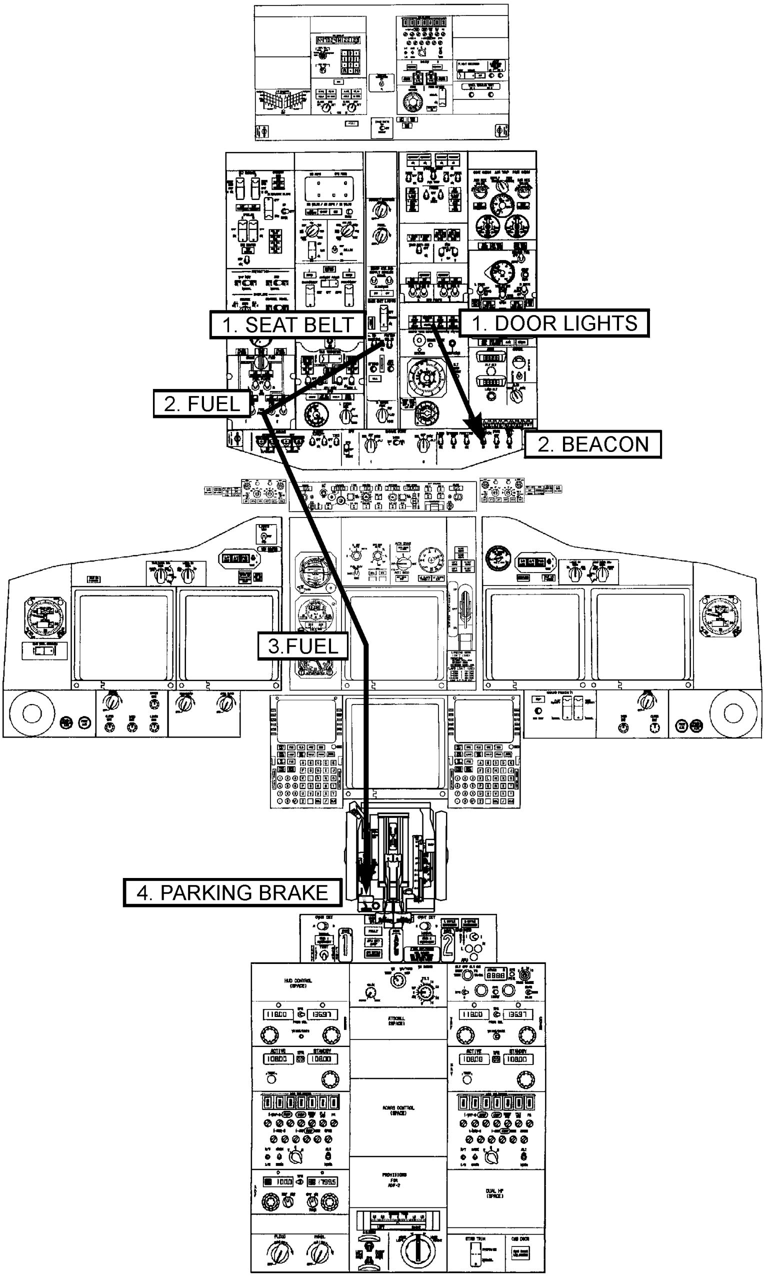
Airspeed Cursor

Set the airspeed cursor at V_2 using the speed selector on the mode control panel.

③ 3 5 BEFORE START FLOW



7 8 9 BEFORE START FLOW



BEFORE START

The Captain will call for the BEFORE START checklist after:

- All cabin doors are closed
- All passengers are seated
- All carry-on luggage is properly stowed.

The BEFORE START flow will be initiated when the Captain calls for the checklist.

If a pushback is required, the checklist will be completed prior to aircraft movement. In the event a pushback is not required, the checklist will be completed prior to engine start.

When engine start clearance is received, the Captain will call for the appropriate engine to be started.

F/O CHALLENGE	BEFORE START	CAPT. RESPOND
Flight Deck Windows		**LOCKED (F, C)**
Seat Belt Sign		**ON**
Door Lights		**OUT**
Beacon		**ON**
Fuel		**____REL, ____ON BOARD, PUMPS ON**

F/O Challenge **Capt. Respond**

Flight Deck Windows .... LOCKED (F, C)

Verify the lock levers are in the locked (forward) position.

Seat Belt Sign .... ON

Door Lights .... OUT

Verify door lights are extinguished prior to pushback and/or engine start. Cargo door may be opened for loading late baggage prior to starting engine #2.

Beacon .... ON

Fuel.................................. _____REL, _____ON BOARD, PUMPS ON

Example: "16.4 Release, 16.4 On Board, Pumps ON."

Check the fuel on board against the dispatch release GATE FUEL, fuel slip, and weight and balance for agreement. (If the value is less than GATE FUEL, ensure at least MIN FUEL plus TAXI onboard.) Any irregular load / distribution of fuel should be investigated. Ensure the wing fuel tanks are balanced. Check that all required fuel documentation is onboard.

Note: 3 5 7 8 9 Completion of the back of the fuel slip is not required for aircraft with DFDMU's installed as long as the unit agrees with the fuel entries.

For start, taxi and takeoff, boost pumps must be on for any tank containing fuel, and crossfeed selector closed. The previous statement does not preclude normal fuel balancing operations; however, check that the crossfeed selector is in the closed position prior to takeoff. If the center tank fuel is less than 1,000 pounds, leave the center tank pumps OFF for the takeoff roll to avoid nuisance caution lights.

Seat Belts (Flow) .... ON (F, C)

Each flight crewmember shall keep their **seat belt** fastened when at their station and the aircraft is moving.

Parking Brake (Flow) .... (AS REQUIRED)

Desired position of the parking brake should be verified.

Note: When engine start is required, configure pneumatics for starting the engines.

GATE DEPARTURE PROCEDURES

GENERAL

Approximately five minutes prior to departure, the ground crew will coordinate the proposed engine start time with the flight crew. At this time, the parking brake should be set and wheel chocks removed. The headset operator is responsible for verifying that all personnel are clear of the aircraft. In addition, he will check that all doors and service panels are properly closed and that the wing tip markers (if installed) are removed. The headset operator should then state: "WALKAROUND COMPLETE. ALL DOORS AND ACCESS PANELS SECURE." The headset operator should also state "READY FOR PUSHBACK" or "CLEARED FOR ENGINE START." If headset communication is not available, a person to person contact must be made with the person in charge of the ground crew.

PUSH BACK GATE

After tow tractor and tow bar have been connected and clearance obtained, give push-out signal to tractor operator. Headset operator must accompany tractor and aircraft during push-out to observe for possible safety hazards. Tractor operator is responsible to observe headset operator and aircraft for signals or possible safety hazards. After tractor and tow bar are clear of aircraft, proceed as described in the Taxi-Out Gate procedure.

PUSH BACK / TOW OUT PROCEDURE

Note: Powerback procedures are not authorized.

This procedure is required when the aircraft is to be pushed back or towed away from the terminal or loading area. Flight interphone contact with ground crew must be established. If flight interphone is not available, engine start is not authorized until pushback / tow out procedure is complete and tow bar has been disconnected.

WARNING: Do not move the nose gear steering until towing operations are complete and the ground crew report has been received.

Pushback With Nose Gear Lockout Pin Installed

Note: Pushback or tow out may be accomplished with hydraulic system A pressurized if the nose gear steering lockout pin is installed.

When Cleared for Pushback / Tow Out:

- Release the brakes

When Aircraft is Stopped (On Signal From Ground):

- Set the parking brake
- Have the tow bar disconnected
- Obtain verification from the ground crew that the tug and tow bar are clear and the nose gear steering lockout pin has been removed
- Clear the headset operator.

TAXI-OUT

The headset operator shall position himself between the aircraft and the terminal building in full view of the flight deck once the headset is removed. Depending on the direction of aircraft movement, this could be on the left or right side of the aircraft.

After the towbar and tug have been disconnected and the flight deck is ready for ground guidance to begin, the Captain will flash the nose gear light one time. The final marshaller must ensure that the area is clear of any moving traffic or other impediments to a safe taxi and then guide the aircraft until it is clear to taxi unassisted. During ground guidance, the final marshaller must remain visible to the flight crew.

When the ground marshaller determines that the flight deck crew no longer requires ground guidance, the “End of Ground Clearance” hand signal will be given. This is followed by the “Clear to Depart” (clear to taxi) salute. The Captain should acknowledge with a salute during the day or one flash of the taxi light at night.

Note: Three flashes of the taxi light indicates that the flight deck crew would like to re-establish headset communication.

Note: The aircraft will not be taxied away from a gate (or pushback position), unless the marshaller gives the crew the proper signal that the aircraft is cleared to taxi. Should, for some reason, the marshaller not be visible, or leave his position on the ramp, the aircraft will not taxi. Call the station on company radio and have the marshaller return and give taxi clearance.

Note: The headset operator is responsible to ensure the aircraft, personnel, and equipment are clear from injury or damage from jet blast before taxi-out signals are given aircraft. High lift trucks at gates immediately behind must be lowered before aircraft taxis out.

ENGINE START PROCEDURE

CAPTAIN	FIRST OFFICER
Announce engine start sequence. Normal starting sequence is 1, 2, when starting both engines. For delayed engine start, Captain will determine the start sequence.	Position the PACK switches to OFF.
Announce "START ENGINE NO.______."	Position ignition select switch to IGN L or IGN R and position engine start switch to GRD and start clock.
Verify increase in N_2 RPM.	
Acknowledge First Officer's report.	Verify increase in oil pressure by the time engine stabilized at idle and announce "OIL PRESSURE RISING" when observed.
Verify N_1 rotation prior to positioning engine start lever to IDLE.	
Position engine start lever to IDLE detent when: • N_2 RPM reaches 25% or Max motoring which ever comes first. • A minimum of 20% N_2. is required. Max motoring occurs when N_2 acceleration is less than 1% in 5 seconds.	
Verify fuel flow and EGT indication within 10 seconds.	
At 3 3 5 46% or 7 8 9 56% N_2 RPM check engine start switch moves to OFF; if not, position start switch to OFF.	Verify duct pressure 3 3 5 increases / 7 8 9 decreases as the start switch moves to OFF and report "START VALVE CLOSED," when start valve **OPEN** light extinguishes.
Monitor N_1, N_2, EGT fuel flow, and oil pressure for normal indications as the engine accelerates and stabilizes at idle.	

Approximate standard day, sea level, stabilized idle indications (new engine).

	N_1 RPM	N_2 RPM	EGT	Fuel Flow
CFM 56-3 3 3 5	21.5%	60.3%	475°C	720 PPH
CFM 56-7 7 8 9	19.4%	58.8%	410°C	600 PPH

Idle EGT may vary from 320°C - 520°C depending on OAT, bleed configuration, and engine conditions. As engine on wing time increases, fuel flow and EGT will increase.

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ENGINE START NOTES

Caution: The following items should be noted and observed:

IGNITION SELECT switch should be alternated between L IGN and R IGN for successive flight segments.

Ensure start pressure is stable prior to starter engagement.

Do not initiate second start until first engine duct pressure has returned to pre-start value.

Do not change pneumatic or electrical configuration while starter is engaged.

Discontinue start if significant duct pressure fluctuations are noted.

Advancing engine start lever prematurely can cause a Hot Start.

Keep hand on engine start lever while observing RPM, EGT, and fuel flow until stabilized.

If fuel is shut off inadvertently (by closing engine start lever), do not reopen engine start lever in an attempt to restart engine.

Failure of engine start switch to hold in GRD until starter cutout RPM is reached can result in a Hot Start. Do not re-engage engine start switch until N_2 RPM is below 20%.

A two minute warm-up at or near idle prior to advancing throttles to high power is required.

Air Conditioning Considerations During Hot Weather Conditions

With an operating APU and high ambient temperatures and/or heavy passenger loads, it is desirable to start #2 engine first. This allows the right pack to be operated while starting #1 engine using the APU.

Note: After #2 engine has stabilized, reposition the ISOLATION VALVE switch to CLOSED, and place the R PACK switch to ON.

There must be coordination with ground personnel to ensure there will be no late baggage.

If the APU is inoperative, and maximum cooling is desired, both engines should be started as soon as practical and used for air conditioning.

Starting Windmilling Engines

A tailwind can cause the low pressure (N_1) rotor to rotate in a reverse direction. During an engine start with the low pressure rotor windmilling in a reverse direction, the rotor will decelerate, stop, and then start rotating in the normal direction. Under these conditions the start will be slower than normal, with a higher than normal EGT as the tailwind velocity increases.

When the low pressure rotor is rotating in the reverse direction:

- With 25 Knots or Less of Tail Wind - Use normal starting procedures.
- With Over 25 Knots of Tailwind - Turn the aircraft into the wind.

If it is impossible to start without exceeding starting limit EGT, make no further attempts until the aircraft can be turned into a cross or headwind position, or wind conditions become more favorable.

Starts made with the low pressure rotor turning in the proper direction will be normal regardless of wind velocity.

Starting With Marginal APU Output

Certain combinations of altitude and temperature may cause the APU bleed valve to limit available air for starting to keep the APU from exceeding temperature limits. In such circumstances, available air may be increased by reducing electrical load.

Prior to starter engagement consideration may be given to turning off one or more of the following:

- Galley or CAB / UTIL switch
- 7 8 9 IFE / PASS SEAT switch (if installed)
- Window heat
- Electric hydraulic pump(s).

Carefully evaluate the effect on the individual system. Electrical load may also be reduced for the second engine start by selecting the first engine generator ON after careful evaluation of nosewheel steering hydraulic configuration.

Do not reduce electrical load with engine starter engaged.

3 3 5 Considerations for starting engines at airport elevations above 7000 feet MSL, if needed, are in section 2.7.

The above procedures should only be used in extreme cases and should not become the norm. If an APU is consistently weak for engine start, enter a maintenance discrepancy.

Engines Running

After engine(s) are running, advise the headset operator that “ENGINE START IS COMPLETE-CLEARED TO DISCONNECT.”

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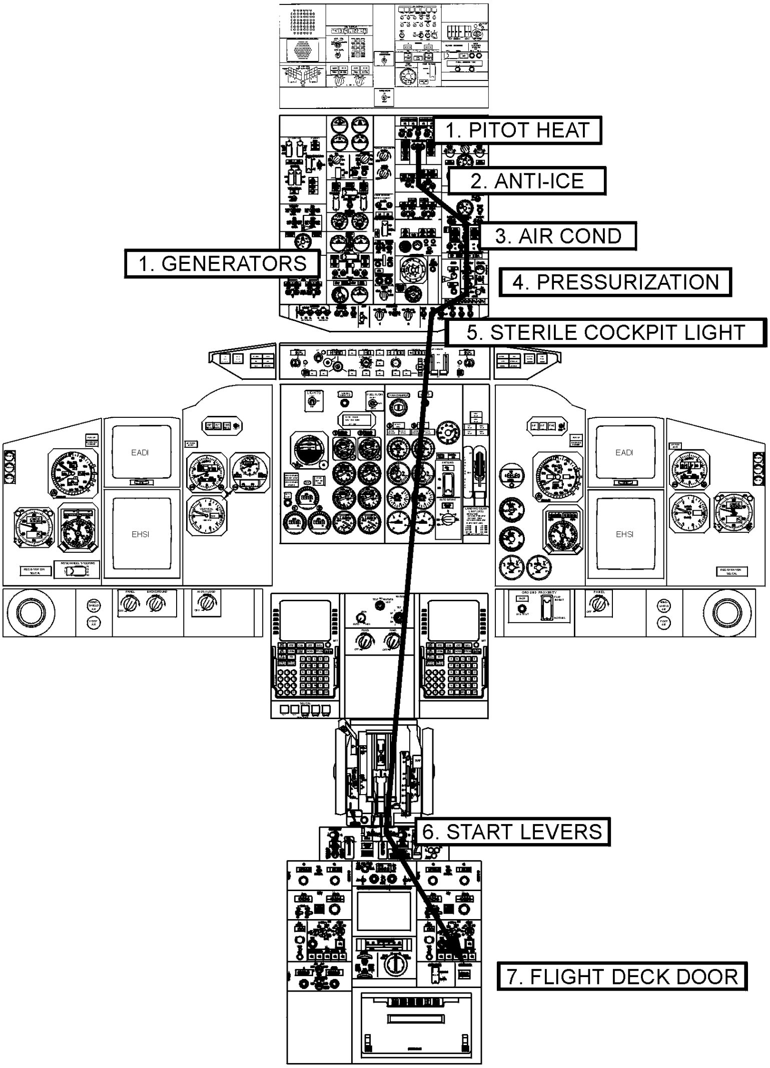
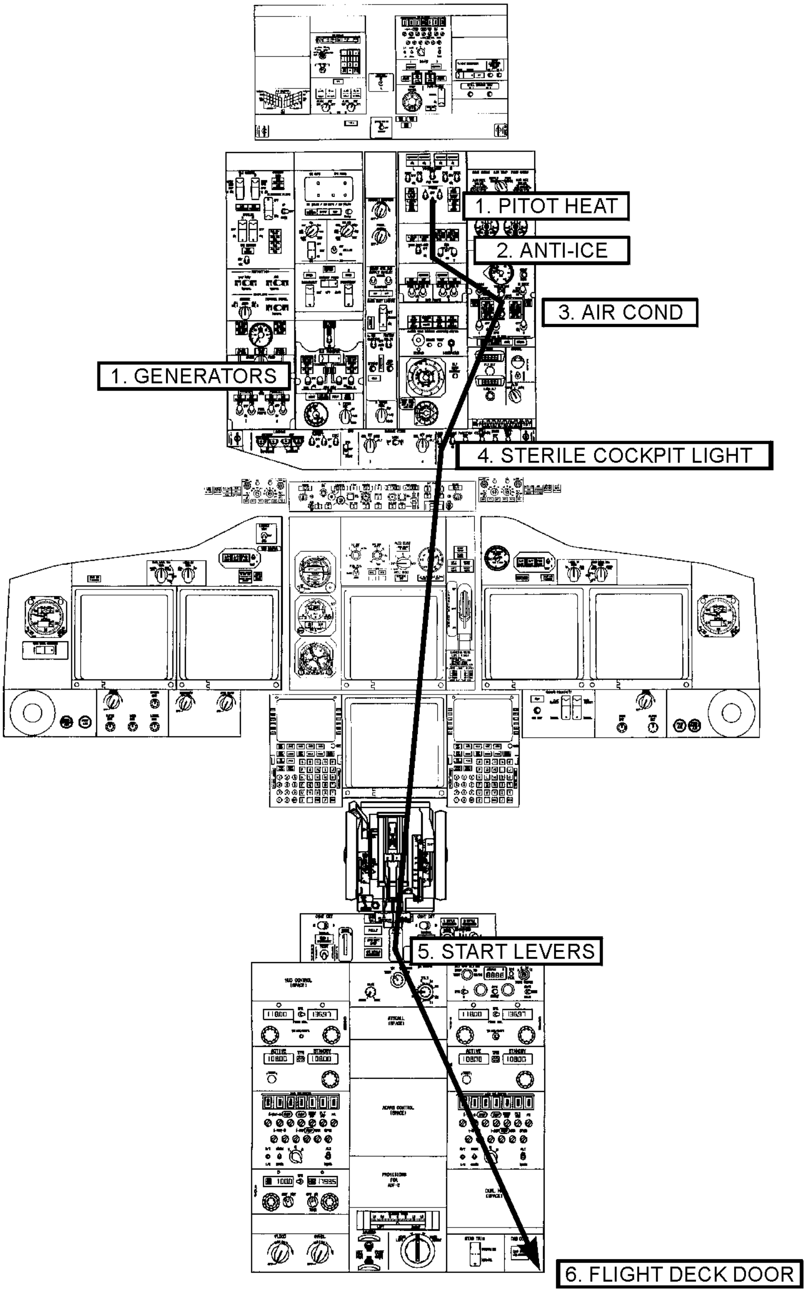
③ 3 5 AFTER START FLOW



7 8 9 AFTER START FLOW



AFTER START

The Captain will call for the AFTER START checklist after the engine(s) have reached a stabilized idle and the headset operator has been cleared to disconnect.

The AFTER START flow will be initiated when the Captain calls for the checklist. This checklist will be completed prior to releasing the brakes for taxi.

F/O CHALLENGE	AFTER START	CAPT. RESPOND
Generator(s)		ON
Pitot Heat		ON
Anti-Ice		(AS REQUIRED)
Flight Deck Door		CLOSED AND LOCKED

F/O Challenge — **Capt. Respond**

Generator(s) .... ON

Position operating generator switch(es) to ON and verify:

③ [3] [5] **GEN OFF BUS** lights extinguish.

[7] [8] [9] **SOURCE OFF** light extinguished.

Pitot Heat .... ON

③ [3] [5] pitot heat switches ON.

[7] [8] [9] probe heat switches ON.

Verify that all amber lights extinguish.

Anti-Ice .... (AS REQUIRED)

When icing conditions exist or are anticipated, position engine and wing anti-ice switches ON. Verify the **COWL VALVE OPEN**, **R VALVE OPEN**, and **L VALVE OPEN** lights illuminated bright, then dim. Engine start switches are to be placed in CONT.

Note: If the **COWL VALVE OPEN** light fails to illuminate from bright to dim with the engine at idle, position the APU bleed air switch to OFF and increase thrust slightly (up to a maximum of 30% N_1).

Air Cond & Press (Flow) .... SET, (AS REQUIRED)

Position the FLT/GRD switch to FLT (as installed). FLT/GRD switch may be left in GRD if a delayed engine start is used.

(8)(9) Position TRIM AIR switch ON after the last power transfer. The TRIM AIR should be left in OFF if a delayed engine start is used.

For two engine taxi, under normal circumstances, configure the air conditioning panel as follows:

Right Air Conditioning Pack.. AUTO
Isolation Valve .... AUTO
Left Air Conditioning Pack .... AUTO
#1 Engine Bleed Air Switch .... ON
APU Bleed Air Switch.. OFF
#2 Engine Bleed Air Switch .... ON

If a Bleeds Off takeoff is planned, the air conditioning panel may be configured as follows:

Right Air Conditioning Pack.. AUTO
Isolation Valve .... CLOSED
Left Air Conditioning Pack .... AUTO
#1 Engine Bleed Air Switch .... OFF
APU Bleed Air Switch... ON
#2 Engine Bleed Air Switch .... ON

For increased cooling on the ground configure the bleeds as follows:

Right Air Conditioning Pack... HIGH
Isolation Valve .... CLOSED
Left Air Conditioning Pack .... HIGH
#1 Engine Bleed Air Switch .... OFF
APU Bleed Air Switch... ON
#2 Engine Bleed Air Switch .... ON

Ensure that the **DUAL BLEED** light is extinguished prior to advancing thrust levers for taxi.

Sterile Cockpit Light (Flow)..ON

The sterile cockpit environment exists while the aircraft is moving under its own power and continues until the aircraft has climbed through 10,000 feet. During that time, activities in the flight deck not required for the safe operation of the aircraft are prohibited. (These include logbook entries, PA's, non-essential conversation, etc.) If the light is not installed or is inoperative, the cycling of the "No Smoking" sign may be used to signal the end of the sterile period to the flight attendants. Increased traffic vigilance should be maintained through 18,000 feet.

Start Lever(s) (Flow)... IDLE

Flight Deck Door..CLOSED AND LOCKED

Flight deck doors must be closed and locked from the *beginning of the aircraft moving under its own power until block in*, with the exception of transit by authorized personnel. **It is imperative that the flight deck door be open only long enough for expeditious transit of authorized individuals or items.** <u>Do not allow the door to remain open for extended periods of time for any reason</u>.

All individuals (including pilots, flight attendants, ACM / jumpseat riders, etc.) desiring access to the flight deck for entrance or for transit of items must comply with the following procedures:

1. Insure the immediate area around the flight deck door (and ideally the forward lavatory(s) on aircraft so equipped) is clear of customers.
2. Identify yourself to the flight crew via the interphone, to include name and, if necessary, employee number. It is appropriate for the flight deck crew to have access to the assigned crew list in the event there is any question as to the identity of someone requesting access. This is especially true with large crew compliments where the flight deck is not likely to recall all crew names or recognize voices. For ACMs / jumpseat riders who may not be familiar with the interphone system (such as FAA inspectors, ATC personnel, etc.) a flight attendant will assist in placing the interphone call and confirming the individual's identity. Any individual who is not part of the working crew, must wear their identification in a clear and visible manner while entering, leaving or on the flight deck. **Do not call until you are ready for access / entry.** Do not request entry and then wait an extended period of time before arriving at the door. Whoever makes the call is responsible to ensure that no unauthorized individuals are allowed access based on their call.

3. **Firmly knock 2 times** on the flight deck door, at which point the flight crew will lift the coverguard and hold down the red UNLOCK switch located on the door control panel until the door is opened. If the flight crew has any reservations as to who has knocked, they will visually confirm the identity of the individual via the door viewing port before unlocking. While the door is open, the amber **OPEN** light on the door control panel will be illuminated to serve as reminder to keep the door open time to an absolute minimum.
4. Anyone exiting the flight deck should first look through the viewing port to check the area outside the door. If possible, try to exit when there are no customers near the door area. The door is normally opened by rotating the door knob in either direction. It is the responsibility of the individual who opens the door, to close the door immediately after transit.

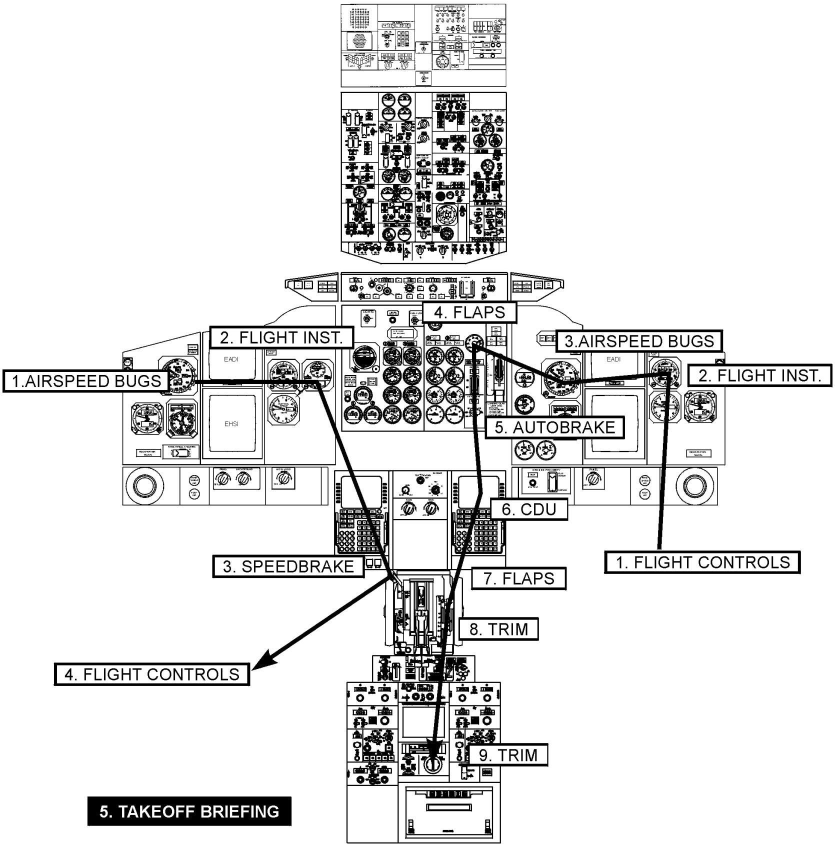
ENHANCED FLIGHT DECK DOOR (If Installed)

Note: **THE DOOR WILL AUTOMATICALLY LOCK WHEN IT IS CLOSED** anytime the aircraft is operating on normal electrical power.

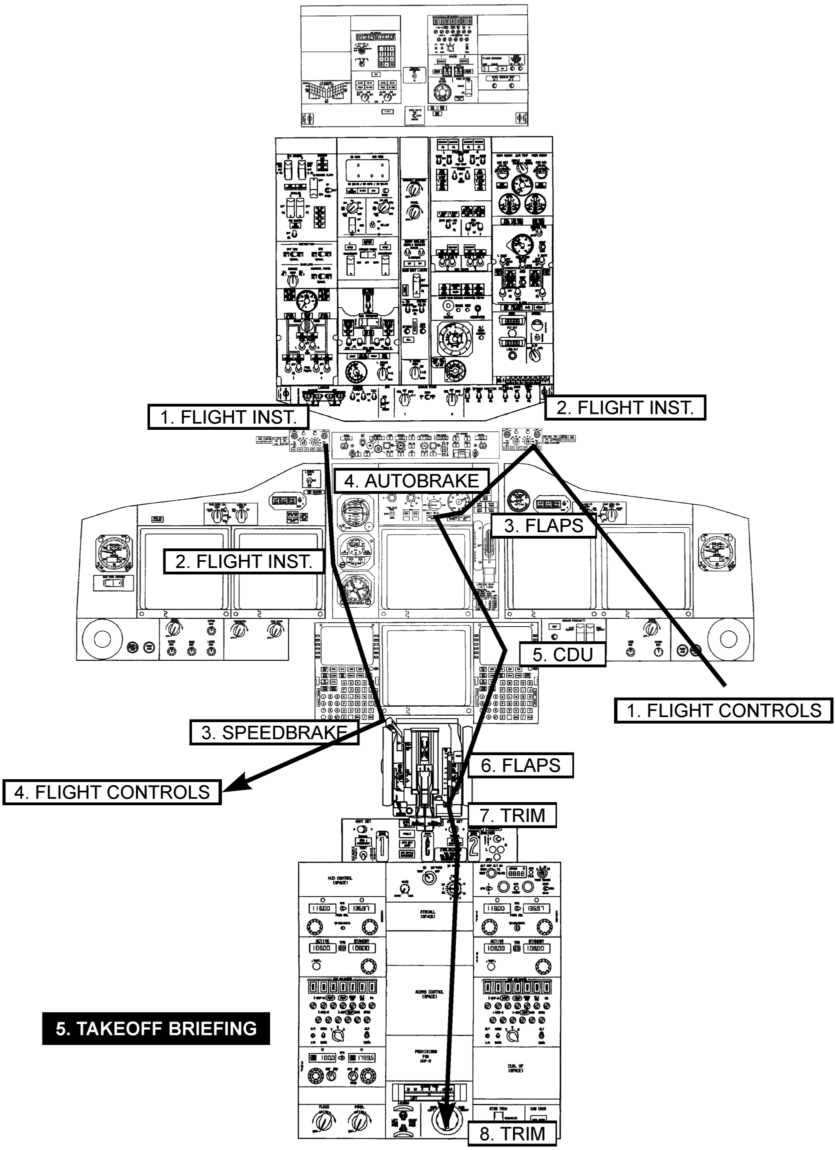
If the door does not electrically lock after closing or if there is an internal system failure, the red **UNLKD** light will illuminate. The crew must investigate the problem and take corrective action, including use of the mechanical lock if necessary to secure the door.

The door will be left open / unlocked by the flight crew when departing the aircraft after the flight. If the door is inadvertently closed (and therefore automatically locked) either a pilot or maintenance technician may use the FLIGHT DECK EMERGENCY ENTRANCE system to gain access.

③ 3 5 TAXI FLOW



7 8 9 TAXI FLOW



TAXI

Once the AFTER START checklist is complete, and the Captain is confident that the area around the aircraft is clear, the Captain will call "FLAPS____, TAXI CLEARANCE." The First Officer will select the required flaps and obtain a taxi clearance.

The Captain will call for the TAXI checklist when clear of congestion. The TAXI flow will be initiated when the Captain calls for the checklist.

Caution: Outside vigilance during taxi is the responsibility of both pilots. Prior to the aircraft movement or flap movement, both pilots should verify that the aircraft is clear of all obstacles.

F/O CHALLENGE	TAXI	F/O RESPOND
Takeoff Briefing		**COMPLETED**
Flight Controls		**CHECKED**
Speedbrake Lever		**DOWN DETENT (F,C)**
Flaps		**SET____, GREEN LIGHT (F, C)**
Autobrake		**RTO**
CDU / Airspeed Bugs		**SET (F, C)**
Trim		**SET, ZERO**

F/O Challenge **F/O Respond**

Takeoff Briefing....................COMPLETED

Prior to the first leg of the trip series, the Captain will conduct a complete departure briefing. This briefing should include, as applicable, a review of the following areas:

- Weather and takeoff alternate
- Runway conditions and required lighting
- SID Departure routing and chart date
  - Displays and automation modes
  - Frequencies / courses
  - Altitudes
- Rejected takeoff / evacuation procedures
- Engine out procedures
- Air return considerations
  - Runway / Weight
- Non-normal and MEL inoperative equipment considerations
- Terrain considerations

If EGPWS is installed, use the TERR feature on the EFIS control panel for departure from any airport with significant terrain features. This feature should be considered for use even in day VFR conditions. The TERR function cannot be displayed with weather radar. Consider using weather radar on one display and terrain on another when faced with a weather / terrain situation.

If EGPWS is not installed, consider using radar to help identify prominent terrain features.

- Transition Altitude
- 10-7 and 10-9 Pages

Whenever practical, it is recommended that the departure briefing be completed at the gate or earlier.

For subsequent flights with the same crew the Captain may substantially abbreviate the briefing. However, any changes or items peculiar to the specific departure should be thoroughly reviewed.

Flight Controls .... CHECKED

7 8 Per Airworthiness Directive 2002-08-20 / AMOC 120S-02-907:

"After any ground deicing / anti-icing of the horizontal stabilizer using Type II or Type IV fluids, airspeed must be limited to 270 KIAS until the flight crew has been informed that applicable maintenance procedures have been accomplished that would allow exceedance of 270 KIAS. Once the applicable maintenance procedures have been accomplished, exceeding 270 KIAS is permissible only until the next application of Type II or Type IV deicing / anti-icing fluids."

Note:

- Aircraft is restricted to a maximum of 270 KIAS after Type II or Type IV fluid application. No MACH restriction.
- Flight Plan Release (amended if required) displays 270-knot restriction.
- Restriction remains in effect for all flights until elevator tab surfaces are cleaned of Type II or Type IV fluids.
- It has been determined that Type I fluid does not affect the flight controls of the aircraft. If **only** Type I fluid is used for deicing / anti-icing, the speed restriction is not applicable.

Caution: Flight Crews will evaluate the need to land at the nearest suitable airport if in-flight vibrations (**ELEVATOR TAB LIMIT CYCLE OSCILLATION**) occur as a result of de-icing.

The Captain will:

- While holding the tiller securely, smoothly and slowly displace the rudder full travel in each direction, verifying full travel and freedom of movement. Ensure that the rudder pedals return to the neutral position and that no abnormal nosewheel steering pressures are noted unless required by a single engine taxi situation.

The First Officer will:

- Smoothly and slowly displace the control wheel and the control column full travel in each direction, verifying full travel and freedom of movement.
- If the aircraft has been deiced and exterior deicing checklist has not been accomplished:
  The control column will be smoothly and slowly cycled from the full aft to the full forward position a minimum of three times to minimize the residual fluids in the balance bay during flight.

Speedbrake Lever..DOWN DETENT (F, C)

The First Officer will:

- Visually confirm that the speedbrake lever is full forward and that the Captain has physically checked the speedbrake lever is seated in the down detent.

The Captain will:

- Physically check the speedbrake lever is seated in the down detent. The speedbrake lever may visually appear to be in the down detent, but may not be completely stowed. This will cause a takeoff warning when throttles are advanced for takeoff.

Flaps ....SET ______, GREEN LIGHT (F, C)

This response refers to the flap setting from the ACCULOAD, the flap position indicator and handle. Verify that the green LE FLAP light is illuminated. The Captain will also verify the correct flap setting and will verbally respond "SET ______, GREEN LIGHT."

Autobrake.. RTO

CDU / Airspeed Bugs .... SET (F, C)

Verify all required entries are made to the FMC.

- V_1, V_R, and V_2 should be set on the TAKEOFF REF page.
- Insure the departure runway has been selected on the ROUTE page.
- If VNAV is the pitch mode desired for departure insure entry of appropriate climb restrictions and speed.

- Reduced thrust temperature if appropriate is entered on the N1 LIMIT page.
- Verify that the TAKEOFF REF page shows **PREFLIGHT COMPLETE**.

③ 3 5 External (White) Airspeed Bugs

Position the white movable reference bugs at V_1, V_R, and V_2 + 15, and V_M Flaps 0 for the appropriate weight, i.e.; 210 knots if 117,000 lbs. or less and 220 knots if more than 117,000 lbs.

7 8 9 Reference Speed Bugs

Select AUTO on the speed reference selector. When gross weight and V-speed entries are made on the CDU V_1, V_R, V_2 + 15, and V_M Flaps 0 speed bugs will be displayed. If the FMC is inoperative, enter the V-speeds manually using the speed reference selector.

Airspeed Cursor

Set the airspeed cursor at V_2 using the speed selector on the mode control panel.

Flight Inst (Flow) .... CHECKED (F, C)

- Check that navigation equipment is operating properly.
    1. ③ 3 5 Ensure that the AUTO-MANUAL switches on the VHF NAV radios are set as appropriate for the type of departure.
    2. 7 8 9 Ensure the appropriate position of the TFR switch.
- Verify that the MCP courses, altitude, heading, and V_2 speed are set for the departure.
- Warning flags should be out of view.
- Confirm N_1 and airspeed bugs have been set.
- Pitch and roll attitude information on the (E)ADI and standby horizon should reflect the aircraft attitude while taxiing.

Trim .... SET, ZERO

Verify stabilizer trim is set for takeoff.

Verify that the rudder trim indicator reads ZERO.

During the initial stages of the takeoff roll be alert for any abnormal rudder pedal displacement or required control force that may indicate an out of trim rudder.

Caution: ACM occupants are not to put their feet on the aisle stand.

TAXI NOTES

GENERAL

Aircraft response to thrust change is slow, particularly at high gross weights. Idle thrust is adequate for taxiing under most conditions. A slightly higher thrust setting is required to start taxiing. Allow time for aircraft response to each thrust change.

To initiate taxi, release brakes, smoothly increase thrust to minimum required for the aircraft to roll forward and reduce thrust to idle. Under normal conditions, 45% N_1 should be considered the maximum N_1 for breakaway thrust. Do not start a turn until sufficient forward speed has been attained to carry the aircraft through the turn at idle thrust.

Thrust use during ground operation demands sound judgment and technique. The air blast effects from the high bypass engines at relatively low thrust can be destructive and cause injury. Avoid following other aircraft too closely. Jet blast is a major cause of foreign object damage.

The tendency is to taxi faster than desired. This is especially true during runway turnoff after landing. The appropriate taxi speed will depend on turn radius and surface condition. Nose wheel scrubbing indicates excessive steering angle and/or taxi speed for surface condition. The normal straight away taxi speed should not exceed approximately 20 knots. Speeds in excess of this, when combined with long taxi distances, cause heat buildup in the tires. When approaching a turn, speed should be slowed to the appropriate speed for the conditions. On a dry surface, use approximately 8 to 12 knots.

Note: Use of reverse thrust is not recommended during taxi. At low speeds, the reverse thrust can cause loose objects on the taxiway to be ingested causing FOD.

The crew should familiarize themselves with the airport taxiways, intersecting runways and any obstructions, which may be a hazard to safety. The crew should not hesitate to discontinue taxiing if any doubt exists about the aircraft's location on the field. If the Captain stops the taxi, the First Officer must notify ground control.

Outside vigilance by both crewmembers is paramount when taxiing. If possible, paperwork and other activities should be accomplished while the aircraft is not moving and the parking brake is set.

While taxiing, utilize the Jeppesen airport diagrams to the maximum extent possible. If confusion exists, ask for clarification from ground control. When cleared for takeoff, ensure that the correct runway is being used.

APU OPERATION

APU operation after engine start is at the discretion of the Captain. In all cases, the APU must be operated for at least one minute in a pneumatically unloaded condition prior to shutdown.

Consideration should be given to bleed configuration for takeoff and departure weather when evaluating APU operation. During long taxi or ground delays, the APU may be shutdown after the appropriate cooling time unless APU is needed for electrical or pneumatic requirements.

TIGHT GATE POSITIONS

Taxing out of tight gate positions can create special problems. Be especially cautious in tight turning situations. Great care on the part of the Captain is necessary to avoid jet blast damage to other aircraft, ground support people, equipment, large windows and concourse structures.

RUDDER TRIM

Rudder trim application will result in uneven rudder pedal position. Rudder pedal differential will also result in abnormal nose wheel steering control displacement during taxi and takeoff. Any significant rudder trim application on the ground should be apparent to the crew during taxi and takeoff roll.

The rudder pedal displacement caused by rudder trim can be compensated for and directional control maintained with the rudder pedals. Rudder trim does not reduce available rudder travel but will increase the pedal force required to oppose the trim.

NOSEWHEEL / RUDDER PEDAL STEERING

Maintain a positive pressure on the nose steering wheel in both directions to prevent the nose gear from returning to center abruptly. Straight ahead steering and large radius turns may be accomplished with rudder pedal steering only. If nose wheel “scrubbing” occurs while turning, reduce steering angle and/or taxi speed. Differential thrust may be required for heavy aircraft during tight turns but should only be used as required to maintain the desired speed in the turn. Center the nose wheel and allow the aircraft to roll straight ahead to relieve stress on the main and nose gear structure prior to stopping after completing a turn. Avoid stopping the aircraft in a turn as excessive thrust will be required to start taxiing again.

Note: 9 Make all turns at a slow taxi speed. The B737-900 is approximately 10 feet longer than the B737-800. This will require that turns are squared more than on the B737-800 to ensure that the main landing gear remains on the taxiway.

BRAKES

Avoid riding the brakes to control taxi speed as brake heat buildup could become excessive. If taxi speed is too high, reduce speed with a steady brake application and then release the brakes to allow them to cool. Continuous braking should be avoided. Allow for decreased braking effectiveness on slick surfaces.

TAXI IN ADVERSE WEATHER

Taxi under adverse weather conditions requires more awareness of surface conditions. Engine and wing anti-ice will be used while taxiing for takeoff during cold weather operations if taxiways and runways are covered with snow, slush, or water.

When taxiing on a slick surface at reduced speeds, use of differential engine thrust will assist in maintaining aircraft momentum through a turn. Differential braking may be more effective than nose wheel steering on very slick surfaces. Reduce speed prior to initiating a turn.

TAXIING IN REDUCED VISIBILITY

Caution must be exercised when taxiing in conditions of reduced visibility. The crew should familiarize themselves with the airport taxiways, intersecting runways and any obstructions which may be a hazard to safety. The crew should not hesitate to discontinue taxiing if any doubt exists about the aircraft's location on the field. If the Captain does stop the aircraft, the First Officer must notify ground control so that any approaching aircraft can be notified.

Outside vigilance by both crewmembers is paramount when taxiing in conditions of reduced visibility. If possible, checklist should be accomplished while the aircraft is not moving and the parking brake is set. While taxiing, utilize the Jeppesen airport diagrams to the maximum extent possible. If confusion exists, ask for clarification from ground control. When cleared for takeoff, ensure that the correct runway is being used.

Note: Taxi operations in RVR < 600 / 175m, require a SMGCS or ICAO equivalent low visibility taxi plan. When the approach chart is issued with RVRs < 600 / 175m minimums, the airport has an approved plan.

TAXI WITH ONE ENGINE

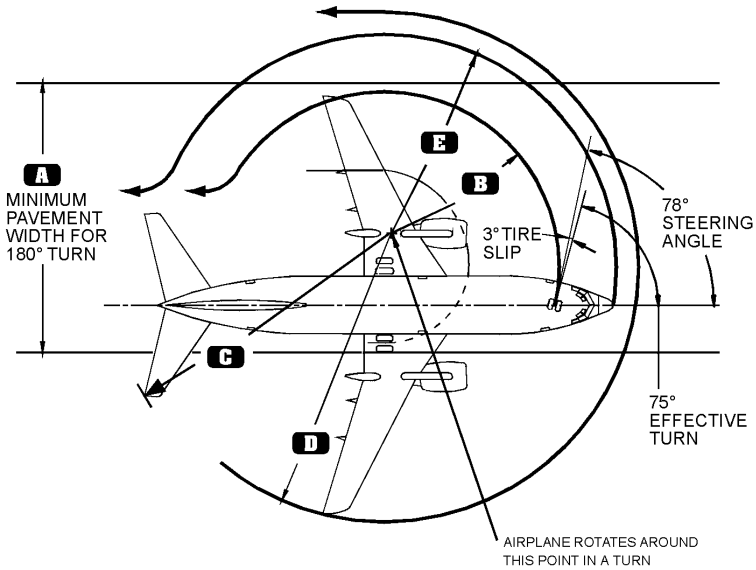
Normally both engines will be started for taxi. If the aircraft is leaving a congested ramp, this keeps jet blast hazards to equipment and personnel to a minimum during initial breakaway. Once clear of the congestion the appropriate engine may be shut down.

Single engine taxi may be used unless gross weight, temperature, or other conditions make it impractical or unsafe. Generally, single engine taxi will result in less overall fuel consumption and is appropriate in most taxi situations. Consider the following factors when planning a single engine ground operation:

- Single engine taxi should result in operating engine breakaway thrust setting no higher than 45% N_1.
- Single engine taxi for fuel savings alone is prohibited on slippery surfaces.
- Constant pressure on the tiller will be required due to the asymmetric taxi thrust. Use of rudder trim to counter the nose wheel turning tendencies is prohibited.
- Thrust requirements may cause activation of the configuration warning. Any attempt to disable the warning by pulling circuit breakers, etc. is prohibited.
- Do not operate thrust reversers or speedbrake while the aircraft is in motion.
- Plan taxi routes carefully. Sharp turns toward the operating engine may be difficult.
- Observe fuel balance limitations during single engine ground operations.
- With the APU inoperative, coordinate the crossbleed start area with the appropriate controlling agency (tower, ramp, ground control).
- Start the second engine in time to allow a minimum of 2 minutes at or near idle prior to advancing throttles to high power.

Turn Radius

CAUTION: Landing gear geometry and sweep back of 737 airplane wings result in an outward motion of the wing tips and tail during turns.



NOTE:
- Turn initiated with airplane in motion.
- Approximately idle thrust on both engines.
- No differential braking.

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	③ 3	5	7	8	9
A	65 ft.	58 ft. 7 in.	66 ft. 4 in.	77 ft. 1 in.	85 ft. 5 in.
B	43 ft.	38 ft.	43 ft. 8 in.	51 ft. 9 in.	58 ft. 10 in.
C	64 ft.	60 ft.	65 ft. 5 in.	74 ft. 9 in.	78 ft. 4 in.
D	60 ft.	59 ft.	69 ft. 6 in.	71 ft. 6 in.	73 ft. 5 in.
E	55 ft.	50 ft.	55 ft. 9 in.	65 ft. 9 in.	70 ft. 11 in.

This turning radius illustration shows the minimum turning radius capability. The tail describes the largest arc while turning and determines the minimum obstruction clearance path except for the –700.

Note: The wing tip and tail travel outboard up to 10 feet in front of the nose.

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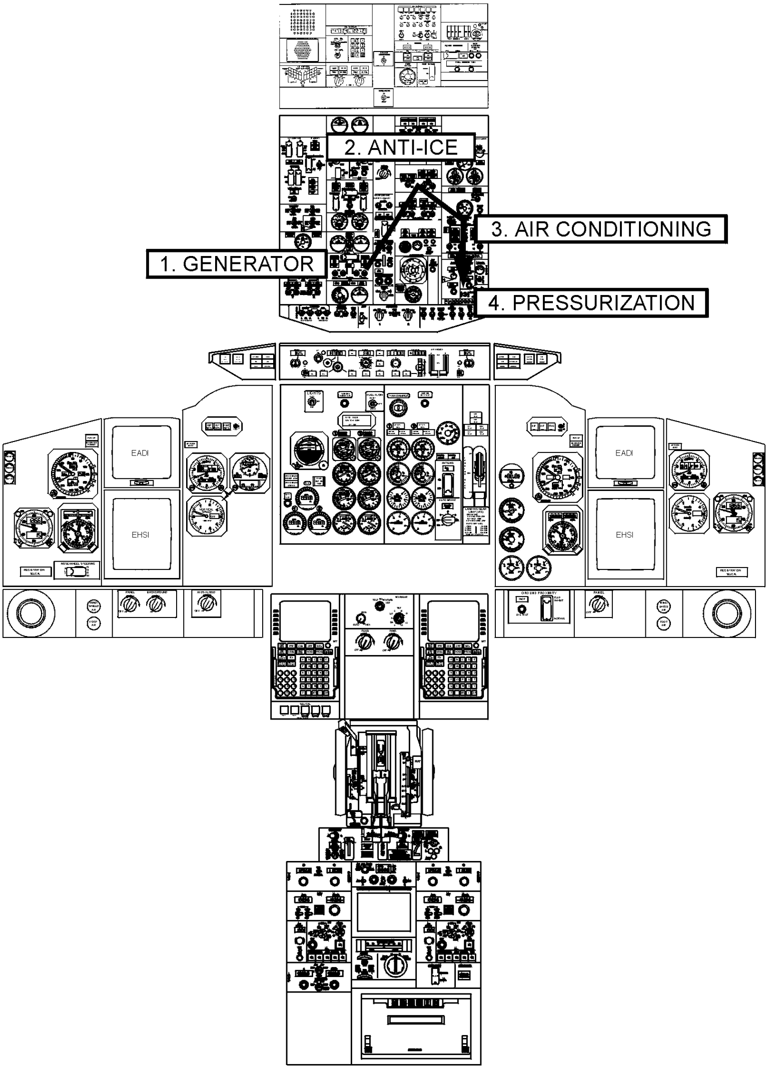
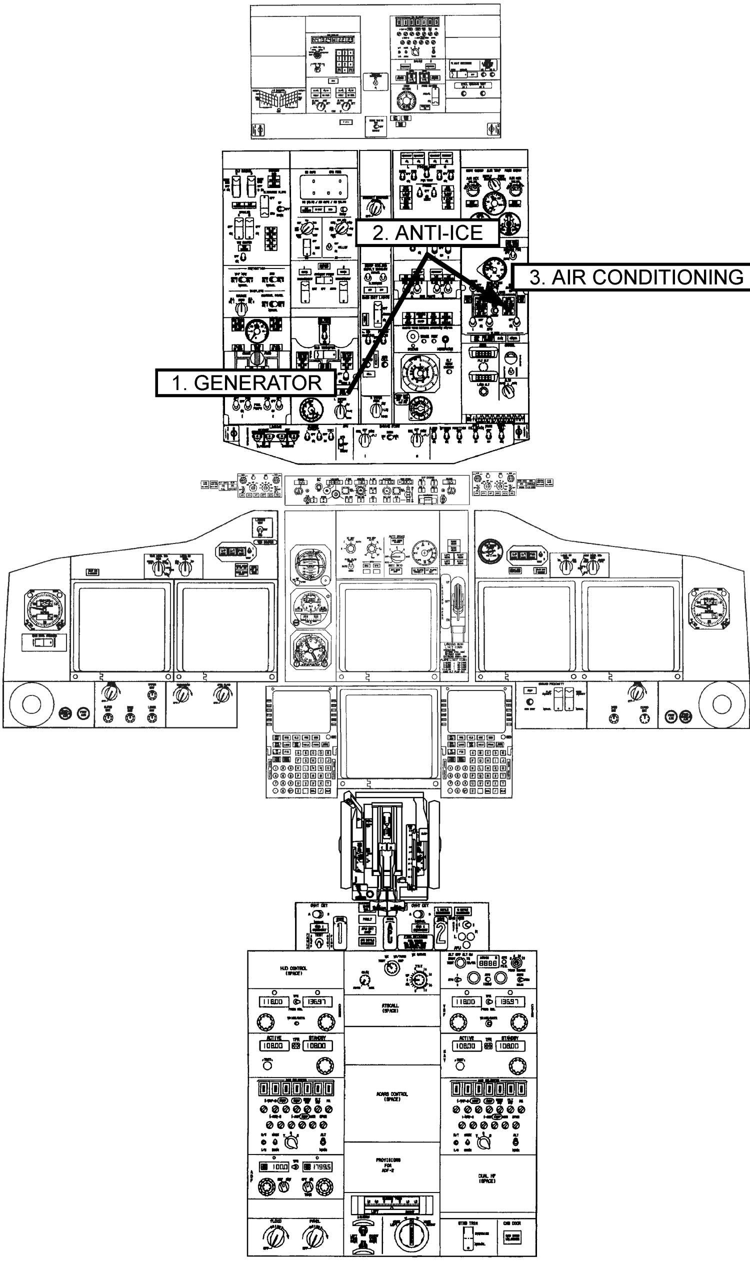
③ 3 5 DELAYED ENGINE START FLOW



7 8 9 DELAYED ENGINE START FLOW



DELAYED ENGINE START

An engine warm-up time (at or near idle) of at least two minutes, is required prior to advancing throttles to high power.

If possible, start the second engine with the aircraft stopped and parking brake set. Use the NORMAL ENGINE START procedure.

If the aircraft is not stopped, the entire engine start procedure may be delegated to, and accomplished by, the First Officer, allowing the Captain to maintain outside vigilance.

F/O CHALLENGE	DELAYED ENGINE START	F/O RESPOND
Generator(s)	....	**ON**
Anti-Ice	....	**(AS REQUIRED)**

Engine Start (Flow):

Configure pneumatics for second engine start.

- If accomplishing a crossbleed start, refer to the ENGINE CROSSBLEED START checklist.
- If accomplishing an APU start, configure to provide APU pneumatics:

  If starting engine #1, close the isolation valve. In this configuration, operation of the right pack during the start is permissible, as is operation of the #2 engine at greater than idle thrust.

  If starting the #2 engine; open the isolation valve, turn both packs OFF, observe the limitations of the **DUAL BLEED** light. If the #1 engine must be operated at greater than idle thrust, turn OFF the #1 bleed switch.

F/O Challenge **F/O Respond**

Generator(s) .... ON

Anti-Ice .... (AS REQUIRED)

For anti-ice requirements, see the AFTER START procedure.

Air Cond & Press (Flow) .... SET, (AS REQUIRED)

Configure pneumatics as described in AFTER START procedure.

8 9 Position TRIM AIR switch ON after the last power transfer.

Start Levers (Flow) .... IDLE

Verify that start levers are in the IDLE detent.

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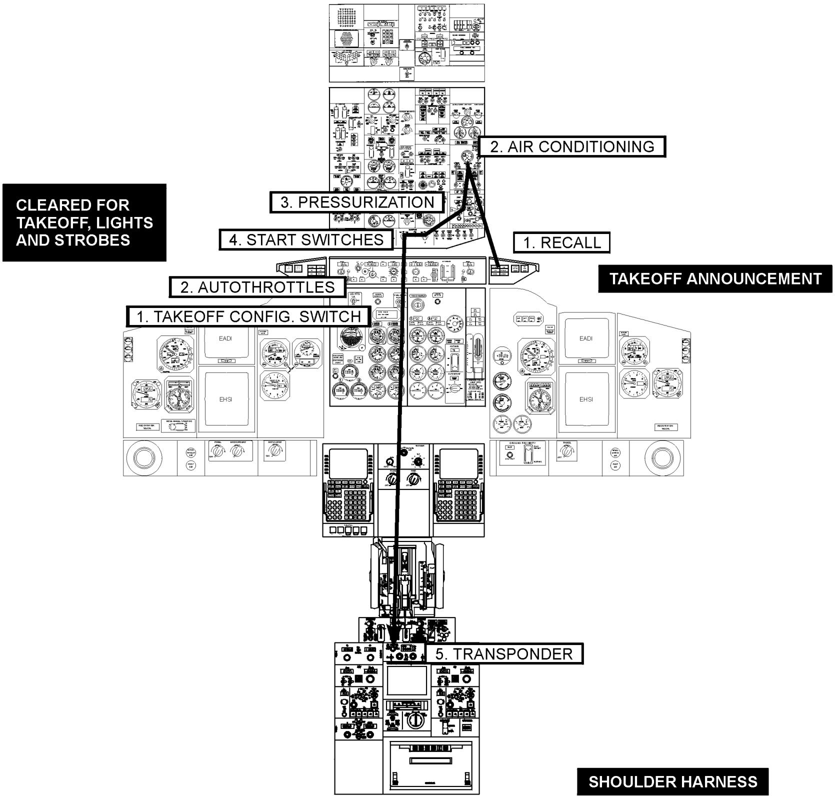
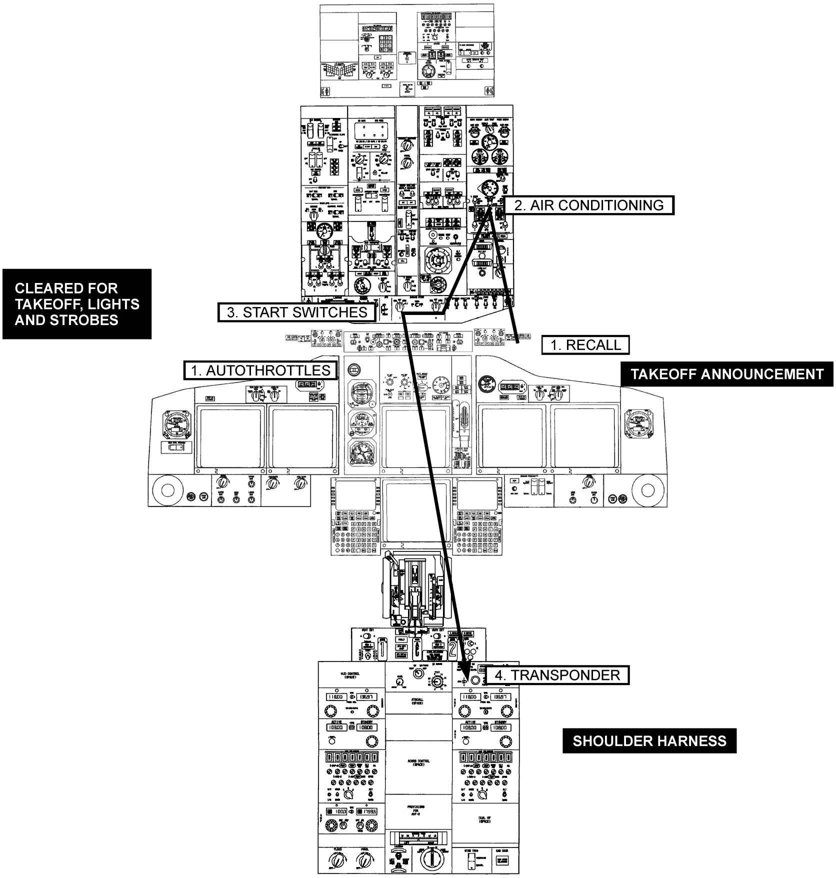
③③⑤ BEFORE TAKEOFF FLOW



7 8 9 BEFORE TAKEOFF FLOW



BEFORE TAKEOFF

The BEFORE TAKEOFF flow may be initiated prior to the Captain calling for the BEFORE TAKEOFF checklist.

The Captain will call for the BEFORE TAKEOFF checklist when cleared onto the active runway.

For both day and night operations all **FIXED LANDING**, **RUNWAY TURNOFF** and **STROBE** lights will be turned on only after takeoff clearance is received as an indication to other traffic that your aircraft is beginning the takeoff roll.

For night operations, some auxiliary lighting including the WING, RUNWAY TURNOFF and LOGO lights in addition to the ANTI COLLISION and POSITION lights (but not the STROBE or the LANDING lights) should be turned on when taking the active runway in order to provide exterior illumination for other traffic to see the aircraft.

Meteorological conditions permitting, the use of the FIXED LANDING, RUNWAY TURNOFF, STROBE & STEADY, ANTI COLLISION and WING lights are required below 18,000 feet for both day and night operations.

F/O CHALLENGE	BEFORE TAKEOFF	F/O RESPOND
Recall		**CHECKED**
Takeoff Announcement		**COMPLETED**
Air Conditioning & Pressurization		**SET**
Start Switches		**CONTINUOUS**
Takeoff Config. Switch (If Installed)		**CHECKED (F, C)**
Transponder		**TA/RA**

F/O Challenge **F/O Respond**

Recall .... CHECKED

Press the recall panel. Observe all **MASTER CAUTION** annunciator lights illuminated. Release the recall panel and observe all lights extinguish.

Takeoff Announcement...COMPLETED

The FO will make the takeoff announcement by stating, "FLIGHT ATTENDANTS PLEASE BE SEATED FOR DEPARTURE."

Air Conditioning & Pressurization ....SET

An engine bleeds ON takeoff is preferred because it reduces flight deck workload and provides improved cabin pressurization. However, weight penalties are incurred for takeoffs with engine bleeds ON. Load planning will calculate whether or not the actual gross takeoff weight permits the use of engine bleed air, and will include the bleed configuration in the pilot weight manifest given to the crew. For bleed configuration adjustments, refer to Section 5.

Bleeds On Takeoff: Configure the air conditioning panel as follows:

Right Air Conditioning Pack.. AUTO

Isolation Valve .... AUTO

Left Air Conditioning Pack .... AUTO

No. 1 Engine Bleed Air Switch .... ON

APU Bleed Air Switch.. OFF

No. 2 Engine Bleed Air Switch… .... ON

Bleeds Off Takeoff: (APU bleed used for air conditioning) configure the air conditioning panel as follows:

Right Air Conditioning Pack Switch .... AUTO

Isolation Valve Switch ....CLOSE

Left Air Conditioning Pack Switch.. AUTO

No. 1 Engine Bleed Air Switch .... OFF

APU Bleed Switch .... ON

No. 2 Engine Bleed Air Switch .... OFF

Caution: If engine failure occurs, do not position engine bleed air switches ON until reaching 1,500 feet or until obstacle clearance height has been attained.

Start Switches... CONTINUOUS

Verify that the ignition selector switch is set at L or R.

If moderate to severe precipitation is a factor, select start switches to FLT.

Takeoff Config. Switch (If Installed)...............................CHECKED (F, C)

The Captain will press and hold the TAKEOFF WARNING TEST switch on the center instrument panel. Verify that the takeoff configuration warning horn does not activate.

Autothrottle (Flow).. ON

Ensure that N_1 limit is TO or REDUCED TO. When clear of congested areas, arm the autothrottle. Observe the A/T mode annunciates **ARM**. Verify power setting from FMC.

Transponder...TA/RA

Rotate selector to TA/RA mode.

WARNING: On aircraft with operational predictive windshear, failure to place the transponder to TA or TA/RA prior to taking the runway will prevent operation of the radar in the windshear mode unless the radar is selected to an active mode.

Shoulder Harnesses (Flow)... ON

Each flight crewmember shall, during takeoff and landing keep their **shoulder harness** fastened.

Note: ③ Update FMC to runway threshold on the TAKEOFF REF page of the FMC/CDU. Depressing the (5R) key and then executing the update is the only way to drive the FMC position to the departure end of the runway.

Note: ③ Depressing TOGA will not automatically update the aircraft position.

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TAKEOFF NOTES

TAKEOFF CONFIGURATION WARNING

The takeoff configuration warning will sound when one of the following conditions exist:

- Speed brake lever out of full FWD detent, or
- Stabilizer trim not in takeoff range (green band), or
- Flaps not in takeoff position, or
- Leading edge devices not in takeoff position, or
- 3 5 7 8 9 Parking brake set.

If a takeoff warning horn sounds when the throttles are advanced for takeoff prior to reaching 100 kts. the takeoff will be rejected unless the Captain determines that continuing the takeoff is a safer course of action under the conditions.

If a takeoff is rejected, the cause of the horn activation must be corrected prior to attempting another takeoff. If the takeoff is continued, the cause must be determined and corrected or the flight should return to the airport of departure, unless the Captain determines a safer course of action is required.

THRUST MANAGEMENT

Reduced Thrust Takeoff

Reduced takeoff thrust is to be used by Continental Airlines on all takeoffs as standard operating procedure.

Reduced thrust takeoffs using the assumed temperature method are the normal procedure whenever performance limits and noise abatement procedures permit. Reduced thrust takeoffs lower EGT, which will extend engine life.

If conditions are encountered during the takeoff where additional thrust is desired such as temperature inversion, windshear, or engine failure, the crew should not hesitate to advance thrust.

WARNING: The untimely application of additional thrust during takeoff may introduce undesirable yaw moments. If a decision is made to increase thrust during takeoff, do so smoothly and compensate with rudder.

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TAKEOFF PROCEDURE

CDU DISPLAY

To allow quick access to data normally required during takeoff and departure the recommended CDU display on takeoff is as follow:

- PF on the TAKEOFF page
- PM on either the LEGS page or the CLB page.

FMC ACCURACY CHECK

③ FMC Runway Update Feature

On the TAKEOFF REF page, the prompt **FMC POS UPD RWXXX (5R)** when selected and executed will update the FMC to the runway coordinates. The runway coordinates in the FMC Nav database are for the landing threshold on that runway.

For the **FMC POS UPD RWXXX** to be visible, entry of the departure runway is required. The update command must be selected and executed prior to 60 knots. If the runway is not entered on the ROUTE page, prompt **5R** on the TAKEOFF REF page will be blank.

Depressing TOGA on the B737-300 (RD) aircraft **will not automatically update the aircraft position.** Depressing the (5R) key and then executing the update is the only way to drive the FMC position to the departure end of the runway for the B737-300 (RD).

Position verification in-flight is required. Select the FIX page, type in the identifier for the VOR that is manually being tuned by the VHF navigation panel and crosscheck the radial and DME from raw data vs. the computed data. Selecting and executing **FMC UPD** should ensure RNP/ANP requirements if needed. If LNAV is required at 400 feet AGL, the monitoring pilot should display raw data.

When FMC position is confirmed, both Nav radios should be selected to **AUTO**. This gives the FMC maximum capability to use navaids for position updating.

VHF Nav tuning is automatically selected when the HSI switch is positioned to NAV.

Note: Aircraft not utilizing the FMC POS UPD feature may require several minutes of airborne time to acquire an accurate FMC position (dependent on navaid update availability).

3 5 7 8 9 TOGA Activation

FMC accuracy check on EFIS/MAP equipped aircraft is accomplished by verifying the aircraft symbol on the MAP overlays the takeoff runway at the time of TOGA activation.

SETTING TAKEOFF THRUST

A rolling takeoff is recommended. As the aircraft is aligned with the runway, the Pilot Flying will smoothly advance both throttles to approximately 40% N_1 (thrust settings between 35% and 45% N_1 are satisfactory) and allow the engines to stabilize. The throttle position will be about ¾” forward of idle. Unrestricted advancement of the throttles can cause asymmetric thrust with directional control problems, especially on slippery runways.

Caution: The nose wheel steering (tiller) should not be used above normal taxi speeds (20 knots).

After the engines are stabilized, the PF will manually advance the throttles toward the takeoff power setting, and engage TOGA when satisfied that engine acceleration is normal. Normally TOGA will be engaged as the throttles reach the vertical (70% N_1) position. As the throttles are advanced beyond 70% N_1, the PF calls “CHECK POWER,” and the PM ensures that the throttles advance to takeoff N_1 (referencing the TAKEOFF PAGE of the FMC) and replies “POWER SET _______%.”

Note: Both F/D switches must be on to engage the F/D Takeoff mode (TOGA). The F/D switches are not required to engage autothrottle only.

A/T annunciates **N_1** and AFDS annunciates **TOGA**. The thrust levers drive forward and flight director bars command 10 degrees nose down. The F/D does not provide runway steering guidance or rotation commands. At approximately 60 knots, the F/D will command 15 degrees nose up.

③ At 64 knots (84 knots - 3 5 7 8 9), A/T annunciates **THR HOLD**.

TAKEOFF ROLL

The Captain will guard and retain exclusive control of the throttles from the time initial takeoff power is set until V_1, and will be prepared to perform the rejected takeoff maneuver if required. When the First Officer is making the takeoff, the First Officer will place both hands on the yoke after initially setting takeoff power.

The PM monitors engine instruments, verifies proper oil pressure, and verifies A/T **N_1** indication changes to **THR HOLD**. If the **THR HOLD** mode annunciation does not appear, no crew action is required unless a subsequent system fault caused unwanted thrust lever movement. Lack of the **THR HOLD** annunciation means the protective feature may not be active.

At 100 knots, the PM calls out “100 KNOTS.”

The PM will call “V_1” at approximately 5 knots prior to the actual V_1 speed (depending upon acceleration rate) so as to complete the call by the time the airspeed indicator has reached the bug set on the actual V_1.

The PM will call “ROTATE” at V_R, and will then monitor the flight instruments throughout the remainder of the takeoff procedure.

After liftoff, THR HOLD mode remains engaged until:

3 3 5 a radio altitude of 400 feet RA is reached and 18 seconds have elapsed since liftoff.

7 8 9 a radio altitude of 800 feet RA.

The A/T mode cannot be changed during this time because power is taken away from the throttle drives to ensure no A/T movement occurs during the takeoff phase. The A/T will automatically annunciate **ARM** and thrust will remain at TO setting. A/T mode can be changed only after the **ARM** annunciation appears. If full thrust is desired during a reduced thrust takeoff, manually position the thrust levers to the thrust limit as indicated by the cursors on the N_1 gauges.

CROSSWIND TAKEOFF

The crosswind takeoff characteristics of the B737 are typical of most swept-wing transports. The upwind wing will tend to rise as the takeoff roll begins. This may be corrected by using aileron as required or by pre-setting a fixed amount of aileron into the wind prior to takeoff roll. In either case, large control wheel oscillations and inputs should be avoided.

Another indication of a crosswind condition is the tendency of the aircraft to weather vane into the wind, requiring rudder application for directional control. As speed increases, the aileron deflection requirement will decrease. Continue to maintain directional control with smooth rudder application. This will result in a cross control condition which must be maintained through liftoff. During rotation, hold the control wheel in a displaced position as required to keep the wings level. When airborne, aileron and rudder cross control should be slowly and smoothly relaxed.

ROTATION AND LIFTOFF

As the airspeed approaches V_1, the slight forward control column pressure is relaxed to neutral, allowing for a smooth rotation to begin at V_R.

At V_R, rotate smoothly with one continuous motion approximating, but no more than 2.5 degrees/sec. Using the normal rotation rate, the aircraft flies off the runway as the pitch attitude increases, and a runway to fuselage clearance of approximately 20 inches results.

Rotate initially toward a 15-degree attitude. This will result in an airspeed of approximately V_2 + 20 knots. Initially, the Flight Director will command 15 degrees nose up. However, the F/D pitch command will not be used during rotation. Indicated airspeed and vertical speed are the primary instruments. After the radio altitude and vertical speed increase, the Pilot Flying will adjust pitch to coincide with F/D input. This pitch command under normal situations will be V_2 + 20 knots. The Flying Pilot will maintain the F/D input of V_2 + 20 until reaching initial flap retraction altitude.

At light gross weights, an initial climbout at V_2 + 20 will produce an excessive deck angle. A slight difference between aircraft symbol and F/D pitch command will be necessary to not exceed 25 degrees of pitch. This pitch limit is for passenger comfort. The F/D pitch command will become synchronized with the aircraft symbol as the flaps are retracted during acceleration to clean maneuvering speed.

Because the aircraft is geometrically limited, it cannot be rotated to a body angle that will prevent it from becoming airborne with takeoff thrust. Premature rotation will probably result in the aircraft becoming airborne before the normal liftoff point, and at a slower than normal speed. Since this speed will be considerably below the best angle of climb speed, the initial climb profile may be greatly reduced.

The aircraft has a very low angle of attack on the ground in three-point attitude. Delaying rotation (waiting for the aircraft to "Fly Itself" off the ground) will increase the liftoff distance considerably.

The airspeed indicator will lag momentarily during rotation due to the vertical movement of the static ports relative to the direction of flight as the nose is lifted.

When a positive rate of climb has been verified on the IVSI and altimeter, either pilot will call, "POSITIVE RATE." When a positive rate of climb is confirmed, the Pilot Flying will call "GEAR UP," stabilize airspeed at V_2 + 20 knots, and transition to the F/D pitch command.

In roll, the F/D commands wings level to 400 feet RA, then selected bank angle limit to the selected heading when a new roll mode is selected.

Selection of pitch and roll modes other than TOGA are inhibited below 400 feet RA.

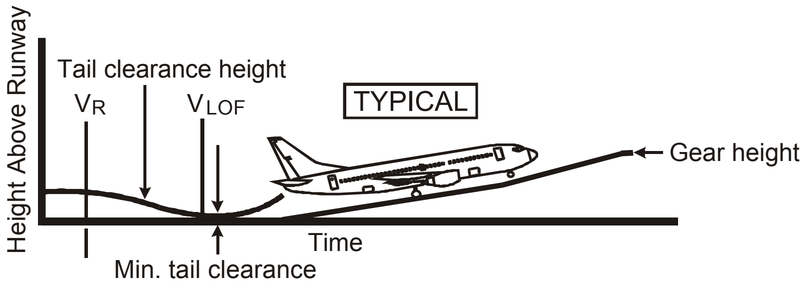
During takeoff or initial climb, if a center tank **LOW PRESSURE** light(s) illuminates, the center tank pump(s) may remain on until the climb attitude is reduced and the light(s) extinguishes or workload allows for the pump(s) to be positioned to OFF. When established in a level attitude at cruise, if the center tank contains usable fuel and the center tank switches are off, center tank pump switches may be positioned to ON again. Verify the **LOW PRESSURE** light extinguish and position both switches to OFF when both **LOW PRESSURE** lights illuminate.

B737 TAIL STRIKE AVOIDANCE

Analysis of tail strike incidents involving Boeing transport aircraft show that certain common factors often play a role in these mishaps. Several not so obvious factors can contribute to a tail strike as well.

Takeoff

During takeoff, the amount of tail clearance achieved for a given flap setting is a function of airspeed at rotation and rate of rotation. Normal pitch attitude at liftoff is only 3° to 4° less than the attitude at which aft body contact with the runway will occur. For optimum takeoff and initial climb performance, initiate a smooth continuous rotation at V_R toward 15 degrees of pitch. Rotate smoothly at an average rate of 2 ½ degrees/second. This rate will result in liftoff of the aircraft at a body attitude of between 7 and 10°, depending upon the B737 model flown. The flight director pitch command is not used for rotation. The point of minimum ground clearance occurs slightly after liftoff, as the aircraft pitch attitude continues to increase towards 15°.



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As shown in the following chart, the –500 has the most tail clearance, the –900 the least.

B737 Model	Typical Flap	Liftoff Attitude	Tail Clearance	* Tail Strike Pitch Attitude
-300	1 5 15	10.0° 9.9° 8.1°	23” 24” 37”	13.4°
-500	5 15	9.9° 8.1°	35” 47”	14.7°
-700	1 5 15	9.1° 9.1° 8.7°	29” 29” 30”	14.7°
-800	1 5 15	8.2° 8.2° 8.0°	20” 20” 22”	11.0°
-900	1 5 15	7.7° 7.6° 7.2°	20” 20” 23”	10.0°

* Aft Fuselage Contact: (Wheels on runway, struts extended)

The leading causes of tail strikes at takeoff are a fast rotation rate (greater than 2.5deg/sec), or early rotation.

A fast, early rotation is therefore the worst possible combination.

Do not pressurize if fuselage contact is suspected. A landing at the nearest suitable airport is recommended. An inspection for structural damage is required before the next flight.

NOISE ABATEMENT

All Continental aircraft are expected to comply with F.A.R. 36 Noise Abatement Requirements. Every takeoff must adhere to the standard noise abatement profile. A few airports will have special procedures and unique situations that may be more restrictive. Safety is of primary concern when following the noise abatement profile. Pilot judgment may require adjustments due to adverse winds, weather or other flight conditions.

Obviously, engine failures or other mechanical problems may require abandonment of noise abatement procedures.

CLOSE IN TURN AFTER TAKEOFF

Normally, a turn after takeoff should not be started until reaching 400 AGL, even if ATC requests a turn as soon as practical. However, a turn required for obstructions, noise abatement, or adverse conditions may be started before reaching 400 feet AGL but no lower than 50 feet AGL. The maximum bank angle after takeoff will be 15 degrees until reaching V_2 + 15. At an airspeed of V_2 + 15 and above, bank angles of 30 degrees are allowable.

AUTOPILOT ENGAGEMENT

The autopilot may be engaged any time above 1,000 ft. AGL. When the initial climb is established, ensure the aircraft is trimmed to meet the F/D roll and pitch commands, then select an autopilot to CMD. If the Captain is flying, A/P "A" is normally engaged, and A/P "B" when the First Officer is flying. This will give the Pilot Flying and the engaged A/P the primary navigational information and FMA display. If the A/P fails to engage in the proper roll or pitch mode, the A/P will revert to CWS ROLL or CWS PITCH and the command bars will bias out of view. Re-selecting a valid roll / pitch mode will return the F/D command bars into view.

TAKEOFF PITCH MODES

VNAV Pitch Mode

The use of TO/GA mode to flap retraction altitude and VNAV for flap retraction and climb is a method of managing the AFDS for takeoff. To use this mode, at flap retraction altitude with at least V_2 + 15 knots and accelerating, the PF calls "FLAPS ___, VNAV." The PM selects the initial flap retraction, selects VNAV on the MCP panel, verifies the desired A/T and pitch mode on the FMA, and that the command bug moves to the desired speed.

With VNAV engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile selected on the FMC. Therefore, the mode control panel IAS display becomes blank, the speed selector is inoperative, and the airspeed cursor is positioned at the FMC commanded airspeed. The AFDS controls pitch to maintain FMC speed.

The preflight entry of V_M Flaps 0 on the TGT SPD line L2 will cause AFDS to command a smooth increase from V_2 + 20 to V_M Flaps 0 upon selection of VNAV. When an acceleration is desired to above V_M Flaps 0 select ECON on the ECON CLIMB page.

The preflight entry of V_M Flaps 0 / 3000 feet AFE on line L3 SPD REST, and 250 knots on line L2 TGT SPD will cause the AFDS to command a smooth increase from V_M Flaps 0 to 250 knots at 3000 feet AFE. Upon reaching an altitude where the pilot wishes to accelerate to the scheduled climb speed select ECON (normally 10,000 MSL).

VNAV should not be used below 3000' AFE with special noise abatement departures such as KSNA.

Level Change Pitch Mode

LVL CHG is used if VNAV is not available or not desired. To use this mode, at flap retraction altitude with at least V_2 + 15 knots and accelerating, the PF calls "FLAPS ___, CLIMB POWER, LVL CHG, SET TOP BUG."

The PM:

- Selects the requested flap setting
- Selects N_1, LVL CHG
- Aligns the speed cursor with the V_M Flaps 0 bug using the speed selector

  Note: 3 3 5 This bug should have been manually pre-positioned after TOGW is known. 7 8 9 The V_M Flaps 0 bug will be automatically positioned to a computed V_M Flaps 0 by the FMC.

- Verifies the desired A/T and pitch mode on the FMA, and that the command bug moves to the desired speed.

During a normal takeoff or go-around with an initial level off altitude set in the MCP Altitude window of 3000' above field elevation or less, ALT ACQ may engage automatically before a pitch mode is selected. If this occurs the A/T N_1 limit will automatically change from the N_1 TO/GA limit to the N_1 climb limit. In this case, the only selection required on the MCP by the pilot is to set Top Bug.

LNAV ENGAGEMENT

The appropriate time for engaging LNAV is at the PF's discretion. For some departure procedures, LNAV may be the appropriate roll mode selection at 400 feet AGL. Normally, LNAV is selected when the aircraft is established on the first route segment, or the appropriate intercept heading to that route segment. Raw data should be monitored as required, and manual radio tuning should be maintained for cross checking (either pilot position) until FMC position is confirmed.

WARNING: In mountainous terrain below FL 250 at least one pilot will monitor raw data to ensure navigational accuracy.

Note: 3 5 aircraft require selection of AUTO on both VHF Nav radio select panels when conditions permit.

MANEUVERING SPEEDS

③ 3 5 FLAP RETRACTION SPEED SCHEDULE

	Flap Setting For Takeoff		
	15	5	1
Select Flaps 5 at	V_2 + 15		
Select Flaps 1 at	180/190*	V_2 + 15	
Select Flaps UP at	190/200*	190/200*	190/200*
Final Segment Climb	210/220*		

* Above 117,000 lbs. brake release weight.

Note: At the takeoff flap setting bank angle must be limited to 15° until reaching a speed of V_2 + 15 knots.

For flaps 5 and flaps 15 takeoffs with at least V_2 + 15 knots and accelerating, flap retraction may be initiated with an altitude of at least 1000 feet AFE. Subsequent flap retractions are made upon reaching the fixed maneuvering speed (V_M) for the existing flap setting.

Example: Flaps 15 takeoff / 120,000 pounds GTOW. Upon reaching 1000 feet AFE with a minimum speed of V_2 + 15 and accelerating, call for retraction of the flaps to 5 degrees. When the aircraft accelerates to 190 knots call for retraction of the flaps to 1 degree. Call for flaps up when the aircraft accelerates to 200 knots.

For a flaps 1 takeoff, the initial flap retraction is made at V_M flaps 1 (190/200 knots) and accelerating.

3 5 Speed Tape indications are as follows:

- F (Minimum Flap Retraction Speed)
- O (Flaps Up Maneuvering Speed), and tip of yellow bar (Minimum Maneuver Speed)

The fixed speeds will be used however for flap retraction and maneuvering.

7 8 9 FLAP RETRACTION SPEED SCHEDULE

	Flap Setting For Takeoff		
	15	5	1
Select Flaps 5 at	V_2 + 15		
Select Flaps 1 at	V_M Flaps 5	V_2 + 15	
Select Flaps UP at	V_M Flaps 1	V_M Flaps 1	V_M Flaps 1
Final Segment Climb	V_M Flaps 0 Speed		

Note: Due to a new wing and rudder design on these aircraft, flap retraction will be done at the V_M speeds shown on the airspeed indicator after V_2 + 15 has been reached.

Note: At the takeoff flap setting, bank angle must be limited to 15° until reaching a speed of V_2 + 15 knots.

For flaps 5 and flaps 15 takeoffs with at least V_2 + 15 knots and accelerating, with an altitude at least 1000 feet AFE, subsequent flap retractions are made upon reaching the maneuvering speed (V_M) for the existing flap setting.

Example: Flaps 15 takeoff / 120,000 pounds GTOW. Upon reaching 1000 feet AFE with a minimum speed of V_2 + 15 and accelerating, call for retraction of the flaps to 5 degrees. When the aircraft accelerates to V_M flaps 5 speed, call for retraction of the flaps to 1 degree. Call for flaps up when the aircraft accelerates to V_M flaps 1 speed.

For a flaps 1 takeoff, the initial flap retraction is made at V_M flaps 1 speed and accelerating.

③ 3 5 AFTER TAKEOFF MANEUVER SPEEDS (V_M)

FLAP POSITION	AT & BELOW 117,000 LBS.	ABOVE 117,000 LBS.
Flaps 0	210	220
Flaps 1	190	200
Flaps 5	180	190
Flaps 10	170	180
Flaps 15	150	160

7 8 9 AFTER TAKEOFF MANEUVER SPEEDS (V_M)

FLAP POSITION	FIXED SPEEDS
UP	V_M Flaps 0 Speed Bug
1	V_M Flaps 1 Speed Bug
5	V_M Flaps 5 Speed Bug
10	V_M Flaps 10 Speed Bug
15	V_M Flaps 15 Speed Bug

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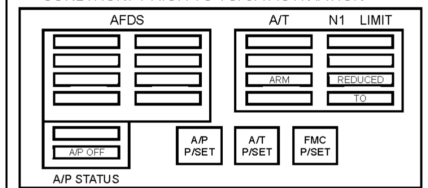
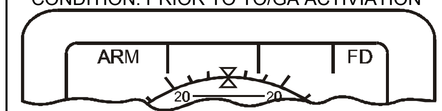
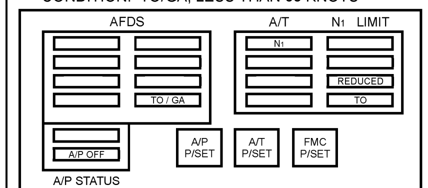
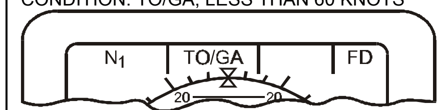
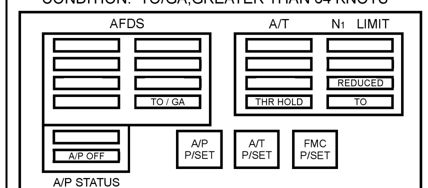
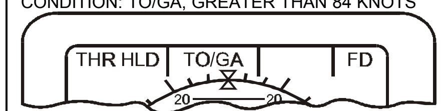
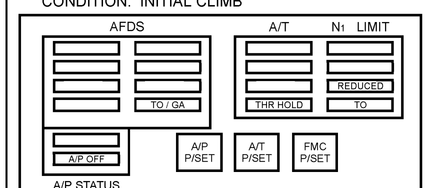
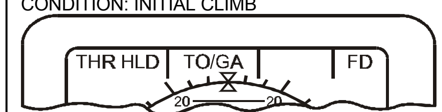
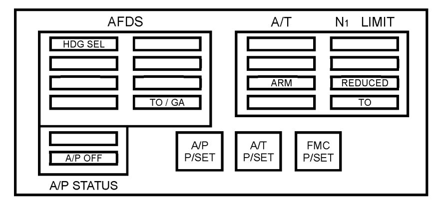
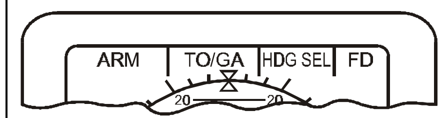
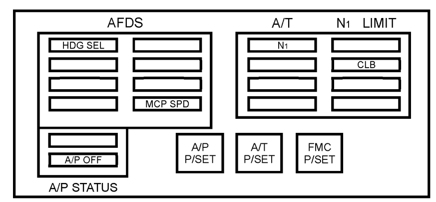
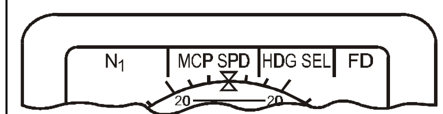
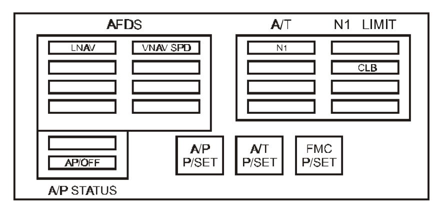
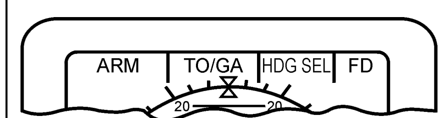
TAKEOFF CHART

PHASE OF FLIGHT	PILOT FLYING: DUTIES / CALLOUTS	PILOT MONITORING: DUTIES / CALLOUTS	③ FMA DISPLAY	3 5 7 8 9 FMA DISPLAY	NOTES
Cleared onto active runway.	Captain: • Call for "BEFORE TAKEOFF CHECKLIST" • Arm Autothrottles	(First Officer) • Complete Before Takeoff Procedure and Read Checklist	CONDITION: PRIOR TO TO/GA ACTIVIATION 	CONDITION: PRIOR TO TO/GA ACTIVIATION 	The N_1 limit on the EFIS aircraft is annunciated on the Thrust Mode Annunicator (TMA) above the N_1 RPM indicators. (---) Annunicated on the TMA indicates the FMC is not computing thrust limits.
Cleared for takeoff.	• Advance throttles to approximately 40% N_1 and stabilize • Advance throttles to vertical and engage TO/GA at approximately 70% N_1. • Ensure engine acceleration to takeoff power range prior to 60 knots • Call "CHECK POWER"	• Observe TO/GA Annunciation • Crosscheck Takeoff N_1 is set at desired power setting • Call "POWER SET _______ % N_1"	CONDITION: TO/GA, LESS THAN 60 KNOTS 	CONDITION: TO/GA, LESS THAN 60 KNOTS 	FMA annunciations depicted assume the full utilization of the flight guidance with all of the autoflight features operating normally.
60 knots to V_1.	• Verify airspeed at "100 KNOTS" First Officer Takeoff: • Place both hands on control yoke after initial power set.	• Observe "THR HLD" • Monitor Instruments and Warning Lights • At 100 KIAS call "100 KNOTS" First Officer Takeoff: • Captain guards and retains exclusive control of throttles after initial power set.	CONDITION: TO/GA,GREATER THAN 64 KNOTS 	CONDITION: TO/GA, GREATER THAN 84 KNOTS 	Command Bars pitch from 10 degrees nose down to 15 degrees nose up at 60 knots. Do not follow pitch commands until after rotating through 15 degrees of nose up pitch during rotation. ③ THR HLD annunciates at 64 kts. 3 5 7 8 9 THR HLD annunciates at 84 kts.
V_1, V_R, Rotation and Liftoff.	• Rotate at V_R (2.5 degrees/Sec) • Call "POSITIVE RATE" • Call "GEAR UP" • Adjust pitch as indicated by F/D Captain Takeoff: • Remove hand from throttles at V_1	• Call "V_1" • Call "ROTATE" • Call "POSITIVE RATE" • Retract Gear on Command	CONDITION: INITIAL CLIMB 	CONDITION: INITIAL CLIMB 	Do not exceed normal rotation rate (2.5 degrees/sec) as tail contact with the runway is possible if the normal rotation rate is exceeded.

TAKEOFF CHART – ICAO B

PHASE OF FLIGHT	PILOT FLYING: DUTIES / CALLOUTS	PILOT MONITORING: DUTIES / CALLOUTS	③ FMA DISPLAY	③⑤⑦⑧⑨ FMA DISPLAY	NOTES - SINGLE CHANNEL
400 Feet AGL	• Call for desired AFDS Roll Mode (HDG SEL or LNAV)	• Upon command select the desired AFDS Roll Mode • Verify FMA	CONDITION: ABOVE 400°, GREATER THAN 18 SECONDS AFTER LIFTOFF 	CONDITION: ABOVE 400°, GREATER THAN 18 SECONDS AFTER LIFTOFF 	'HDG SEL' will automatically arm with any pitch mode change after a TO/GA takeoff (ALT ACQ, ALT HLD, MCP SPD, V/S). If ALT ACQ, then ALT HLD will engage automatically. The A/T will automatically revert to MCP SPD and the N_1 LIMIT to CLB, then CRZ limit.
1,000 Feet AFE	• Reduce pitch toward 10 degrees <u>Calls are for a Flaps 5 departure</u> • Call "FLAPS 1 VNAV" or if level change departure call "FLAPS 1 CLIMB POWER LVL CHG, SET TOP BUG" • Continue flap retraction on schedule; Call "FLAPS UP, AFTER TAKEOFF CHECKLIST" • Climb at VM Flaps 0 speed to 3000 feet AFE	• Select Flaps on command • Press VNAV on MCP or if level change mode takeoff is desired Press N_1; LVL CHG ;Slew Airspeed Cursor to Vm Flaps 0 speed. • Check FMA (TMA on EFIS) for CLB • Check FMA for Pitch Mode, MCP SPD or VNAV • Complete After Takeoff Procedure and Checklist	CONDITION: CLEAN AIRCRAFT CLIMBING TO 3,000 AGL 	CONDITION: CLEAN AIRCRAFT CLIMBING TO 3,000 AGL 	If the autopilot is engaged after 1000 feet AGL, the A/P STATUS annunciation of A/P OFF on the non-EFIS aircraft will go blank. On the EFIS aircraft, the A/P STATUS will change from FD to CMD.
3,000 Feet AGL	• Call for "VNAV" if not called for already (Manual) • Select "VNAV" (Autoflight) Pilot Option: To remain in LVL CHG and slew Airspeed Cursor (Command Bug on EFIS) to 250 KIAS	• Select "VNAV" on command • Check FMA annunciation	CONDITION: LNAV / VNAV CLIMB AUTOPILOT OFF 	CONDITION: LNAV / VNAV CLIMB AUTOPILOT OFF 	When FMC waypoint navigation is desired the LNAV roll mode may be engaged to provide AFDS steering for the flight planned course entered on the CDU. CDU updates below 10,000 feet should be avoided if they decrease outside vigilance.

Level Change Departure:

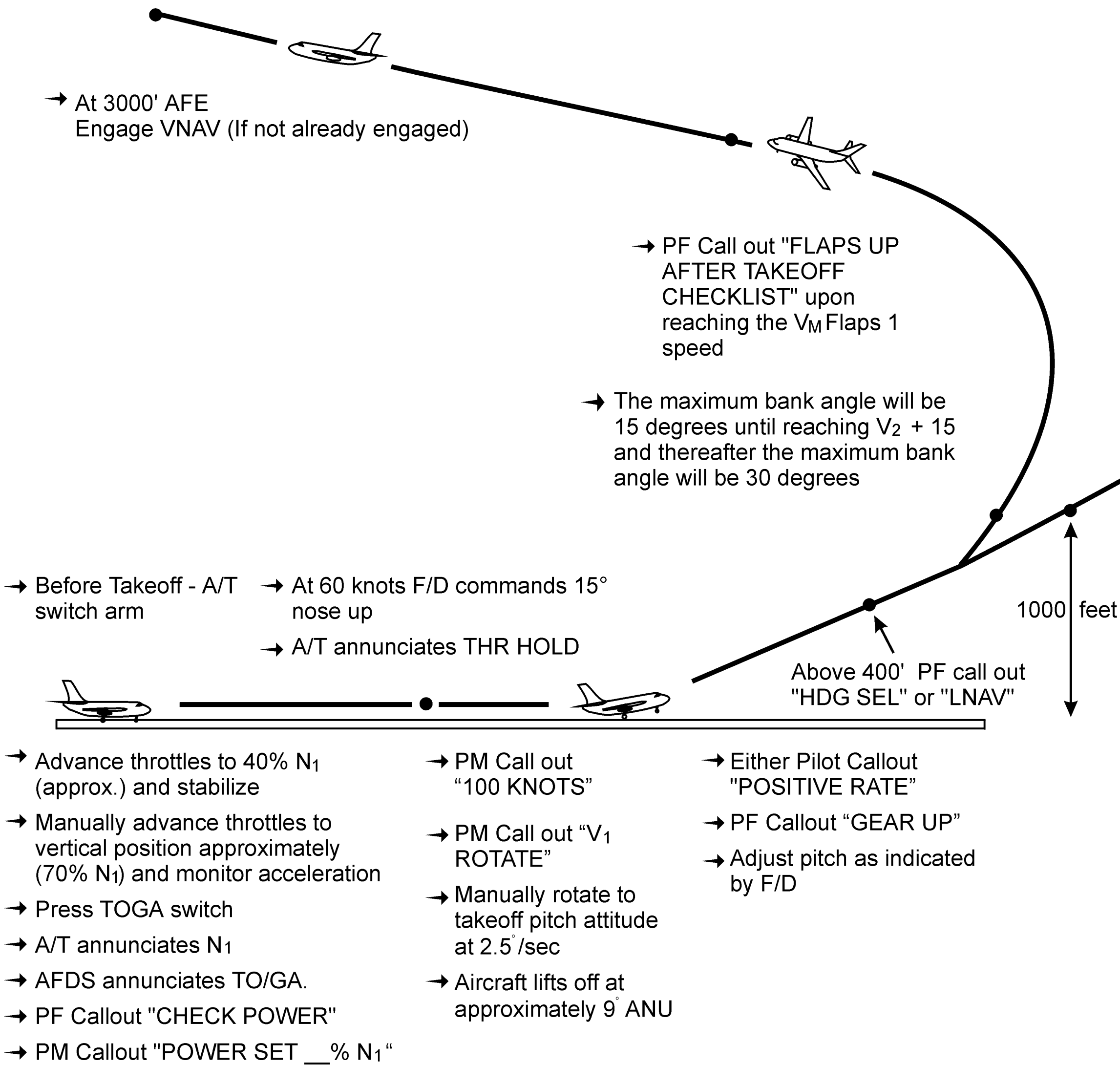
After flaps 5 and flaps 15 takeoffs with at least V_2 + 15 knots and accelerating and an altitude of at least 1000 feet AFE, flap retraction may be initiated. The PF calls "FLAPS ___, CLIMB POWER, LVL CHG, SET TOP BUG" The PM selects the initial flap retraction, selects N_1, LVL CHG, and TOP BUG on the MCP panel, verifies the desired A/T and pitch mode on the FMA, and that the command bug moves to the desired speed.

Subsequent flap retractions are made upon reaching the (V_M) for the existing flap setting and accelerating.

VNAV Departure:

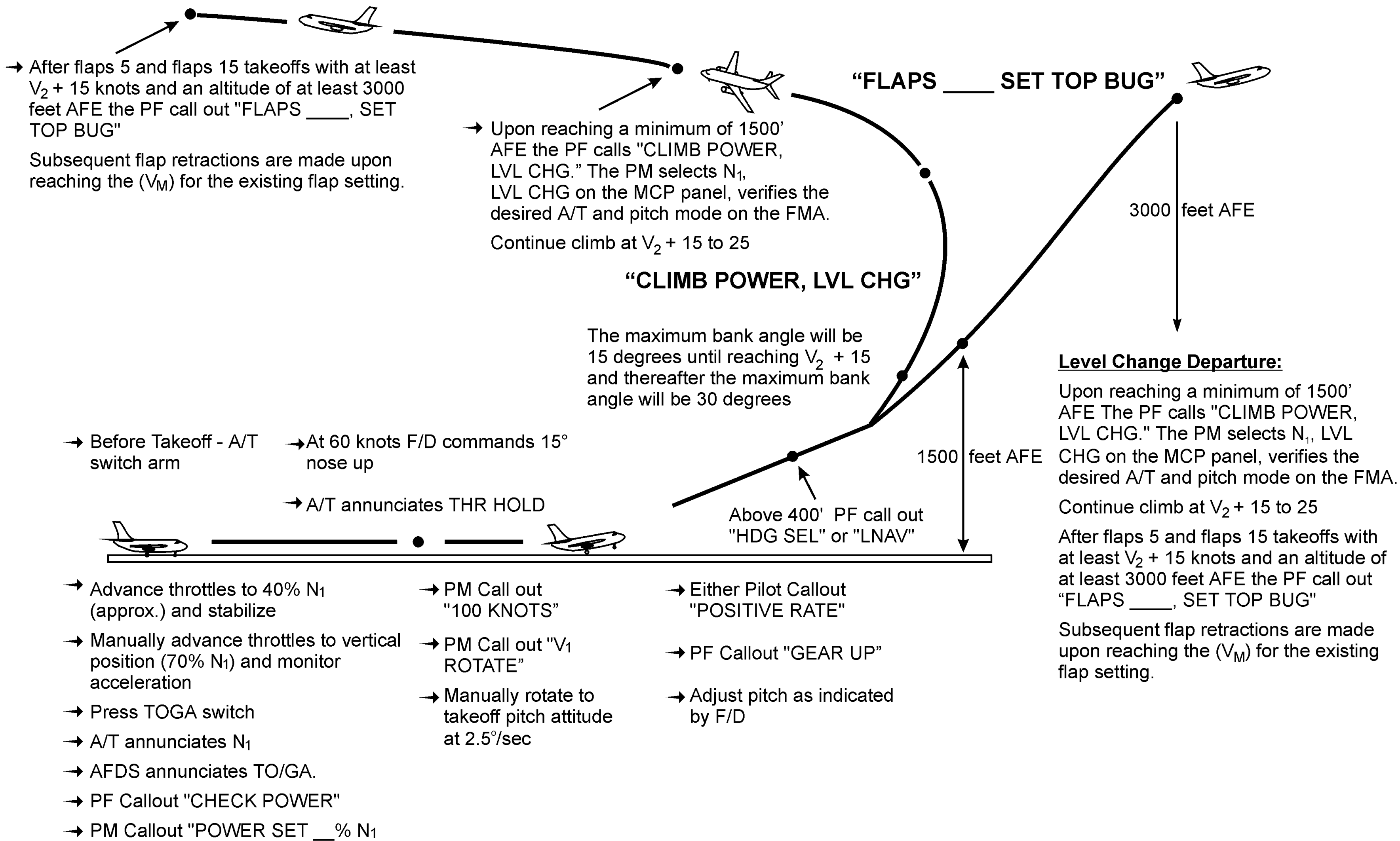
After flaps 5 and flaps 15 takeoffs with at least V_2 + 15 knots and accelerating and an altitude of at least 1000 feet AFE, flap retraction may be initiated. The PF calls "FLAPS ___, VNAV" The PM selects the initial flap retraction, selects VNAV on the MCP panel, verifies the desired A/T and pitch mode on the FMA, and that the command bug moves to the desired speed.

Subsequent flap retractions are made upon reaching the (V_M) for the existing flap setting and accelerating.



NORMAL TAKEOFF
(ICAO Procedure B)

Note: VNAV departures (L2 or L3 Climb) require the FMC to be programmed accordingly. Do not accelerate above VM flaps 0 until above 3000' AFE.



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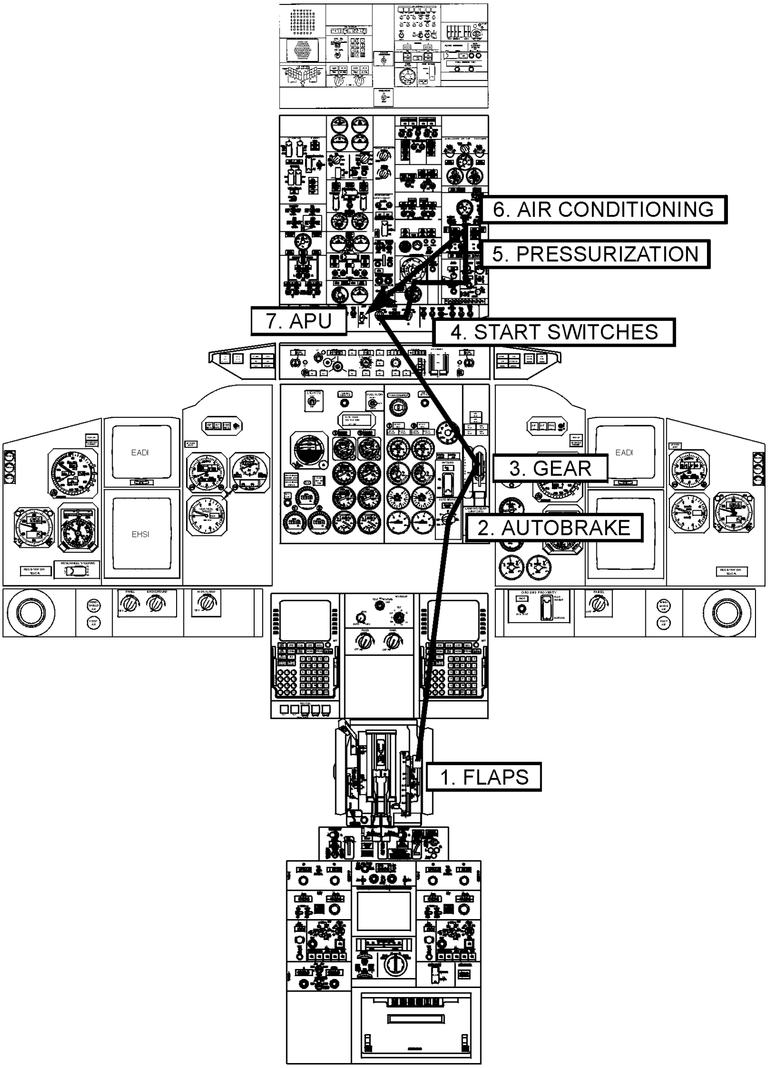
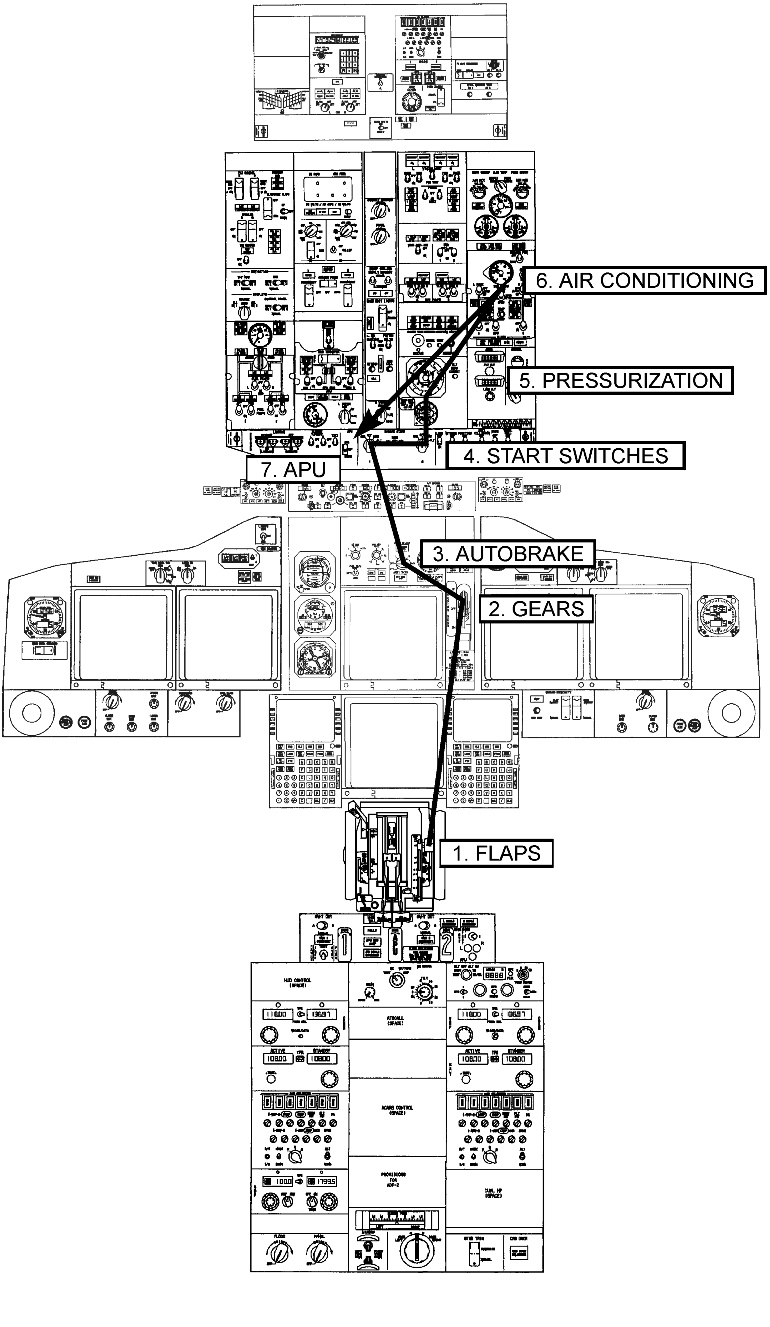
TAKEOFF PROFILE
(ICAO Procedure A)

Note: To be used at airports that require close in noise abatement procedures. (Ref. Jeppesen 10-7 page for specific airport.)

③ 3 5 AFTER TAKEOFF FLOW



7 8 9 AFTER TAKEOFF FLOW



AFTER TAKEOFF

The Pilot Flying should call for the AFTER TAKEOFF checklist in conjunction with the Flaps Up call. The AFTER TAKEOFF flow will not be initiated until the PF calls for the checklist. The Pilot Monitoring will ensure the procedures have been accomplished and then read the checklist. Do not allow the reading of the checklist to interfere with outside vigilance while departing the terminal area.

Caution: To avoid the possibility of the shoulder harness buckles snapping back and inadvertently pulling circuit breakers, hold both straps before releasing and then allow the straps to retract slowly to the stowed position.

PM CHALLENGE	AFTER TAKEOFF	PM RESPOND
Air Conditioning & Pressurization		**SET**
Gear		**OFF, LIGHTS OUT**
Flaps		**UP, LIGHTS OUT**

PM Challenge **PM Respond**

Air Conditioning & Pressurization ....SET

Verify that the cabin is climbing to the pre-selected altitude, the rate of climb is within the desirable range, and cabin differential pressure is increasing.

If takeoff was made using APU for pressurization (bleeds off takeoff), restore pressurization using the following procedure.

Caution: Do not configure the Bleed Air Switches to ON prior to 800 feet AGL

No. 2 Engine Bleed Air Switch .... ON

When cabin rate of climb indicator stabilizes:

APU Bleed Switch ....OFF

No. 1 Engine Bleed Air Switch .... ON

Isolation Valve Switch ....AUTO

Start Switches (Flow) ....(AS REQUIRED)

Normally turned OFF. Ignition switches will be in the CONT position prior to engine anti-ice activation and will remain in CONT position during engine anti-ice operation.

Gear...OFF, LIGHTS OUT

Leave landing gear lever in the UP position approximately 10 seconds after all red landing gear lights have extinguished to ensure positive uplock of the landing gear.

Flaps .... UP, LIGHTS OUT

Check that flap gauge indicates up and that leading edge lights are extinguished.

Autobrake (Flow)... OFF

APU (Flow) ....(AS REQUIRED)

If the APU was used for takeoff and no longer required, it should be shutdown after being pneumatically unloaded for a minimum of one minute.

CLIMB

THRUST MANAGEMENT

Once climb thrust is set, the ③③⑤ PMC / ⑦⑧⑨ EEC will automatically compensate for the various changes in environmental conditions during the climb.

③③⑤ With the PMCs off or inoperative, thrust should be adjusted as necessary during acceleration and while climbing to prevent exceeding maximum climb thrust and to ensure that full climb thrust is maintained.

Benefits in the area of engine maintenance may be realized by operating the engines at less than the full climb ratings.

The FMC provides two pre-scheduled reduced climb thrust selections on the N_1 LIMIT page. Selecting REDUCED CLIMB 1 or 2 will reduce the climb thrust 3% N_1 for CLIMB 1 and 6% N_1 for CLIMB 2 (approximately 8% and 16% thrust reduction). Reduced climb thrust may also be automatically selected by the FMS depending upon the amount of thrust reduction made for takeoff. Reduced climb thrust N_1 values may be monitored on the CLB page. Climb thrust reductions are automatically programmed to be removed by 15,000 feet.

The use of reduced climb thrust will result in an increase in the climb distance. This distance is dependent upon performance variables and the extent to which a thrust reduction is used.

⑦⑧⑨ Automatic thrust reduction occurs at 1500 feet AGL above the departure airport. The THR REDUCTION altitude may be manually entered in the FMC on TAKEOFF REF page 2.

CLIMB CONSTRAINTS

Climb constraints may be automatically entered in the route when selecting a departure procedure, or manually entered through CDU entry. When the aircraft levels off at a MCP altitude, that altitude is treated as a climb constraint by the FMS.

When initiating a climb with multiple altitude constraints the highest cleared altitude will be set in the MCP altitude window.

Caution: If a VNAV mode is not engaged during the climb or disengages, all hard altitude constraints must be set in the MCP.

NORMAL CLIMB SPEED

3 5

Maintain V_M flaps 0 speed to expedite the initial climb. When the normal noise abatement takeoff profile has been completed, the aircraft is generally headed towards its destination, and there are no altitude or airspeed restrictions, accelerate to the desired climb speed schedule. The sooner the aircraft can be accelerated to the climb speed schedule, the better the overall flight efficiency from a fuel conservation and enroute flight time standpoint.

The FMS computed economy climb speed schedule minimizes trip cost. It varies with gross weight, cost index, and other factors.

In the event FMS computed climb speeds are not available, use the speeds on the flight plan.

MAXIMUM ANGLE OF CLIMB

Maximum angle climb speed is normally used for obstacle clearance, minimum crossing altitude, or to reach a specified altitude / flight level in a minimum distance. It varies with gross weight and is approximately the same as V_M flaps 0 speed.

MAXIMUM RATE OF CLIMB

The maximum rate climb speed provides both high climb rates and good minimum time to cruise altitude.

USE OF ALTITUDE ALERTING AND OTHER CONTROL INPUTS

Flight deck workload, autopilot status, communications requirements, etc. can all influence which pilot should perform certain functions at any given time. The guidelines set forth below establish the preferred procedures. If the pilot normally expected to accomplish a given task is distracted by other duties, or flight deck workload / convenience so dictates, it is permissible for the other pilot to make the appropriate changes. In this event, the pilot making the changes must verbally state the changes made.

The altitude alerting system shall be used during all phases of flight to assist the flight crew in altitude awareness and to prevent deviation from assigned clearances. During climb, the flight crew shall set the next clearance altitude in the altitude selector window.

With the autopilot ON, the PF will set the new clearance altitude in the altitude selector window.

With the autopilot OFF the PM will set the new clearance altitudes in the altitude selector window.

Both pilots will verbally and visually acknowledge the cleared altitude set in the altitude selector window.

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CRUISE

ALTITUDE SELECTION

The altitude selection for cruise should normally be as close to optimum as possible. Optimum altitude is the altitude that gives the best fuel mileage for a given configuration and gross weight. It normally provides at least a 1.5g (approximately 47 degrees bank to buffet onset) or better buffet margin. Prior to installation of U10.1 FMC software, pilots could routinely fly above the Optimum Altitude displayed in the FMC without approaching the 1.3g buffet margins (approximately 30 degrees of bank to buffet onset). A common "rule of thumb" had been you could fly 2000 feet above Optimum Altitude with minimal degradation of aircraft performance. This "rule of thumb" technique was used to achieve step climb profiles at the earliest possible time.

With the installation of 10.3 and higher software, the 1.5 buffet margin provided at Optimum Altitude is reduced significantly when flying above the FMC displayed Optimum Altitude. Additional reduction of this buffet margin may occur from turbulence, temperature variations, increased drag, and airspeed decay. These factors may influence aircraft performance to the point where <u>sufficient thrust is not available to maintain altitude</u>. Flying above Optimum Altitude also increases the fuel burn 1 to 2 percent.

Crew Action: Before requesting or accepting an altitude above Optimum, it is **required** that crews check the 1.3 G Buffet Boundaries Low / High IAS chart in the QRH to determine if the flight has the required operational airspeed performance margins. If altitude changes enroute are difficult to obtain, some thought should be given to selecting an initial cruise altitude based on maximum thrust limits. Selecting a cruise thrust limited altitude is dependent upon the cruise level temperature.

CRUISE PERFORMANCE ECONOMY

The dispatch computed fuel burn from departure to destination is based on certain assumed conditions, i.e., takeoff gross weight, cruise altitude, route of flight, temperature, wind enroute, and cruise speed. Cruise fuel burn will increase when flying:

- Other than optimum altitude.
- Speed faster than planned or slower than long-range cruise if planned for long-range cruise.
- Stronger headwind component.
- Unbalanced fuel.

- Improperly trimmed aircraft.
- Excessive thrust lever adjustments.

The higher the aircraft flies above optimum altitude, the more buffet margin is reduced. Before accepting an altitude above optimum, determine that it is, and will continue to be, acceptable as the flight progresses under projected conditions of temperature and turbulence.

NAVIGATION

"Fix to Fix" direct navigation should be requested and utilized whenever possible. This, combined with the use of FMC ECON CRUISE, will result in the most economical cruise profile. While at cruise, both Nav Radios should be operated in the AUTO position to allow FMC radio updating. Substantial deviations from flight planned altitudes and/or airspeeds due to weather or ATC, etc., should be analyzed with a combination of computer information, conventional fuel planning, buffet boundaries, etc.

Ideally, an END OF DESCENT POINT within the terminal area of the destination airport, including speed and altitude, should be inserted while at cruise. All expected descent profile information should be programmed at cruise altitude so as to minimize low altitude programming.

HIGH ALTITUDE / HIGH SPEED FLIGHT CHARACTERISTICS

Aircraft Flight Characteristics

The aircraft exhibits excellent stability throughout the high altitude / Mach range. Mach buffet is not normally encountered at high Mach cruise, even at M_{MO}. However, even in Mach buffet, control response is smooth and normal.

The aircraft exhibits a slight nose down trim change when accelerating to speeds approaching M_{MO}. However, control force changes are light and easily managed. When the Mach trim system is operative, the nose down trim change is nearly imperceptible except by referencing the control column position.

Trim Technique

If an "out of trim" condition is suspected, check engine parameters for indication of unequal thrust. Set and maintain a balanced thrust condition. Trimming the aircraft to counteract this condition results in further increase in drag with its resultant loss of fuel mileage. Check fuel quantities for lateral imbalance. Zero the aileron and rudder trim. If trim is required, hold the wings level with the control wheel using the ADI for a reference. Apply rudder to maintain heading. When heading is stabilized, trim out any force that is being held on the rudder and the control wheel. The wheel should be approximately neutral.

Inadvertent Rudder Trim

Inflight, inadvertent activation of the rudder trim by an observer seat occupant or by an object placed in contact with the trim switch is recognizable in manual flight by the control force necessary to maintain the flight path. With the autopilot engaged, the condition can be recognized by a sustained control wheel deflection opposite to the direction of the rudder trim. If the trim continues to the limit of the autopilot control wheel deflection, the aircraft will turn in the direction of the trimmed rudder while holding opposite aileron. If the trim continues beyond the limits of the autopilot, the autopilot will disengage, resulting in an abrupt roll / yaw in the direction of the rudder deflection.

FUEL MANAGEMENT

When established in cruise, the crew should verify that the fuel remaining on board meets or exceeds all requirements for a safe completion of the flight. This can be done via FMC forecast of fuel on board at destination compared to flight plan fuel estimates. Fuel verification should occur periodically throughout the flight.

Note: To ensure accurate forecast fuel at destination, all significant winds aloft information should be entered on the RTE DATA page.

Center Tank Fueled (No Aux. Tank or Aux. Tank Empty):

Climb and Cruise............................... SIX PUMPS ON AND CROSSFEED SELECTOR CLOSED

In this configuration, both engines are being pressure fed from the center tank, with tanks No. 1 and No. 2 standing by as backups. This configuration is maintained throughout the entire flight. As the center tank quantity decreases to near empty, one **LOW PRESSURE** caution light may be illuminated before the other. As the center tank runs dry, the two center tank **LOW PRESSURE** lights will illuminate. The engines will now be pressure fed from tanks No. 1 and No. 2.

During takeoff or initial climb, if a center tank **LOW PRESSURE** light(s) illuminates, the center tank pump(s) may remain on until the climb attitude is reduced and the light(s) extinguishes or workload allows for the pump(s) to be positioned to **OFF**. When established in a level attitude at cruise, if the center tank contains usable fuel and the center tank switches are off, center tank pump switches may be positioned to **ON** again. Verify the **LOW PRESSURE** light extinguish and position both switches to OFF when both **LOW PRESSURE** lights illuminate.

Center Tank LOW PRESSURE Illuminated ..... PUMP SWITCHES OFF

Center tank fuel pump switches must be positioned to OFF when both center tank fuel pump low pressure lights illuminate. Any residual fuel will be transferred to the No. 1 tank by the center tank scavenge system.

Center and Auxiliary Tanks Fueled (Aux. Tank Installed):

Climb and Cruise.. ALL PUMPS ON AND CROSSFEED SELECTOR CLOSED

In this configuration, engine No. 2 is being pressure fed from the center tank, engine No. 1 is being fed from the auxiliary tank, and wing tanks No. 1 and No. 2 are standing by as back ups. As the auxiliary tank quantity decreases to near empty, one LOW PRESSURE caution light may illuminate before the other. When the auxiliary tank runs dry, the two auxiliary tank LOW PRESSURE lights illuminate. Fuel feed now reverts to the same as the Center Tank Fueled (No Aux Tank or Aux Tank Empty) procedure.

Auxiliary Tank LOW PRESSURE
Lights Illuminated.. PUMP SWITCHES OFF

Confirm auxiliary tank quantity is zero, and place the auxiliary tank fuel pump switches OFF.

Fuel Balancing:

Maintain No. 1 and No. 2 tank fuel balance within limitations.

Note: Fuel pump pressure should be supplied to the engines at all times. Above 30,000 feet without fuel pump pressure a thrust deterioration may occur.

If the Center/Aux tank contains fuel:

Center/Aux Tank Pump Switches... OFF

Crossfeed Selector .... OPEN

Fuel Pump Switches (Low Tank) .... OFF

When quantities are balanced:

Fuel Pump Switches (Main Tank) .... ON

Center/Aux Tank Fuel Pump Switches .... ON

Crossfeed Selector .... CLOSE

If the Center/Aux tank contains no fuel:

Crossfeed Selector .... OPEN

Fuel Pump Switches (Low Tank) .... OFF

When quantities are balanced:

Fuel Pump Switches .... **ON**

Crossfeed Selector .... **CLOSE**

FUEL TEMPERATURE

Fuel freeze should not be confused with fuel ice caused by frozen water particles, but with the formation of wax crystals suspended in the fuel, which can accumulate below the freeze point. Fuel tank temperature should be maintained at least 3°C above the freezing point of the fuel being used (see Section 1).

Maintaining a minimum fuel temperature should not be a concern unless the fuel temperature lowers to within a few degrees of that limit. The rate of cooling of the fuel at this point can be expected to be 3°C / hour with a maximum of 12°C / hour possible under the most extreme cold-day conditions.

Fuel temperature will tend to change toward total air temperature. If the total air temperature is lower, it may be increased to raise the fuel temperature.

Total air temperature can be raised by:

- Deviating to a warmer air mass.
- Increasing mach number.

It may take up to an hour to stabilize the fuel temperature. In most cases, the required descent would be within 3,000 to 5,000 feet below optimum altitude. In the more severe cases, a descent to altitudes of 25,000 feet to 30,000 feet might be required. An increase of .01 mach will result in an increase of 0.5°C to 0.7°C total air temperature.

TURBINE ENGINE MONITORING PROGRAM

Continental employs an in-flight engine condition monitoring procedure called "T.E.M.P." (Turbine Engine Monitoring Program). Engine data, gathered by the crew and relayed by ACARS or individual forms, generates computerized trend analysis of each individual engine's condition and performance. With this data, early engine deterioration can be detected and action taken to prevent failure.

Each crew will send this information for each flight segment greater than one hour, conditions permitting. The minimum is one message per flight number for flights of over one hour.

T.E.M.P. reports should be relayed via ACARS. If ACARS is inoperative or not installed, use the T.E.M.P. logbook provided on the flight deck.

③ The ACARS format for relaying engine data is displayed in the ACARS CDU by pressing the ENG key. A sequence of data entries will appear starting with "Gross Weight." It is essential that the crew enter all the data carefully and accurately. A complete engine condition report is illustrated on the following page.

3 5 7 8 9 Engine Data Reports are transmitted automatically. No crew action is required.

3 5 If Maintenance requests an Engine Report from the crew, use the following steps to select the ENGINE DATA REPORT: Press <ACARS <INFLIGHT <ENGINE DATA. Touch AUTO to activate the MANUAL Engine Data Report. Follow the prompts through the report.

Note: Allow both engines to stabilize at cruise thrust for at least 3 minutes prior to initiating the recording sequence. The autothrottles should be disengaged during the engine-recording period and engine anti-ice switches should be OFF.

	DATA	ACTUAL DATA	CREW ENTRY
GWT	Gross Weight	102550	1025
ALT	Aircraft Altitude	FL 350	350
SAT	Static Air Temp.	-44	44
TAT	Total Air Temp.	-19.1	19
TAS	True Airspeed	437 K	437
IAS	Indicated Airspeed	249 K	249
MACH	Mach	.741	741
ISO	N/A		ENT
ISO	N/A		ENT
PAC1	Pack Valve Position	Open	1
		Closed	0
PAC2	Pack Valve Position	Open	1
		Closed	0
EPR	N/A		ENT
EPR	N/A		ENT
1 N_1	#1 N_1	84.9	849
2 N_1	#2 N_1	84.8	848
1 EGT	#1 EGT	657	657
2 EGT	#2 EGT	644	644
1 N_2	#1 N_2	90.4	904
2 N_2	#2 N_2	90.1	901
1 FF	#1 FF	2410	2410
2 FF	#2 FF	2360	2360
1 TL	#1 Throttle Position		4
2 TL	#2 Throttle Position	See Chart	
1 OIL P	#1 Oil Pressure	42	42
2 OIL P	#2 Oil Pressure	44	44
1 OIL T	#1 Oil Temperature	112	112
2 OIL T	#2 Oil Temperature	112	112
1 VIB	#1 Vibration	.6	6
2 VIB	#2 Vibration	1.2	12
1 BLD	#1 Engine Bleed Pos	Open	1
		Closed	0
2 BLD	#2 Engine Bleed Pos	Open	1
		Closed	0
1 FQ	#1 Fuel Quantity	6840	6.8
2 FQ	#2 Fuel Quantity	7420	7.4
3 FQ	Center Tank Qnty	0	0
KF	N/A		ENT

SEND

Throttle Position Codes

#1 throttle, regardless of position, is reported as position "4."

#2 throttle position is reported relative to #1 throttle as follows:

1	=	Greater than 1 knob behind
2	=	1 knob behind
3	=	½ knob behind
4	=	Throttles aligned
5	=	½ knob ahead
6	=	1 knob ahead
7	=	Greater than 1 knob ahead

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DESCENT

A good descent profile takes into consideration many variables and can account for significant fuel savings.

Maintaining the desired descent profile and utilizing the MAP mode (if available) to maintain awareness of position will ensure a more efficient operation. The crew should be aware of the destination weather and traffic situation and consider the requirements of a potential diversion. A review of the airport approach charts and pages, and a briefing for the approach and landing will be conducted. Complete this approach briefing as soon as practical, preferably before arriving at top of descent so the crew may give full attention to aircraft control.

The ECON PATH descent with VNAV engaged should be used whenever possible. This will result in a CRUISE descent if initiated beyond 50 miles from T/D and a DES NOW descent if initiated within 50 miles of the T/D. The use of a VNAV descent is preferred over a descent utilizing vertical speed due to the reduced fuel burn. Flight deck workload increases as the aircraft descends into the terminal area. Distractions must be minimized, administrative and nonessential duties completed before descent or postponed until after landing. The earlier that essential duties can be performed, the more time will be available for the more critical approach and landing phases. Below 10,000' MSL, limit programming of the FMC to minimize pilot head-down time.

Traffic considerations and speed control at specific airports frequently prevent execution of an ideal descent at best economy speeds. In these cases, the pilot should adjust his descent point so that an idle power descent is accomplished.

ENROUTE DESCENT

Due to the low drag of the advanced technology wing, proper descent planning is necessary to arrive at the desired altitude at proper speed and configuration. The distance required for the descent is approximately three times the altitude loss for no-wind conditions.

In addition, excess airspeed is slow to dissipate and generally requires a level flight segment.

Use the speed as indicated on the descent page of the FMC. If the information is not available from the FMC, use .74M/250 for minimum fuel burn. Use ③ 3 5 .70M/280/250 7 8 9 .76/280/250 for turbulent air or ATC requirements.

Plan the descent to arrive at traffic pattern altitude at flaps up maneuvering speed about:

- 12 miles out when proceeding straight-in.
- About 8 miles out when making an abeam approach.

A good cross check is to be at 10,000 feet AFE, 35 miles from the airport, with a speed of 250 knots.

B737 aircraft are equipped to record the uninterrupted audio signals received by a boom or a mask microphone. Flight crewmembers are required to use the boom microphone below 18,000 feet MSL.

DESCENT IN MODERATE TO HEAVY PRECIPITATION

If, at all possible, moderate or greater precipitation in the form of rain, hail, or sleet should be avoided. Advance planning and effective use of weather radar to detect areas of precipitation will usually provide alternative flight paths around hazardous weather conditions. If rain, hail, or sleet of moderate or greater intensity is encountered or anticipated, the engine ignition switches should be placed to the FLT position.

SPEED BRAKES AND THRUST USAGE

While using the speedbrake during descent, allow sufficient margin in altitude and/or airspeed so that a smooth level off can be accomplished while lowering speedbrake and adding thrust without causing passenger discomfort or overshooting the desired altitude. Lower the speedbrake before adding thrust.

Thrust Indications During Descent

It should be noted that during high speed descents from altitude with idle thrust set, a variation in all engine parameters may occur due to engine efficiencies and tolerances. Differences as high as 15% N_1 between left and right engines have been observed during initial descent. These variations tend to diminish as altitude and airspeed decrease, and should be minimal by 10,000 feet. This condition is within normal operating limits.

HOLDING

Begin speed reduction within 3 minutes prior to estimated arrival at the fix so as to arrive at the holding fix at or below the maximum authorized holding speed for the altitude.

During selection of the holding pattern in the FMC, verify proper holding pattern direction and inbound course are entered. PM monitor raw data.

Upon arrival at the fix, maintain holding speed and hold as instructed. Maintain the last assigned altitude / flight level.

Make all turns during entry and while holding at 30 degrees bank angle, or 25 degrees bank angle using the flight director system. If holding using LNAV, the FMC will determine the bank angle.

Compensate for known effect of wind, except when turning.

Advise ATC immediately if an increase in airspeed is necessary due to turbulence, or if unable to accomplish any part of the holding procedures.

CONFIGURATIONS

Above 14,000 feet - Hold clean and use holding chart speed, but not above FAA maximum speeds without ATC approval.

At or Below 14,000 feet - Extensive holds should be made in the clean configuration. When expected approach time or altitude to which cleared indicates that an approach clearance is imminent, flaps should be extended and airspeed reduced as required.

MAXIMUM AIRSPEEDS (FAA / ICAO STANDARD)

Altitude	Speed	Time
MHA - 6000 MSL	200K IAS	1 Min
Above 6000 MSL - 14,000 MSL	230K IAS *	1 Min
Above 14,000 MSL	265K IAS	1 ½ MIN

* 210K where published.

- Holding airspeeds at international destinations may be further limited by State Regulations. Refer to the Jeppesen STATE RULES AND PROCEDURES for specific holding speeds at foreign destinations.

TIMING

Timing of the initial outbound leg should be 1 minute at or below 14,000 feet MSL, and 1½ minutes above 14,000 feet MSL. Timing for subsequent outbound legs should be adjusted as necessary to achieve proper inbound leg time.

Outbound timing begins abeam the fix. If the abeam position cannot be determined, start timing when the turn to the outbound heading is complete and the wings are level.

The time required to complete a 180 degrees turn will vary with weight, altitude, and speed. Example: At 5,000 feet and 200 knots, it will take approximately 1¼ minutes. At 20,000 feet and 230 knots, it will take approximately 1½ minutes.

Plan the holding pattern so as to arrive at the holding fix at the correct time to meet EFC requirements.

STANDARD PATTERN

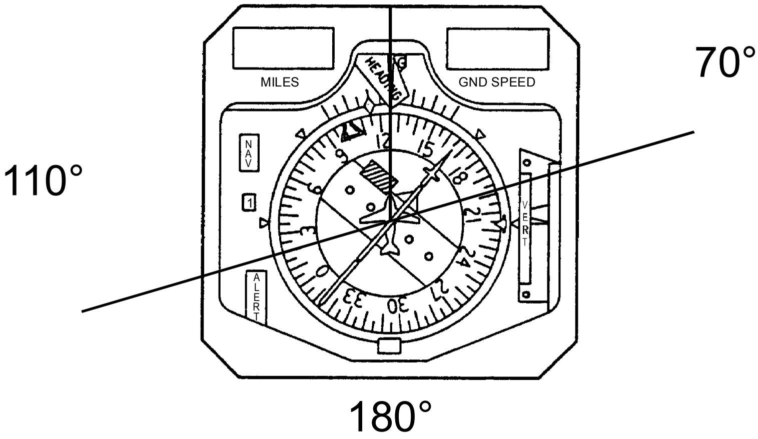
Parallel Entry - Parallel holding course, turn left, and return to holding fix or intercept holding course.

Teardrop Entry - Proceed on an outbound track of 30 degrees (to the holding course) for 45 seconds, then turn right to intercept the holding course.

Direct Entry - Turn right and fly the pattern.

Recommended method for determining entry - Put tail of course needle on outbound course (holding radial).

Ensure proper inbound holding course is entered in FMC.



37374ARC

Outbound course (holding radial) within 70 degrees ARC, fly teardrop entry.

Outbound course (holding radial) within 110 degrees ARC, fly parallel entry.

Outbound course (holding radial) within 180 degrees ARC, fly direct entry.

NON-STANDARD PATTERN

Change the FMC HOLD page to left pattern.

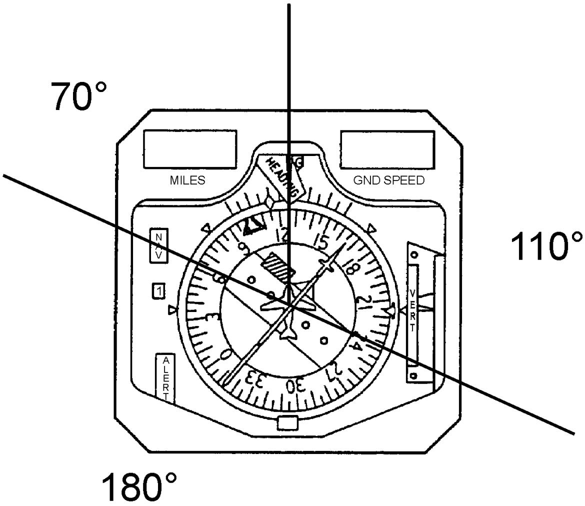
Parallel Entry - Parallel holding course, turn right and return to holding fix or intercept holding course.

Teardrop Entry - Proceed on an outbound track of 30 degrees (to the holding course) for 45 seconds, then turn left to intercept the holding course.

Direct Entry - Turn left and fly the pattern.

Recommended method of determining entry - Put tail of course needle on outbound course (holding radial).

Ensure proper inbound holding course is entered in FMC.



7374ARC

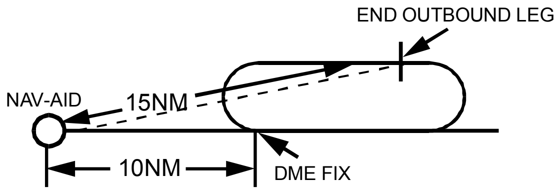
Outbound course (holding radial) within 70 degrees ARC, fly teardrop entry.

Outbound course (holding radial) within 110 degrees ARC, fly parallel entry.

Outbound course (holding radial) within 180 degrees ARC, fly direct entry.

DME HOLDING

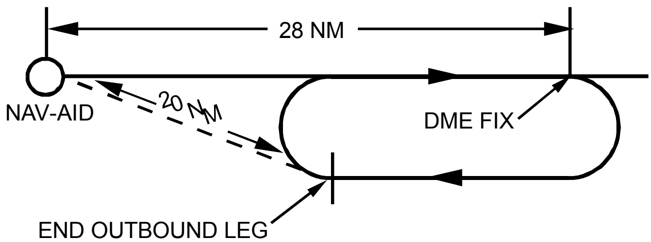
Example #1 - Inbound to the VOR hold east of the 10-mile DME fix on the 090 degrees radial, 5 mile legs, right turns.



7374220

Since the inbound course is toward the navaid, the fix distance is 10 NM and the leg length is 5 NM. The end of the outbound leg will be reached when the DME reads 15 NM.

Example #2 - Outbound from the VOR hold west of the 28 mile DME fix on the 090 degrees radial, 8 mile legs, right turns.



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Since the inbound course (to the fix) is away from the navaid, the fix distance is 28 NM and the leg length is 8 NM. The end of the outbound holding legs will be reached when the DME reads 20 NM.

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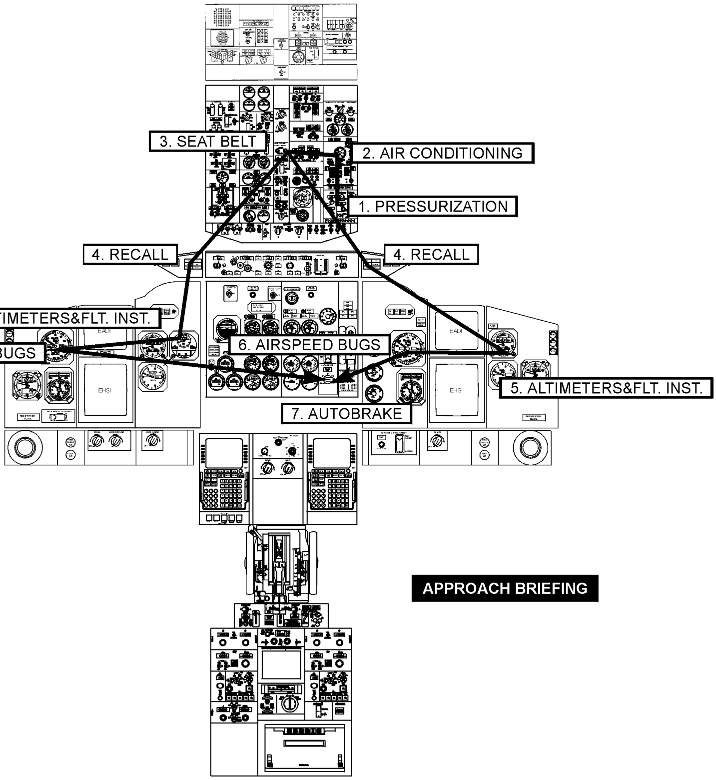
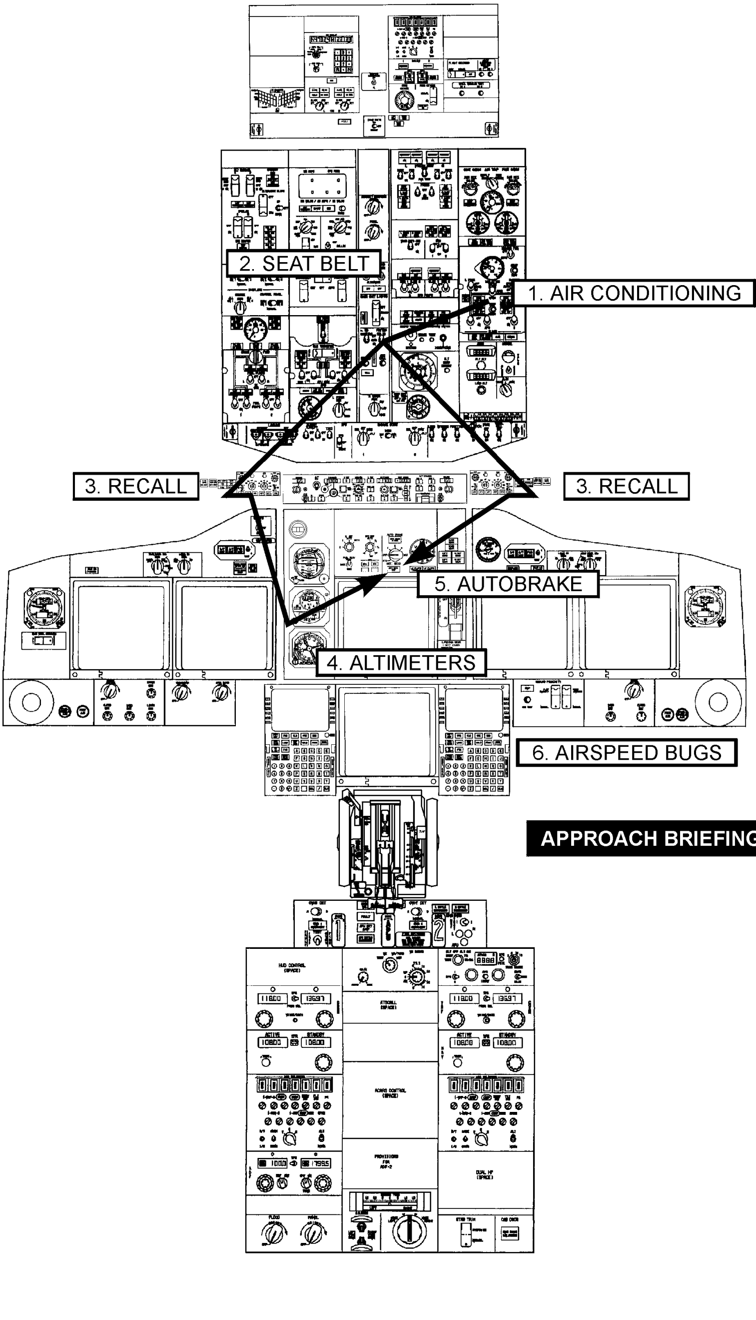
③❸❺ IN RANGE FLOW



7 8 9 IN RANGE FLOW



APPROACH BRIEFING

IN-RANGE

The IN-RANGE flow may be initiated prior to Top Of Descent.

The Pilot Flying should call for the IN-RANGE checklist at approximately 18,000 feet. For flights with cruise altitudes below 18,000 feet, the IN-RANGE checklist should be called for at Top Of Descent.

Approximately 10 minutes before landing, the no smoking switch should be cycled once indicating that landing is imminent.

Note: Flight crewmembers are required to use the boom microphone below 18,000' MSL.

Meteorological conditions permitting, the use of landing lights, logo lights and strobe lights are required below 18,000'.

PM CHALLENGE	IN-RANGE	PM RESPOND
Air Conditioning & Pressurization		**SET**
Seat Belt Sign		**ON**
Recall		**CHECKED**
Altimeters & Flt Instruments		**SET, CHECKED (PM, PF)**
Airspeed Bugs		**SET (PM, PF)**
Autobrake		**SET**
Approach Briefing		**COMPLETED**

PM Challenge **PM Respond**

Air Conditioning & Pressurization ....SET

③ 3 5 If operating the pressurization in the standby mode, verify the cabin altitude is set 200 feet below the landing airport elevation.

Note: If descending into a high elevation airport refer to AUTOMATIC PRESSURIZATION CONTROL LANDING AIRPORT ELEVATION ABOVE 6000 FEET checklist if necessary.

Seat Belt Sign .... ON

Recall... CHECKED

The Pilot Monitoring should press recall. This is the last check of canceled warnings prior to landing.

Altimeters & Flt Instruments .... SET, CHECKED (PM, PF)

Set barometric pressure on all altimeters as required. If transition level is below 18,000 ft. MSL set barometric pressure on all altimeters when cleared to an altitude below the transition level.

Set appropriate BARO and RADIO minimums for the planned approach.

On a CAT I ILS or a Non-Precision approach, the BARO altimeter is the primary reference to DA / DDA. DH on a CAT II ILS is determined solely from the radio altimeter or inner marker, as appropriate. DH on CAT IIIA approaches will be determined solely by reference to the radio altimeter.

Set the reference altitude bug on the altimeters as follows:

APPROACH TYPE	ALTIMETER BUG REFERENCES	
	BAROMETRIC	RADIO
Visual	N/A	N/A
NPA (Non-Precision Approach)	DDA or Published DA CONTROLLING (1)	250’
CAT I	Published DA CONTROLLING (1)	Published DH
CAT II	Published DA	Published RA CONTROLLING (1)
CAT IIIA 7 8 9 Only	TDZE + 50’	50’ CONTROLLING (1)

Airspeed Bugs .... SET (PM, PF)

③ 3 5 Position the white movable reference bugs at 80 knots, V_{REF}, V_{REF} + 15, and V_M flaps 0 for the appropriate weight.

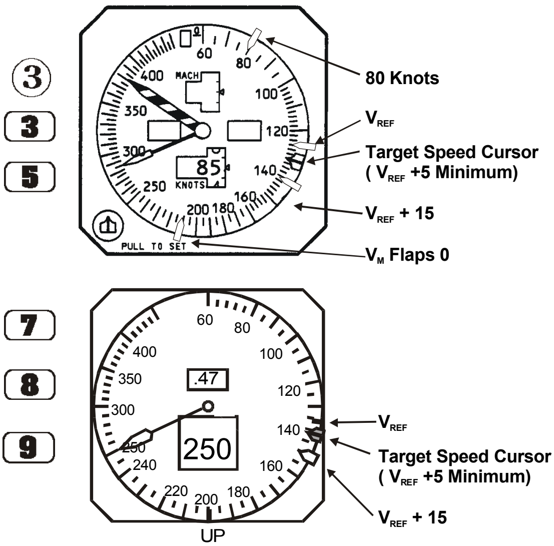
7 8 9 Once the desired landing flaps have been determined, the flight crew may select the FMC computed speed or manually enter another value into the field corresponding to the desired landing flap configuration. This speed will then be transmitted by the FMC and the symbol generator will display 3 5 the “-R” symbol opposite that speed on the speed tape, 7 8 9 the appropriate V_{REF} bug on the airspeed indicator (MASI).

The target speed will be determined by adding ½ the reported wind and all the gust not to exceed plus ③ 3 5 7 20 knots 8 9 15 knots to V_{REF}. The minimum target speed will be V_{REF} + 5 knots.

Example: If the reported wind 12 kts gusting to 20 kts. Target setting is V_{REF} plus 14 knots.

1. ½ of 12 kts = 6 kts.
2. The difference between the steady state wind of 12 kts and the reported gust of 20 kts is 8 kts.
3. Add the 6 kts (Steady State) and 8 kts (Reported Gust) to obtain the additive of 14 kts.

For landings without autothrottles, the wind correction will be entered at 5R on the APPROACH REF page.



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Autobrake...SET

If operational, the use of auto brakes for landing is required.

It is estimated that manual braking techniques frequently involve a 4 to 5 second delay between main gear touchdown and brake pedal application, even when conditions reflect the need for a more rapid initiation of braking. This delayed braking can result in the loss of 800 to 1000 feet of runway. Directional control requirements for crosswind conditions and low visibility may further increase the above delays as can the distraction arising from a malfunctioning reverser system. Use of reverse thrust will allow the autobrake system to reduce brake pressure to the minimum level, thus minimizing brake and tire wear and keeping brake temperatures in the normal range. The use of minimum reverse thrust will almost double the brake energy requirements. During landing roll if the deceleration is not suitable for the desired stopping distance, take over manual braking. The autobrake should be released by smoothly applying brake pedal force, as in a normal stop, until the autobrake system disarms, as noted by the illumination of the **AUTO BRAKE DISARM** light, or by moving the speedbrake lever full forward.

For normal operation of the autobrake system, it is necessary to arm it by selecting a deceleration setting. The following is offered as selection criteria:

1 This selection should be made as the normal setting for routine operations. It will provide a nominal deceleration rate.

2 or 3 These settings should be used when moderate deceleration rates are required for wet and slippery runways, when landing rollout distance is limited, any time a reverser is inoperative, single engine landings, and any landing requiring higher than normal landing speeds.

MAX This setting should be used when maximum deceleration rates are required for minimum stop distance. The deceleration rate is less than produced by full manual braking.

Approach Briefing..COMPLETED

Normally the approach briefing should be accomplished at cruise altitude when the destination ATIS information becomes available. However, if this is impractical the crew brief will be accomplished as soon as approach information is available. The briefing should include the following items as appropriate to approach conditions.

- Weather and alternate
- Runway conditions and required lighting
- STAR approach and chart date
  - Displays and automation modes
  - Frequencies / courses
  - Altitudes
- Missed approach procedures
- Engine inoperative missed approach
- Non-normal and inoperative equipment considerations
- Terrain considerations.

If EGPWS is installed, use the TERR feature on the EFIS control panel for arrival to any airport with significant terrain features. This feature should be considered for use even in day VFR conditions. The TERR function cannot be displayed with weather radar. Consider using weather radar on one display and terrain on another when faced with a weather / terrain situation.

If EGPWS is not installed, consider using radar to help identify prominent terrain features.

- Transition Level
- 10-7 and 10-9 Pages

For a visual approach, the briefing may be abbreviated to only include the following:

- Weather and runway conditions
- Non-standard crew or equipment requirements, and 10-7 page information. However a discussion of the electronic aides (if available) to be used to verify proper runway and descent guidance is mandatory.

Note: The pilot who will fly the approach briefs the approach. For monitored approaches the Captain will brief the required callouts and duties associated with the specific monitored approach.

Note: For night visual approaches or visual approaches where IMC conditions may be encountered, consideration should be given to accomplish a full instrument approach briefing.

Note: It is important to note that it is the responsibility of each crewmember to review and understand all procedures and phases for any approach.

WARNING: Prior to descent into mountainous or significant terrain:

- All enroute charts, STARS, and approach charts associated with arrival will be out and available.
- The flight crew will review all Grid MORAs MEAs.
- MOCAs AMAs to include position of high terrain along the route.
- For aircraft with EGPWS, at least one pilot will have TERR selected.
- In mountainous terrain below FL 250 at least one pilot will monitor raw data to ensure navigational accuracy.

The MAP mode normally provides the best situational awareness. Since raw data is primary it must be displayed prior to commencing the approach. The ADI display of LOC/GS information, and the RDMI display of NDB azimuth information suffice for this requirement.

Note: During VOR approach, at least one pilot will have VOR data displayed on his/her HSI prior to and after intercepting the final approach course.

APU INFLIGHT START

If started in flight, the APU should be stabilized and up to speed prior to reaching the Final Approach Fix.

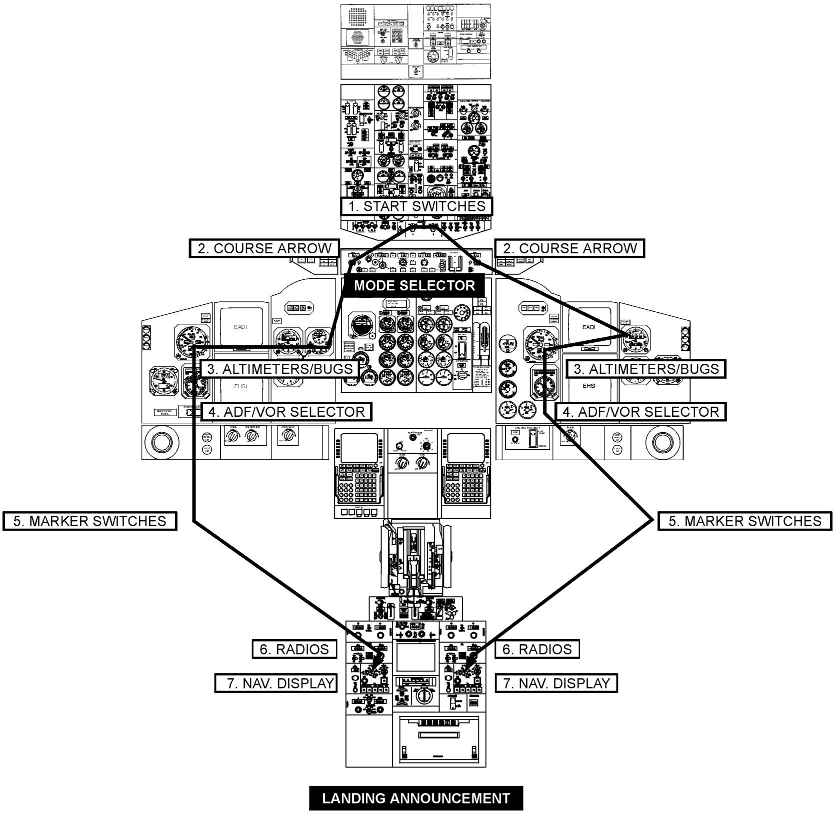
BLEEDS OFF LANDINGS

Prior to commencing the approach, there may be situations where a bleeds off landing will be done to meet performance requirements. With the APU running, configure pressurization in the following manner:

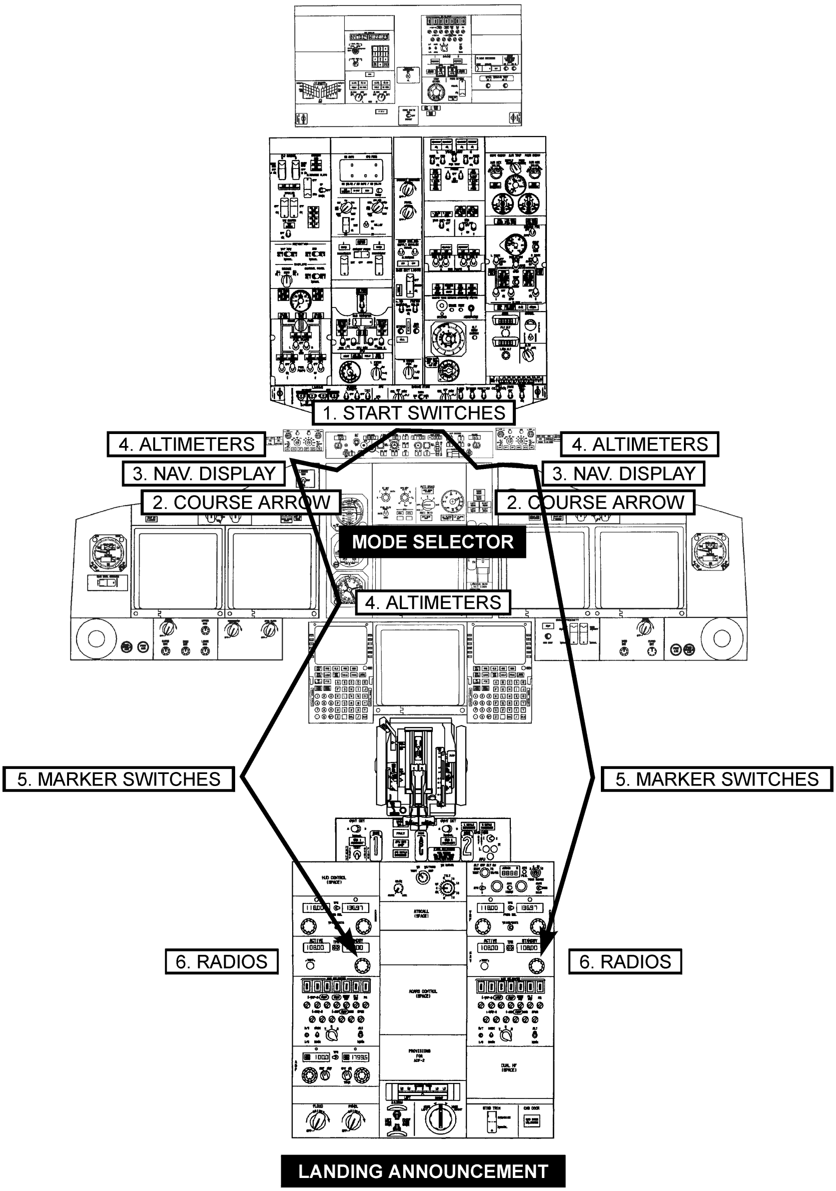
Bleeds Off (APU bleed for air conditioning):

Right Air Conditioning Pack Switch...AUTO
Isolation Valve Switch ....CLOSE
Left Air Conditioning Pack Switch ....AUTO
No. 1 Engine Bleed Air Switch...OFF
APU Bleed Switch (Max. Altitude of 17000’) .... ON
No. 2 Engine Bleed Air Switch...OFF

③ 3 5 APPROACH FLOW



7 8 9 APPROACH FLOW



APPROACH

The APPROACH flow may be initiated once in the approach environment and after descending through the transition level.

The Pilot Flying will call for the APPROACH checklist once in the approach environment and after descending through the transition level.

PM CHALLENGE	APPROACH	PM RESPOND
Start Switches		**CONTINUOUS**
Altimeters / Bugs		**SET (PM, PF)**
Radios		**IDENTIFIED**
Nav Displays		**SET**
Course Arrow		**AS REQUIRED**
Landing Announcement		**COMPLETED**

PM Challenge **PM Respond**

Start Switches.. CONTINUOUS

If operating in moderate to heavy precipitation, select start switches to FLT.

Altimeters / Bugs .... SET (PM, PF)

Verify all altimeters and approach minimums are set.

Radios..IDENTIFIED

All appropriate radios must be tuned and identified for the approach planned.

Nav Displays..SET

For VOR or LOC (BC) approaches, at least one pilot must select either 3 5 FULL or EXPANDED VOR/ILS ③ VOR/ILS on the HSI display prior to reaching the final approach fix. Since raw data for NDB approaches is available on the RDMI indicators, and raw data for ILS, LOC approaches are available on the ADI display selections are at the discretion of each pilot. However, for maximum situational awareness, the HSI MAP mode is recommended.

7 8 9 The recommended display option for this aircraft is **MAP** since the display unit will always have an HSI displayed.

For all ILS, LOC, and LOC (BC) approaches, the standby attitude indicator ILS selector switch should be placed in the appropriate position.

Course Arrow...AS REQUIRED

The final approach course for any approach based on a VHF NAV tracking must be set in both MCP course windows no later than on an intercept heading to the final approach course.

Caution: Setting of an incorrect inbound course in the MCP window will cause the AFDS to turn toward the selected incorrect course.

ADF/VOR Selector (Flow)...(AS REQUIRED)

The ADF/VOR selector switches on the ③ 3 5 RDMI / 7 8 9 EFIS Control Panel should be positioned consistent with the approach.

Note: 3 5 Selection of #2 ADF on EFIS aircraft provides no information.

7 8 9 ADF not installed.

Marker Switches (Flow)...(AS REQUIRED)

Marker beacon switches on audio selector panel should be on if required for the approach.

Landing Announcement...COMPLETED

The PM will make the landing announcement by stating, "FLIGHT ATTENDANTS PLEASE BE SEATED FOR ARRIVAL."

Note: Ensure appropriate AFDS mode selected for approach. Autopilot engaged in command for coupled approaches. Both autopilots engaged for autoland approaches.

APPROACH PROCEDURES

GENERAL

This section describes the procedures used for the various types of approaches flown on the B737. These procedures should be used in normal operations. ATC influences or other outside factors may require modifications.

COURSE REVERSAL

General

A procedure turn is specified wherever it is necessary to reverse direction to establish the aircraft inbound on an intermediate or final approach course. The approach plate will specify the outbound and inbound courses, the distance within which the procedure turn shall be completed, the side of the inbound course on which the turn should be made, and a minimum altitude to be maintained.

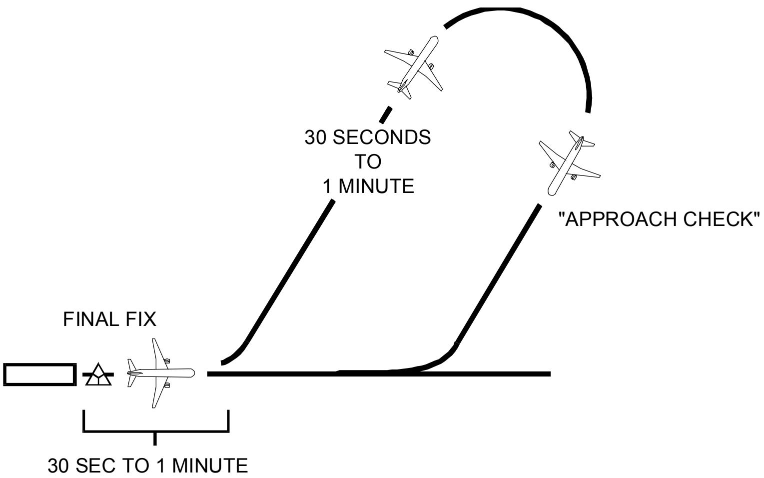
The aircraft shall cross the fix or facility and fly outbound on the specified track descending as necessary to the specific altitude. If a further descent is specified after the inbound turn, this descent shall not be started until established on the inbound track. The definition of "established" is as follows:

- ILS and VOR approaches: Within one half of the full scale deflection.
- NDB approaches: Within ± 5 degrees of the required bearing.
- RNP based approaches: The magenta course line is within the confines of the aircraft symbol in the 10 N.M. scale.

Procedure Turn - Standard

Unless specified on the approach plate, the point at which the procedure turn is started is left to the discretion of the pilot.

It is recommended that the turn to the outbound heading be commenced between 30 seconds and one minute past the final approach fix. Timing on the outbound procedure turn heading is also recommended at between 30 seconds and one minute. Adjust time accordingly for known winds, configuration, and/or other approach restrictions. Normally the procedure turn will be accomplished with flaps 5 configuration and maneuvering airspeed.



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Note: A racetrack or teardrop pattern may be specified on the approach plate and must be flown as depicted. Times may be adjusted as required for wind.

Procedure Turn – DME Arc

A DME arc is the track of an aircraft maintained at a constant distance from a navigational aid by reference to distance measuring equipment (DME).

The distinguishing feature of the DME arc is you are required to fly your aircraft along a circular track around the VORTAC station at a specified distance.

Many transitions, which incorporate DME arcs, are already included in the FMS database and may be selectable by choosing the appropriate approach transition.

Note: (3)(5)(7)(8)(9) A DME arc may be created on the Map by selecting a distance reference (mileage) for a desired FIX page waypoint.

When turning onto an arc, plan to lead your turn to avoid overshooting the desired arc. A good rule-of-thumb is to lead desired DME indication by 1% of your ground speed.

Example: For a 200-knot ground speed, lead 2 miles, and so forth.

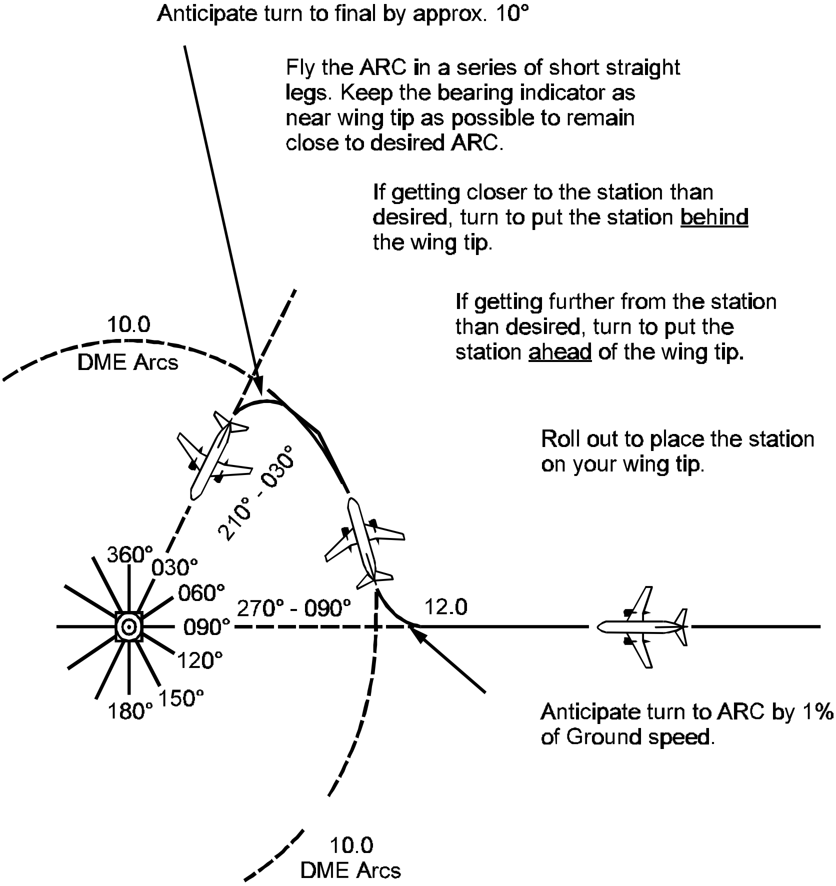
Keeping a bearing or radial indicator near the wing tip will keep you close to the desired arc. Flying in a series of short, straight legs are usually the best technique to use. Do not attempt to fly in a continuous bank.

The DME indication will be the same as the published DME distance each time the VOR-RDMI needle passes through the wing tip position. If you drift off the ARC:

- If getting closer to the station than desired, turn to put the station behind of the wing tip.
- If getting further from the station than desired, turn to put the station ahead of the wing tip.
- Technically speaking, correct 10° for each ½ mile outside the arc, and 5° for each ½ mile inside the arc.

Since a graphic presentation of the station's position is important to flying a DME arc, do not attempt this maneuver with the bearing indicator inoperative.

For most DME transitions, a lead of approximately 10 degrees will be adequate for turning from the arc to the final approach course (at 15 NM from the station, 10 degrees of arc is equivalent to 2½ NM).



DME Arcs

DMEARCS

MANEUVERING SPEEDS

The flap maneuvering speed schedule provides the maneuvering speeds for various flap settings. When recommended procedures are followed the flap maneuvering speed schedule provides adequate buffet margin for an inadvertent 15° overshoot beyond the normal 30° bank.

These speeds provide:

- A deck angle, which will provide increased forward visibility for traffic separation in VMC.
- A higher than minimum maneuver margin.
- A thrust requirement, which is at or near, the minimum required to sustain level flight (maximum fuel efficiency).
- A speed, which can be maintained with minimal thrust changes when the aircraft is maneuvering in a bank.

③ 3 5 Flap Maneuvering Speed Schedule (V_M)

FLAP POSITION	AT & BELOW 117,000 LBS.	ABOVE 117,000 LBS.
Flaps 0	210	220
Flaps 1	190	200
Flaps 5	180	190
Flaps 10	170	180
Flaps 15	150	160
Flaps 25	140	150

Note: Target speed provides 25 degree bank capability with a 15 degree overshoot protection.

7 8 9 Flap Maneuvering Speed Schedule (v_M)

Flaps 0	V_M Flaps 0 Speed Bug
Flaps 1	V_M Flaps 1 Speed Bug
Flaps 5	V_M Flaps 5 Speed Bug
Flaps 10	V_M Flaps 10 Speed Bug
Flaps15	V_M Flaps 15 Speed Bug
Flaps 25	V_M Flaps 25 Speed Bug

Note: Target speed provides 25 degree bank capability with a 15 degree overshoot protection.

Initial pattern entry will be in a clean configuration. Slow to appropriate VM flaps 0 speed prior to entering an airport traffic area. Flaps will be extended to the next setting prior to decelerating below VM for the existing flap setting.

Note: Flap maneuver speeds provide approximately 15 to 20 knots above the minimum maneuvering speed for each flap setting.

For normal traffic patterns and approaches, the internal (salmon colored) airspeed bug should be progressively set to the flap maneuvering speed for each flap position during flap extension. The Pilot Flying should call "FLAPS ______, SPEED" when flaps are required to be extended to the next flap position. This call will not be made until the aircraft is below the maximum flap extension speed for the desired flap position.

While not prohibited, the use of speedbrakes with the flaps extended should be avoided due to aircraft buffet. Speedbrake should not be deployed with the flaps extended beyond 15°. High sink rates during the approach should be avoided, and speedbrake usage must be terminated by no lower than 1000 feet AGL.

When operating in an autothrottle speed mode, timely speed selections will minimize thrust lever movement during the approach, reducing cabin noise levels and increasing fuel efficiency. When flaps and landing gear are extended, be prepared to select the next lower speed just as the additional configuration drag takes effect. Delaying the speed selection will cause an increase in thrust, while selecting the lower speed too quickly will cause thrust to decrease, then increase.

Normally, the landing gear should not be extended until after flaps 5 have been extended. However, if additional drag is required landing gear extension may be accomplished at any time below 270 knots.

AUTOTHROTTLE

In all cases other than a Dual-Channel approach and autolanding with **FLARE** annunciated on the FMA, the autothrottle must be disconnected prior to:

- Non Autoland Precision Approaches: No lower than 50 ft. AGL.
- Non Precision or Visual Approaches: No lower than 100 ft. AGL.

The characteristics of the Autothrottle Landing Flare Retard Mode are not intended, nor are they predictable enough, for landing with manual aircraft control inputs.

At 400 feet RA and below, autothrottle is placed in a rapid engine acceleration range.

When the autothrottle is disconnected, at any point prior to touchdown, it is imperative that the target speed reflects the full wind correction (1/2 of the reported steady wind plus the full gust increment not to exceed plus 3 3 5 7 20 knots 8 9 15 knots to V_{REF}). The minimum target speed will be V_{REF} + 5 knots.

Should a missed approach become necessary after the Captain has taken control, the Captain will fly the missed approach.

Caution: During low visibility, the touchdown point may not be visible to the pilot at decision height. Be aware of the tendency to "duck under" the glideslope when this condition exists.

Note: When the autothrottle is planned throughout approach and touchdown, position the internal bug to V_{REF} + 5 knots, regardless of wind speed. The autothrottle design features include automatic gust compensation. Therefore, it is not necessary to set gust or wind strength corrections on the speed selector. The system will handle the normal wind conditions encountered during the final approach and landing. However, flight crews must be alert for any unusual or extreme windshear conditions and be ready to take manual control of the aircraft to complete the approach and landing or execute a go-around.

TARGET SPEEDS

Target speed is the minimum maneuvering speed for the selected landing flaps. Target approach speed is V_{REF} + 5 knots for landing in reported winds of zero to light and variable (up to 10 knots). When landing in higher wind conditions, add ½ the steady wind and the full value of the gust to V_{REF}. The total wind additive should not exceed plus ③ 3 5 7 20 knots 8 9 15 knots.

Example: If the Reported wind 12 Kts gusting to 20 Kts. Target setting is V_{REF} plus 14 knots.

1. ½ of 12 Kts = 6 Kts.
2. The difference between the steady state wind of 12 Kts and the reported gust of 20 Kts is 8 Kts.
3. Add the 6 Kts (Steady State) and 8 Kts (Reported Gust) to obtain the additive of 14 Kts.

Note: V_{REF} speed provides adequate buffet margin for an inadvertent 15° overshoot beyond 15° bank.

This procedure will result in minimal trim and power adjustments. On other types of instrument approaches, the facility and minimums may dictate the point at which the final landing flap configuration is established.

On a visual approach, final landing configuration should be established so as to be stabilized by 1,000' above TDZ. Unstabilized approaches will not be allowed to continue below 500 ft. above field elevation.

STABILIZED APPROACH

The most optimum and consistent landing performance is achieved through the use of a stabilized approach. The optimum stabilized approach is defined as a flight on the glidepath (visual or electronic) at a steady rate of descent, on the "target" approach speed, in the landing configuration, in trim, and with the proper thrust setting. The dynamics of flight often dictate that flight parameters will vary from optimum. However, experience has shown that a stabilized approach is essential for a safe operation.

Approaches will be considered unstable, and result in a missed approach if:

1) The airspeed is greater than +15 knots or less than –5 knots from target speed, OR
2) Vertical speed is greater than 1500 ft/min., OR
3) Engines are less than minimum spooled. (At least 40% N_1)

For aircraft operating in VMC, these parameters must be met before reaching 500 ft. above touchdown zone elevation. In IMC, these parameters must be met before reaching 1000 ft. above touchdown zone elevation, or a go-around will be announced by the Pilot Monitoring.

The decision made when passing DH, DA, DDA or MDA is not a commitment to land. It is only a decision to continue the approach. It is possible, after passing the applicable minimums, that visual references may deteriorate, or the aircraft may deviate from the desired flightpath to a point where a safe landing may not be assured. A missed approach capability exists until selection of reverse thrust.

ALTITUDE CALLOUTS

Altitude callouts for non-precision and CAT I precision approaches will be made using the barometric (electric) altimeters by the Pilot Monitoring.

The callouts will be:

- At 1000 feet above touchdown zone (TDZE), callout "1000."
- At 500 feet above TDZE and at each 100-foot increment thereafter, call out altitude and any significant deviation from target airspeed or descent rate.

  Note: A significant deviation from airspeed is ±5 knots from computed target speed. A significant deviation in vertical velocity is a descent rate of 1000 FPM or greater.
- Call "APPROACHING MINIMUMS" approximately 100 feet prior to DH, DA or DDA on instrument approaches, as applicable.
- At DH, DA or DDA/MDA Pilot Monitoring will call "MINIMUMS" (non-monitored approach).
- During a CAT I or Non-Precision approach (unmonitored), the Pilot Monitoring will inform the Pilot Flying when he/she acquires either a portion of the approach lighting system and/or the runway by stating "APPROACH LIGHTS IN SIGHT" and/or "RUNWAY IN SIGHT" as appropriate.
- "100, 50, 30, 20, 10" FROM THE RADIO ALTIMETER (note the word "feet" is not part of the callout).

  ③ The altitude calls below 100 feet are accomplished by the pilot monitoring.

DECISION ALTITUDE (DA) / DERIVED DECISION ALTITUDE (DDA) / MINIMUM DESCENT ALTITUDE (MDA)

Do not continue the approach below DA / DDA / MDA, as read from the barometric altimeter, unless the aircraft is in a position from which a normal descent to the runway of intended landing can be made.

The callouts “APPROACH LIGHTS” and/or “RUNWAY IN SIGHT” are informative only. When conducting non-precision and CAT I ILS approaches, descent below the applicable DA / DDA / MDA requires that one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot:

- The approach light system, except that the pilot may not descend below 100 feet above the TDZE using the approach lights as a reference unless the red terminating bars or the red side row bars are also distinctly visible and identifiable.
- The threshold.The threshold markings.
- The threshold lights.
- The runway end identifier lights.
- The visual approach slope indicator.
- The touchdown zone markings or touchdown zone lights.
- The touchdown zone lights.
- The runway or runway markings.
- The runway lights.

Decision Height (DH)

When conducting CAT II ILS approaches, descent below the DH, as read from the radio altimeter, requires that:

- The approach light system be in sight, and
- Sufficient visual references exist to maneuver the aircraft, or monitor the autoflight system, to a safe landing within the touchdown zone.

When conducting CAT IIIA ILS approaches, descent below the DH, as read from the radio altimeter, requires that:

- Sufficient visual references exist to ensure the autoflight systems will safely deliver the aircraft to the touchdown zone, and
- RVR requirements are met.

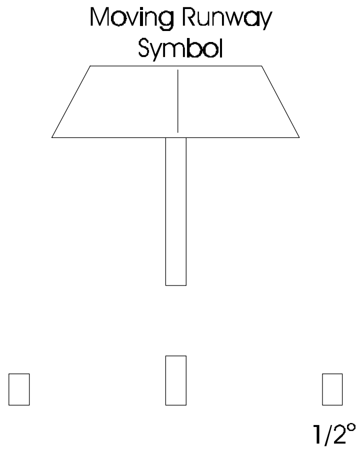
RAW DATA / FMS DISPLAY

The MAP display normally allows for maximum situational awareness. LNAV and VNAV may be used in the terminal area when transitioning to published approach segments; however, raw data must be monitored, if available. The final approach segment of ILS, LOC, LOC BC, LDA SDF and VOR approaches will be flown with direct reference to navaid raw data as follows:

- The display and tracking of ILS, LOC, LDA, and SDF raw navaid data is required prior to either glideslope intercept or the FAF as applicable. This requirement may be met by displaying any combination of MAP, Full or expanded VOR/ILS, since the ADI displays the tuned navaid raw data.

  Note: When the course deviation on the EADI is slightly more than ½ dot and the VOR/LOC or APP mode is engaged, the scale expands to ½ degree deviation per dot. This expanded mode means that as the moving runway symbol reaches full scale deflection in the expanded mode the aircraft has reached approximately 5/8 dot deflection as depicted on the EHSI. The on course definition of one dot does not apply to the expanded mode.

  If the pilot wishes to reference the actual limit of the LOC course the FULL or EXPANDED mode of the EHSI needs to be selected.



EADI Symbology After scale expands

MONITORED APPROACH PROCEDURES

General

It is CAL policy that approaches should be flown coupled using monitored approach procedures when the following conditions exist:

- Precision approaches with an RVR of 2400 feet or less.
- Non-precision approaches with visibility of 1sm mile or less (RVR 5000 or less).

A monitored approach is a procedure that allows each crewmember to concentrate on his/her specific tasks. It utilizes the Quiet Flight Deck method that eliminates all unnecessary conversation. Any calls, other than the normal monitored approach calls, should indicate that an abnormal exists or that a performance limit was exceeded.

Using the monitored approach procedure, the First Officer is assigned the task of flying the aircraft and executing the missed approach, if necessary. This allows the Captain additional time to acquire and assess visual cues prior to reaching DA/DDA/MDA.

If the autopilot is inoperative, the Monitored Approach Procedure should still be used. The First Officer should fly the aircraft manually using CAT I Monitored Approach Procedures. An auto-coupler is required for less than 1800 RVR (CAT II).

If the aircraft and flight crew are autoland capable, Category II approaches will be made using the autoland system. If the approach is being conducted to a Category I facility, use of the autoland system is discretionary.

If the RVR is 2400 feet or less, the flight crew will brief the category of approach having the lowest minimum for which the aircraft, ILS facility, and flight crew are capable of conducting, even if the latest reported weather would permit a category of approach that has a higher minimum.

The approach briefing must be completed prior to beginning the final approach segment. If equipment failure or any unforeseen circumstance necessitates a change in the type of approach to be flown during the final approach segment, a missed approach should be initiated and the new approach re-briefed.

On all monitored approaches, the F/O will brief the approach to be flown and the Captain will brief the required callouts and duties associated with the specific monitored approach.

Note: The items considered minimum briefing by the Captain for the monitored approach are located on the page titled MONITORED APPROACH BRIEFING, this section or the QRH.

Braking action must be reported as "fair" or better for approaches conducted in weather conditions of less than 1200 RVR. Touchdown zone and runway centerline lights must not be obscured by snow or ice when visual references is required.

Because of the requirement for transfer of control, the Monitored Approach procedure is not authorized with an engine inoperative even though a coupled approach is authorized in most instances. In the event an engine has failed and the RVR is 2400 or less, the pilot flying the approach will also make the landing. This will eliminate the transfer of aircraft control at low altitudes with asymmetric thrust.

First Officer Duties

A monitored approach is flown coupled with the First Officer operating the Autopilot and controlling the airspeed with the use of Autothrottle, if operable. The First Officer should assume the flying responsibilities early in the approach but no later than intercept heading or, in the case of a straight in approach, 4 miles outside the outer marker.

The First Officer upon reaching minimums will call "MINIMUMS, GOING AROUND" and execute the missed approach if the Captain has not taken control of the aircraft. The F/O will execute a missed approach any time prior to minimums if directed by the Captain. If the Captain takes control of the aircraft, the First Officer will monitor the flight progress and make appropriate altitude calls.

The normal calls from 100 feet to touchdown are omitted by the PM if the Mode 6 aural alerts for the GPWS altitude callouts are operational.

Captain Duties

During a monitored approach, the First Officer is supervised or "monitored" by the Captain. This includes supervising or monitoring the aircraft as well as the actions of the First Officer.

The Captain will make the following call-outs with reference to TDZE:

- "1,000"
- "500"
- "400"
- "300"
- "200" (CAT IIIA)

- At 100 feet above minimums "APPROACHING MINIMUMS I'M GOING HEADS UP."
- If decision is to land, "I HAVE THE AIRCRAFT."

Keeping call-outs to a minimum creates a Quiet Cockpit concept, allowing increased concentration in the decision regime.

When calling "APPROACHING MINIMUMS, I'M GOING HEADS UP," the Captain will place his/her left hand on the yoke near the A/P disconnect button and right hand aft and below the throttles in anticipation of assuming control.

Prior to or upon reaching minimums, if the Captain has distinctly established at least one of the required visual references, and decides a safe landing can be made, the Captain will call out "I HAVE THE AIRCRAFT," move the First Officer's hand up and away from the throttles. The Captain will assume control of the aircraft, continue the approach and execute the landing. Once the Captain has taken control of the aircraft, the Captain will fly the missed approach if required.

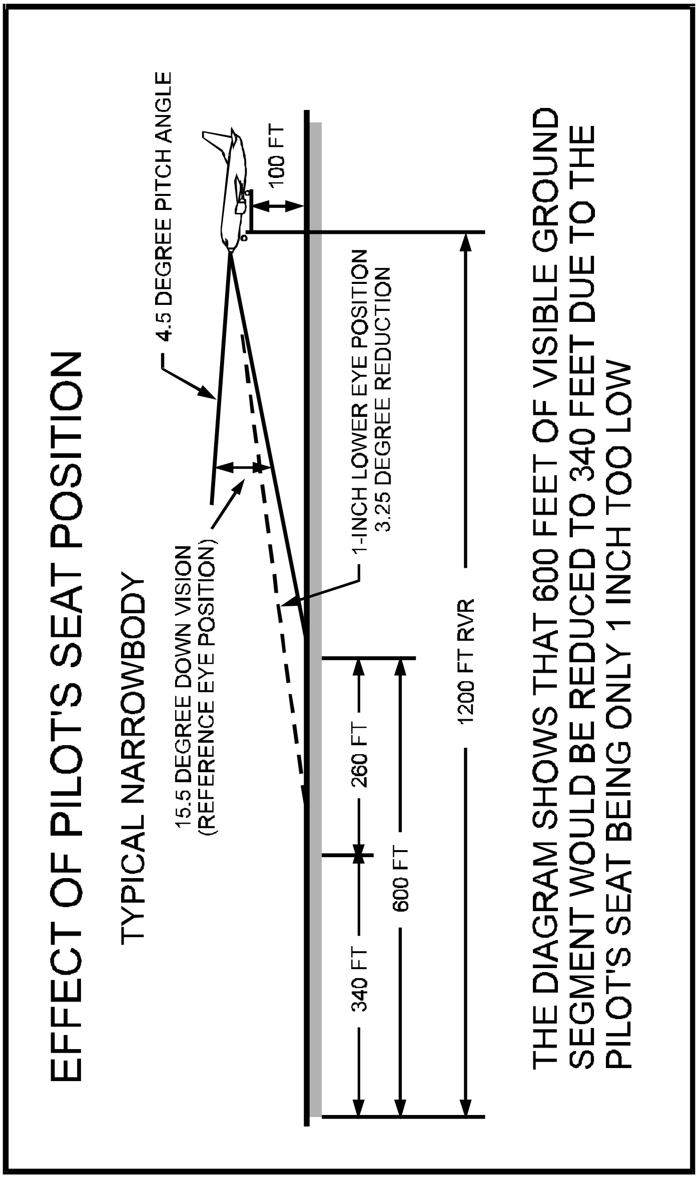
Caution: During low visibility, the touchdown point may not be visible to the pilot at DH / DA / DDA / MDA. Be aware of the tendency to "duck under" the glide path when this condition exists.

The Importance of Visual Cues

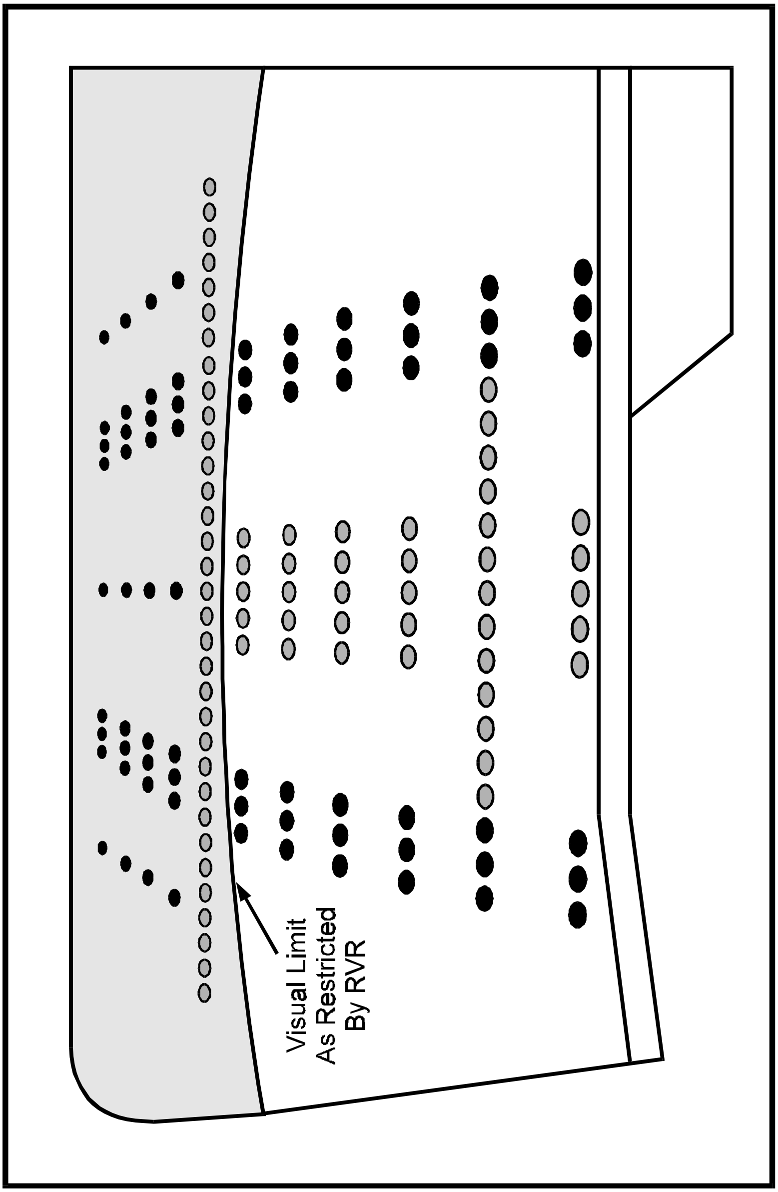
Use of the Autopilot to the minimum authorized altitude is desired to prevent "duck under" and allow the maximum amount of time for acclimation to visual cues prior to Autopilot disconnect.

For Category II / IIIA operations, the importance of increased visual cues prior to and during descent below DH cannot be overemphasized. To improve the forward visual sight picture, a Flaps 40 approach is recommended to reduce the deck angle. DH is defined as a specified height above the elevation of the touchdown zone at which a decision must be made to continue the approach or to initiate a missed approach. At DH the flight crew must be satisfied that the total pattern of visual cues provides sufficient guidance to continue the approach and landing and that the aircraft is tracking so as to remain within the lateral confines of the runway and, if not, they must initiate a missed approach. If the approach is continued, it is imperative that the required visual reference be continuously maintained. Flight crews should realize that visual cues can be lost after DH by encountering shallow fog, snow flurries, or heavy precipitation. Whenever visual cues are lost after DH, the flight crew should immediately initiate a missed approach.

Use of the landing lights is at the option of the Captain. Under certain atmospheric conditions, the use of landing lights will actually reduce visibility at decision height. Flight crews may find it advantageous to delay the use of landing lights until after touchdown.


EFFECT OF PILOT'S SEAT POSITION
TYPICAL NARROWBODY
4.5 DEGREE PITCH ANGLE
100 FT
15.5 DEGREE DOWN VISION
(REFERENCE EYE POSITION)
1-INCH LOWER EYE POSITION
3.25 DEGREE REDUCTION
260 FT
340 FT
600 FT
1200 FT RVR
THE DIAGRAM SHOWS THAT 600 FEET OF VISIBLE GROUND
SEGMENT WOULD BE REDUCED TO 340 FEET DUE TO THE
PILOT'S SEAT BEING ONLY 1 INCH TOO LOW

SEATPOS



VISULRVR

Missed Approach

Upon reaching minimums as indicated by the barometric altimeter, radio altimeter or inner marker (as appropriate), if the Captain has not called out “I HAVE THE AIRCRAFT,” the First Officer will execute a missed approach. First Officer will call out “MINIMUMS, GOING AROUND” (see GO-AROUND PROCEDURES this section).

Should a missed approach become necessary after the Captain has called “I HAVE THE AIRCRAFT,” and he has taken control, the Captain will fly the missed approach.

Under no circumstances will a landing be attempted after a go-around has been initiated.

If unable to touchdown in the touchdown zone (first 3,000 feet), go around.

MONITORED APPROACH BRIEFING

DOUBLE OUTLINE AREA SIGNIFIES MINIMUM CREW BRIEF

CALL OUTS FOR MONITORED APPROACHES

CAPTAIN	FIRST OFFICER
“1000” (above TDZE) **“500”** **“400”** **“300”** **“200”** (CAT IIIA only) 100’ above DH / DA / DDA: **“APPROACHING MINIMUMS I’M GOING HEADS UP”** At decision to pass DH / DA / DDA: **“I HAVE THE AIRCRAFT”**	Verify second A/P, if Applicable. **“FLARE ARMED”** (If AUTOLAND) If the Captain has NOT taken control of the aircraft by DH / DA / DDA: **“MINIMUMS, GOING AROUND”**

MANDATORY MISSED APPROACH

BELOW 500 FEET AND ABOVE MINIMUMS	BELOW MINIMUMS
• **FLARE ARMED** not annunciated on the FMA (AUTOLAND only) • Change in approach mode • Loss of required aircraft component • Loss of required ground component • Exceeding a performance limit	• No AUTOLAND (RVR Less than 1200) • RVR below minima at DH (CAT IIIA only) • Loss of required visual references • Not on the runway in the TDZ • Out of normal landing position

APPROACH TYPE	ALTIMETER BUG REFERENCES	
	BAROMETRIC	**RADIO**
NPA (Non-Precision Approach)	DDA or Published DA **CONTROLLING (1)**	250’
CAT I	Published DA **CONTROLLING (1)**	Published DH
CAT II	Published DA	Published RA **CONTROLLING (1)**
CAT IIIA 7 8 9 ONLY	TDZE + 50’	50’ **CONTROLLING (1)**

(1) Altimeter reference from which to execute the missed approach.

MONITORED APPROACH PROCEDURE

APPROACH LIMITS – CAT II / CAT II AUTOLAND / CAT IIIA	
PERFORMANCE LIMITS (500 Feet To Flare)	**WIND LIMITS (Including Gusts)**
• Glideslope deviation not to exceed 1 dot • Localizer deviation not to exceed 1/3 dot on raw data • Airspeed ± 5 kts. of target • Maximum rate of descent is 1,000 FPM • Maximum stabilized crab angle is 10° • No new warning lights or flags allowed • Raw data must match with computed data • No GPWS activation	• Maximum headwind - 20 kts. • Maximum crosswind - 15 kts. • Maximum tailwind - 10 kts. • No LLWAS activation • No reported windshear gain or loss greater than 10 kts.

AIRCREW REQUIREMENTS – CAT II / CAT II AUTOLAND / CAT IIIA

Captain: 100 PIC in Type.

If the Captain has **less than** 100 hours PIC in type, the following crew restrictions apply:

- CAT IIIA Not Authorized
- CAT II Authorized (Autoland required)
- CAT I Authorized (Autopilot required)

AIRPORT REQUIREMENTS– CAT II / CAT II AUTOLAND / CAT IIIA

- Localizer / Glideslope
- Outer and inner marker or authorized substitute
- ALSF-1, ALSF-2 or ICAO equivalent (SFL not required for CAT IIIA)
- High Intensity Runway Lights (HIRL), Touchdown Zone Lights (TDZ), Center Line Lights (CL)
- Full runway length available (reduced runway may be approved by dispatch)

TRANSMISSOMETERS				**VISIBILITY**
RVRs	**CAT I RVR ≥ 1800**	**CAT II RVR < 1800 TO RVR ≥ 1200 (2) RVR ≥ 1000**	**CAT IIIA RVR < 1200 TO RVR ≥ 600 (4)**	**NON-PRECISION APPROACH (NPA) (5)**
TDZ RVR	Controlling	Controlling	Controlling	For Non-Precision Approaches reported visibility is controlling
Mid RVR	Not required / (1) Advisory	Not required / (3) Advisory	Controlling	
Rollout RVR		Not required / (3) Advisory	Required / Advisory	

(1) For CAT I approaches, Mid RVR may be substituted for TDZ if TDZ is not reporting.

(2) CAT II approaches with the published minima of RVR 1000 require an AUTOLAND approach. An AUTOLAND approach is required anytime TDZ RVR is less than 1200.

(3) For CAT II approaches, if TDZ RVR is below 1600 RVR / 500m, an advisory Mid or Rollout RVR must be reported.

(4) For CAT IIIA, approach minimum is per the specific approach plate.

(5) For NPA, if visibility is equal to or less than 1sm or 5000 RVR, a monitored NPA is required.

Note: If conducting an autoland with an RVR ≥ 2400, ATC must be advised. This is to ensure that the ILS critical area will be protected.

Note: With RVRs 2400 feet or less, the flight crew will brief the category of approach having the lowest minimum for which the aircraft, facility and flight crew are capable of conducting.

Note: With RVRs 2400 feet or less, coupled Monitored Approach Procedures should be used.

Note: With RVRs less than 1800 feet, an auto-coupler is required.

Note: Taxi operations in RVR < 600 / 175m, require a SMGCS or ICAO equivalent low visibility taxi plan. When the approach chart is issued with RVRs < 600 / 175m minimums, the airport has an approved plan.

AUTHORIZED RVR – FEET / VISIBILITY (SM) / METERS

FEET	500	600	700	1000	1200	1600	1800	2000	2400	3200	4000	4500	5000
VIS (SM)	-	-	-	-	-	1 / 4	-	-	1 / 2	5 / 8	3 / 4	7 / 8	1
METERS	150	175	200	300	350	500	550	600	720	960	1200	1400	1500

<table>
<tr><th colspan="3">AIRCRAFT REQUIREMENTS</th></tr>
<tr><td colspan="3">Maintenance Status Annunciator: Located on the Captain’s instrument panel indicates aircraft capability, unless further restricted by the MEL, Dispatch Release or Approach Chart.</td></tr>
<tr><th>Approach Type to be Flown</th><th>Maintenance Status Annunciator</th><th>Approach Capability</th></tr>
<tr><td>CAT I</td><td>NOT CAT II</td><td>CAT I</td></tr>
<tr><td>CAT II</td><td>CAT II</td><td>CAT II (Single CH)
CAT I</td></tr>
<tr><td>CAT II AUTOLAND</td><td>CAT II AUTOLAND</td><td>CAT II Autoland
CAT II (Single CH)
CAT I</td></tr>
<tr><td>CAT IIIA 7 8 9 ONLY</td><td>CAT IIIA</td><td>CAT IIIA
CAT II Autoland
CAT II (Single CH)
CAT I</td></tr>
</table>

AIRCRAFT REQUIREMENTS				
EQUIPMENT **R: Required** **NR: Not Required**	**NPA**	**CAT 1**	**CAT II**	**CAT II AUTOLAND – OR- CAT IIIA**
	Coupled / Manual	**Coupled / Manual**	**Coupled**	**Coupled**
AFDS FMA	1	1	2 (1)	2 (1)
Anti-Skid	NR	NR	NR	NR
Autopilot	1 / 0	1 / 0	1	2
Autopilot Disconnect Light	NR	NR	R	R
Autopilot Yoke Disengage Switch	NR	NR	2	2
Autothrottle	NR	NR	NR	R
Autothrottle Disconnect Switch	NR	NR	NR	R
EADI	2 (1)	2 (1)	2 (1)	2 (1)
Electrical Busses	NR	NR	All Powered	All Powered
Engines	1 (2) or 2	1 (2) or 2	2	2
Flight Controls	NR	NR	All Normal	All Normal
Flight Spoilers	NR	If Autoland	If Autoland	R
Flight Director Display	0 / 1	0 / 1	2	2
Generator	1 / 0	1 / 0	2	2
HYD System	A or B / 0	A or B / 0	A and B	A and B
ILS	0	1	2	2
IRU (NAV)	1	1	2	2
Radio Altimeter	0	0	2 (1)	2 (1)
RDMI	NR	NR	2	2
Stab Out Of Trim Light	NR	NR	R	R
Status Annunciator	R	R	R	R
Standby ADI	NR	NR	NR	NR
Thrust Reversers	NR	NR	NR	R
Windshield Wipers	NR	NR	R	R

(1) Must be supplied by separate symbol generators if installed.
(2) Single engine approaches may be flown to NPA or CAT I minimums, but only fly monitored approaches with two engines operating.

MISSED APPROACH PROCEDURES	
MANUAL OR SINGLE AUTOPILOT	**DUAL AUTOPILOT**
• Simultaneously: ⇒ Press either TO/GA switch. ⇒ Manually rotate to initial go-around attitude (15 degrees Nose Up). ⇒ Ensure thrust levers move to required thrust. • Call "FLAPS 15, CHECK POWER." • Call "POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE." • Call "LNAV" or "HDG SEL" • Retract Flaps on schedule.	• Press either TO/GA switch. • The Autopilot rotates the aircraft to initial go-around attitude (15 degrees Nose Up). • Ensure thrust levers move to required thrust. • Call "FLAPS 15, CHECK POWER." • Call "POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE." • Call "LNAV" or "HDG SEL" • Retract Flaps on schedule.

- Prior to the "I HAVE THE AIRCRAFT" call, if any of the required parameters are exceeded, the F/O will initiate the missed approach.
- At the DH, DA or DDA if the Captain has not made the "I HAVE THE AIRCRAFT" call, the F/O will initiate the missed approach.
- After the "I HAVE THE AIRCRAFT" call the Captain assumes responsibility to execute a missed approach if required.

CAUTION: UNDER NO CIRCUMSTANCES WILL A LANDING BE ATTEMPTED AFTER A GO-AROUND IS INITIATED.

LANDING PROCEDURES

- Proper seat height is necessary to ensure optimum flight deck cut-off angle for a visual landing. Approach lights will appear directly in front of the nose in low visibility.
- Approaching the DH, DA or DDA the Captain should place his/her hand on the throttle quadrant below the F/O's in anticipation of the "I HAVE THE AIRCRAFT" call and assuming control of the aircraft.
- To continue below the DH, DA or DDA the pilot must have:

  CAT I and NPA – Sufficient "visual reference to the intended runway."

  CAT II - Sufficient "visual reference with the CAT II lighting system" to safely continue the approach by visual reference alone.

  CAT IIIA - Sufficient "visual reference with the touchdown zone or touchdown lights" to verify landing in the touchdown zone **AND** required RVRs.
- Use of the landing lights is at the option of the Captain. It may be advantageous to delay using the landing lights until after touchdown or not at all.
- Use of the autopilot to minimum authorized altitude is advised.
- The use of flaps 40 increases visibility over the nose and should be used if practical on ILS approaches with RVRs less than 1800.

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PRECISION APPROACHES

GENERAL

A precision approach is one in which electronic glideslope information is available. On approaches incorporating a DA or DH, the aircraft is descended on the glideslope and a decision to either land or execute a missed approach must occur at or before the DA or DH. A decision to continue the approach below the DA or DH requires adequate visual reference as per this section, and the aircraft must be in a position to make a safe landing.

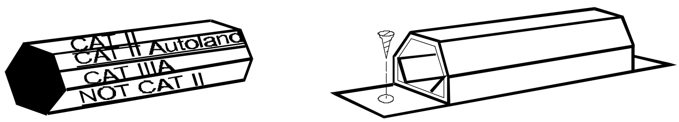
Depending on weather conditions, an ILS can be accomplished with raw data, with the flight director, or with the autopilot approach coupler.

If weather conditions are below 4000 RVR or ¾ mile visibility; a flight director must be used, or a coupled approach must be made.

ILS approaches in weather conditions above 2400 RVR may be hand flown at pilot's discretion, however a flight director must be used.

MAINTENANCE STATUS ANNUNCIATOR

The mechanical Maintenance Status Annunciator is located on the Captain's instrument panel. The status annunciator is used to indicate the maintenance status of the aircraft in terms of the lowest minima authorized in conjunction with the Minimum Equipment List. The following nomenclatures will be indicated by the mechanical status indications.



STATUS INDICATIONS

1.CAT II 2.CAT II Autoland 3.CAT IIIA 4.Not CAT II

CAT2 3

Maintenance Status Annunciator	Approach Capability
NOT CAT II	CAT I
CAT II	CAT II (Single CH) CAT I
CAT II Autoland	CAT II Autoland CAT II (Single CH) CAT I
CAT IIIA	CAT IIIA CAT II Autoland CAT II (Single CH) CAT I

STANDARD ILS PROCEDURES

The transition to the approach may be completed using LNAV and VNAV if a complete arrival procedure to the localizer and glideslope capture point has been selected via the CDU. If so, the LEGS page sequence and altitude restrictions must reflect the ATC clearance. Prior to each altitude change point in the approach procedure, a lower altitude must be set in the ALT SELECT window. If this step is delayed beyond the altitude change point, the VNAV mode will disengage and ALTITUDE HOLD will engage. ATC imposed airspeed restrictions may require the use of LVL CHG or VERTICAL SPEED.

Note: ③ 3 5 Prior to commencing the approach both pilots must select MANUAL on the AUTO/MANUAL tuning switch (VHF NAV radio panel), and select the desired frequency for the approach.

The VHF NAV unit on the same side as A/P in use or side with the illuminated Master (**MA**) light, must be tuned to the primary approach facility. The remaining NAV unit may be used for determination of intersections and continued enroute navigation when necessary. Both units should be tuned to the primary approach facility as soon as conditions permit.

Note: GO-AROUND mode (GA) is armed when the radio altitude is less than 2000 feet. Below this altitude, an unintentional TO/GA switch activation will interrupt the approach routine, as the AFDS and A/T commence the go-around function.

When turning to the localizer intercept heading, and when cleared for the approach, the pilot should select the APP mode and observe the **VOR/LOC** and **GS** armed annunciations on the FMA.

The flight mode annunciator will always annunciate the A/P mode. The A/P on the same side as the Pilot Flying should be engaged. This will give the Pilot Flying and the engaged A/P the primary navigational and FMA display.

After selection of APP mode the second autopilot may then be engaged as desired for the type of approach. After the APP mode has been selected, if a single autopilot is engaged and A/P changeover is desired, the A/P must be disengaged, then the desired A/P engaged.

Flight Director

When the A/P is in CWS or OFF and both F/D's are ON, the Captain's flight mode annunciator is driven from the "A" FCC and the First Officer's flight mode annunciator is driven from the "B" FCC when in the approach mode after localizer capture. In all other modes, both flight mode annunciators are driven from the FCC associated with the first F/D turned on.

The Captain's F/D command bars are always driven from the "A" FCC. The F/O's F/D command bars are always driven from the "B" FCC. Both F/Ds should be ON for the approach to provide F/D guidance in the event of a go-around. (The Pilot Flying should place his F/D switch ON first.)

Final Approach

A 45-degree or less intercept angle is optimum. Higher intercept angles and airspeeds may cause course overshoot. The APP mode should be armed prior to being within 5 degrees of course centerline. Otherwise the adaptive capture feature may not be able to capture the course correctly, resulting in undesirable overshoots.

Approach mode selection arms the AFDS to capture the localizer and glideslope. It must be engaged for dual or single channel autopilot precision approach operations. The approach mode enables dual autopilot selection if desired. After setting the localizer frequency and course, pressing the APP switch selects the APP mode. The APP switch illuminates, subsequently arming both VOR LOC and GS and permits selecting CMD on the second A/P. If the second autopilot is engaged, it should be available for automatic engagement after LOC and GS capture and descent below 1500 feet RA.

Upon localizer capture, **VOR LOC** annunciates. **SINGLE CH / 1 CH** is annunciated for A/P status, the previous roll mode disengages and the aircraft turns to track the localizer signal.

Localizer capture occurs at a variable point dependent on intercept angle, speed and localizer deviation and rate, but never at less than ½ dot. During localizer capture, bank limit is 30 degrees regardless of bank limit selection.

After localizer capture, select a heading to match the approach course heading. Maximum bank angle is reduced to 8 degrees after LOC capture.

Localizer False Course Capture

Auto Flight Control System (AFCS) equipped aircraft cannot be totally protected from false localizer captures. False captures are short lived deviations because they will not be followed when the published localizer course signal guidance becomes valid.

False localizer course captures can occur at azimuths anywhere from 8 degrees to 12 degrees azimuth from the published localizer course. This equates to approximately 1.3 NM when intercepting the localizer at 10 NM from the threshold.

Pilots should use all available navaids and the FMCS to ensure the correct localizer course is captured. Should a false localizer course be captured, it may be necessary to deselect and re-arm the APP mode in order to intercept the correct localizer course. If both LOC and GS have captured, the APP mode can be exited only by pressing a TO/GA switch or by disengaging the A/P and turning off both F/D switches or retuning a VHF nav receiver or manual override to CWS pitch.

The aircraft must be stabilized on the localizer and glidepath prior to descending below 1000 feet above TDZE if in IMC.

RAW DATA

- ③ ILS navigation signals are displayed on the ADI and HSI when the appropriate HSI switch is in VOR/ILS.
- 3 5 7 8 9 ILS navigation signals are displayed on the EADI. The same signals are displayed on the HSI when the display mode is selected to FULL or EXP VOR/ILS.

The course deviation display on the ADI (Runway Symbol) will indicate only 1 dot deviation from the ILS beam center. On the EFIS EADI the normal localizer deviation scale is one degree per dot. When the course deviation on the EADI is approximately $^5/_8$ degree deviation ($^5/_8$ dot) and the VOR/LOC or APP mode is engaged, the scale automatically expands to ½ degree deviation per dot. The course deviations on the HSI/EHSI indicate the full 2 dot deviations from the ILS beam center. Additional ILS raw data can be displayed on the standby horizon (EFIS aircraft) when the ILS position is selected.

The HSI/EHSI is the primary navigation instrument used during a raw data ILS approach. Lateral navigation is performed by maneuvering the aircraft so as to place the HSI/EHSI aircraft symbol in the correct relationship to the course deviation bar. The course deviation bar will represent the ILS localizer when the localizer front course is selected using the course selector.

Flaps 5 or flaps 10, and appropriate maneuvering speed, is recommended when maneuvering to intercept the localizer.

When inbound in the procedure turn the localizer intercept angle can be easily determined by the relationship of the symbolic aircraft to the course deviation bar. Keep the nose of the symbolic aircraft pointed at the top of the course deviation bar. This will place the aircraft on the correct intercept angle / course with very little reference to the actual heading required.

As the course deviation bar starts to center, bank the aircraft to keep the nose of the symbolic aircraft pointed at the top of the course deviation bar. This technique will provide a very smooth intercept and roll out on course. In a crosswind, it will be necessary to adjust the heading a few degrees into the wind. The track indicator in the HSI may be used to help establish the proper drift correction.

To make corrections back toward the course deviation bar, bank toward the bar until it starts moving toward the center, then level the wings. To stop an inward movement of the bar, bank away from it until it stops, then again level the wings. Large bank angles will rarely be required while maneuvering to track the localizer. Use only a 5 to 10 degree bank angle.

ADF magnetic bearing information, when appropriate, should be referenced on the RDMI's to supplement and enhance initial course intercept and outer marker reference.

COURSE GUIDANCE

The final approach segment of a Category I/II/IIIA ILS begins at the point in space on the localizer course where the published glideslope intercept altitude (height) intersects the nominal glidepath. Descent on the final approach segment must never be initiated until the aircraft is within the tracking tolerance of the localizer. The ILS obstacle clearance criteria assume that the pilot does not normally deviate from the centerline more than a half scale deflection (1 dot), as referenced on the HSI, after being established on track. Failure to remain within this tolerance, combined with failure to remain within the glideslope tolerances, could place the aircraft outside protected obstacle clearance airspace.

During the final approach segment, the following recommended parameters apply:

- Localizer deviation: +/- 1 dot
- Glideslope deviation: +/-1 dot
- Airspeed: -5/+10 knots of target

Exceeding any of the above listed parameters is indicative of an unstabilized approach. Deviations from the localizer and/or glideslope parameters are acceptable only for brief periods of time, and only if positive action is being taken to correct the deviation. It is recognized that ATC instructions often necessitate airspeeds higher than optimum during the initial portions of an ILS approach. When operationally desired, higher than normal airspeeds can be flown until the aircraft is in the stabilized approach regime. Unstabilized approaches must not be allowed to continue below 500 feet above field elevation in VMC conditions, or below 1000 feet above field elevation in IMC conditions.

Limitations and restrictions while conducting Category II and IIIA approaches are, in many cases, more restrictive. Refer to the Category II and IIIA portion of this section for specific guidance.

SINGLE CHANNEL APPROACH – SINGLE AUTOPILOT

When 1 ½ dots below glideslope and below maximum flap extension speed, announce "GEAR DOWN, FLAPS 15, SPEED, LANDING CHECKLIST."

At glideslope capture, verify proper mode annunciation, and check N_1 cursor driven to go-around limit.

Continue flap sequencing and call "FLAPS ____, TARGET," as necessary for landing. Set MCP speed selector to the appropriate target speed.

Note: The above profile will result in glideslope intercept and aircraft configuration for landing with minimum power adjustments assuming the aircraft has all systems operating and no unusual ATC considerations exist. The pilot flying may modify the profile as necessary to meet the needs of the situation.

CAUTION: Due to speed requirements imposed by ATC or for other reasons, flap extension(s) may not be possible under normal profile procedures. Pilots must not call for or physically extend flaps above maximum flap extension speeds.

- G/S Capture

  Glideslope capture occurs at approximately 2/5 dot deviation. On 3 5 7 8 9 the G/S cannot be captured prior to localizer capture.

  Note: Glideslope may be captured from above. However, the selected altitude must be set sufficiently below the anticipated G/S intercept altitude to preclude entering ALT ACQ mode prior to G/S capture.

  WARNING: With the autopilot engaged, if the glideslope is captured from above, the autopilot may pitch over abruptly and could cause a hazard to personnel not strapped into their seats.

  At this point the following occur:

  1. FMA pitch mode annunciates **G/S** (green).
  2. ALT HOLD and ALTITUDE ALERT deactivate.
  3. APP mode switch extinguishes indicating APP mode can only be deactivated by disengaging the A/P and both F/D's, detuning the ILS, manual override to CWS pitch, or pressing TO/GA.
  4. N_1 limit annunciates **GA**.
  5. A/T maintains selected speed using GA N_1 limits.

Missed approach altitude should now be selected with the altitude selector.

- Decision Altitude

SINGLE CH / 1 CH autopilot operation is authorized to FAA Category II minimums. The Pilot Flying disengages the autopilot by pressing the A/P DISCONNECT switch, located on the wheel, no lower than 50 feet radio altitude. Disengagement results in a flashing red **A/P DISENGAGE** light and an aural warning. A second activation of the switch resets the light and the horn. The disengage light and aural warning remain active for a minimum of two seconds. The remaining portion of the approach including flare and decrab (if necessary) is performed manually.

Flight director guidance is available until reaching 50 feet RA at which time the F/D bars bias out of view.

- Go-Around (G/A)

F/D and autothrottle G/A is available any time below 2000 feet. No autopilot G/A is available from a SINGLE CH / 1 CH approach.

To execute the go-around, press either TO/GA switch. The autopilot automatically disengages and **G/A** is annunciated. The F/D commands 15 degrees nose up and the A/T advances to achieve a nominal climb rate.

Manually rotate to G/A attitude and retract the flaps to the 15°. Speed command automatically sets to a precomputed maneuvering speed for the selected flap position. If full G/A thrust is desired after thrust for the nominal climb rate has been established, press TO/GA a second time. The A/T then advances to G/A limit.

Above 400 feet radio altitude with the F/D switches ON, other F/D modes may be selected. Select HDG SEL or LNAV as appropriate.

Approaching the MCP selected go-around altitude, FMA annunciates **ALT ACQ**, and **MCP SPD** and the A/T reduces to climb limit. If TO/GA was initiated with F/D switches OFF, F/D TO/GA operation will terminate approaching MCP altitude and the command bar(s) will retract from view unless an autopilot is re-engaged or at least one F/D switch is placed ON prior to ALT ACQ.

The A/P may be re-engaged above 1000' AGL at pilot's discretion after the aircraft is in trim. Normal mode selection is available.

Note: If A/P is re-engaged during TO/GA, AFS engages in LVL CHG and HDG SEL. A/T will reduce to CLB limit.

DUAL CHANNEL APPROACH (AUTOLAND) – DUAL AUTOPILOT

When cleared for the approach the APP mode should be armed. At this time the second autopilot (autopilot A) should be engaged.

Note: The dual autopilot operation provides fail passive control through landing flare and touchdown or automatic go-around. During fail passive operation, the flight controls respond to the autopilot commanding the lesser control movement.

- G/S Capture

  G/S capture occurs as described under SINGLE CH / 1 CH operation. The first channel engaged in COMMAND will capture the glideslope in dual channel operation.

  Approximately ten seconds after glideslope capture and below 1500 feet RA, the second engaged autopilot pitch channel is engaged and the ILS Deviation Warning Test is performed. After the ILS Deviation Warning Test has been completed, the second channel is fully engaged. The **SINGLE CH** annunciation disappears and **FLARE ARMED** is annunciated. The pitch and roll axes cannot be overridden into CWS during dual autopilot operation. Manual override of the Autopilots will result in Autopilot disengagement. If an autopilot fails the test, it will automatically disengage. Additionally, if a system failure occurs during dual channel operation, the inputs from the malfunctioning channel will be countered and canceled out by the other channel and the autopilot will automatically disengage. If weather minimums require dual channel autoland, immediately initiate a missed approach. Autoland is not certified with SINGLE CH / 1 CH operation.

- 1000 Feet Above TDZE (Barometric)

  Verify second autopilot has been engaged.

- 800 Feet Radio Altitude

  The second autopilot must be engaged in COMMAND by this point. If the second autopilot has not been engaged by 800 feet, it is locked out.

  The **A/P DISCONNECT** warning light on each FMA illuminates steady red if the stabilizer is out of trim below 800 feet in a dual channel approach. Check that this light is extinguished at 500 feet and terminate the dual channel approach if the light is illuminated at any time.

- 500 Feet Above TDZE (Barometric)

  FLARE must be checked for annunciation. If not annunciated, the dual approach should be terminated, as beam-tracking accuracy cannot be guaranteed.

  The 500-foot required callout shall be answered by the First Officer with "FLARE ARMED" if applicable.

- 500 Feet Radio Altitude

  The A/P DISCONNECT warning light on each FMA illuminates steady red if the stabilizer is out of trim below 800 feet in a dual channel approach. Check that this light is extinguished at 500 feet and terminate the dual channel approach if the light is illuminated at any time.

- 400 Feet Radio Altitude

  The stabilizer is automatically trimmed an additional amount nose up at this point, and is complete within 20 seconds. Should an A/P fault occur after the mis-trim takes place, the aircraft will begin to pitch up even before automatic disconnect occurs. After automatic disconnect, the Pilot Flying will typically find that a slight push on the column is required to maintain constant flight path. If the disconnect occurs in flare, it may not be necessary to take any corrective action as the aircraft will tend to "flare" by itself.

  If FLARE is not armed by approximately 350 RA, both A/Ps automatically disengage.

  The A/T is placed in the rapid acceleration range.

- Flare

  The FLARE command is a function of radio altitude and starts at approximately 50 RA and results in a gradual reduction in flight path angle to touchdown. The sink rate at touchdown will be 150 feet per minute. The touchdown will be approximately 450 feet past the glideslope transmitter.

  At 27 feet RA, the A/T annunciates RETARD and closes the thrust levers at a rate which will reach the closed position in six seconds (approximately at touchdown).

  Approximately two seconds after touchdown the A/T disengages automatically.

  After touchdown, the autopilots should be disconnected.

- A/P Go-Around Mode

An automatic go-around mode is enabled in dual channel operation when **FLARE** is annunciated. Selection of the mode is through the TO/GA switches. The G/A mode is available after **FLARE** is annunciated until the A/P senses touchdown.

Note: If the GA mode is selected after touchdown and prior to A/T disengagement, the A/Ps will disengage and the A/Ts may command GA thrust.

- Pitch Go-Around Control

When TO/GA mode is selected, the thrust levers advance toward the reduced go around N_1. The autopilot initially commands a 15 degree nose-up attitude, and the airspeed cursors display maneuvering speed for the flap setting. When a programmed rate of climb is established, the A/P controls pitch to hold airspeed based on the flap maneuvering speed.

The pitch mode cannot be changed from TO/GA unless sufficient nose down trim has been input to allow for single A/P operation. This nose down trim is automatically added to reset the trim input that occurred at 400 feet RA and 50 feet RA. If the pitch mode is the first to be changed from TO/GA, the selected pitch mode engages in single A/P operation and is controlled by the A/P which was first in CMD. The second A/P disengages and the roll mode changes to CWS R.

With pitch engaged in TO/GA, ALT ACQ engages when approaching the selected altitude, and ALT HOLD engages at the selected altitude if the stabilizer position is satisfactory for single A/P operation.

The transition from TO/GA to ALT ACQ is normally successful if the selected altitude is at least 1,000 feet above the TO/GA engagement altitude. A higher selected altitude may be required if full GA thrust is used.

If stabilizer trim is not satisfactory for single A/P operation, ALT ACQ is inhibited and the A/P disengage lights illuminate steady red and pitch remains in TO/GA. To extinguish the A/P disengage lights, a higher altitude may be selected if available, or the A/Ps may be disengaged.

- Roll Go-Around Control

When the TO/GA mode is selected, the autopilot will maintain the existing track.

When above 400 feet radio altitude, other roll and pitch modes may be selected. If a pitch mode is selected, the autopilot reverts to single channel.

During the missed approach procedure, at 1000' AGL when "level change" is selected the " last" autopilot engaged will disconnect. This will be autopilot "A" under normal operations, and if the Captain flies the missed approach, autopilot "B" will be the master. All autopilot input will be received from the First Officers navigation receiver and Flight Director.

DUAL CHANNEL (AUTOPILOT) APPROACH AND GO-AROUND WARNINGS

WARNING	WHEN	CAUSE	PILOT RESPONSE	
			VMC	IMC
Steady red A/P disengage warning light	Below 800' RA during approach	Stabilizer out of trim	Disengage A/P and execute manual landing or go-around	Disengage A/P and immediately execute manual go-around
	During GA	Elevator position not suitable for single channel operation	Disengage A/P and execute manual level off OR select higher go-around altitude	
No FLARE arm annunciation	500' above field elevation during approach	Pitch and roll monitors may not be enabled, or only first A/P channel up is engaged	Disengage A/P and execute manual landing	Disengage A/P and immediately execute manual go-around
Flashing red A/P disengage warning light and aural warning	Below 800' RA during approach	A/P disengagement	Disengage A/P and execute manual landing or go-around	Disengage A/P and immediately execute manual go-around
Flashing red A/T disengage warning light	Any time	A/T disengagement	Disengage A/P and execute manual landing or go-around	Disengage A/P and immediately execute manual go-around

Category I / II / II (AUTOLAND) / 7 8 9 IIIA Low Visibility Approach Procedures

Category I / Category II / II (AUTOLAND) / IIIA ILS low visibility approaches (RVR at or below 2400) will be autopilot coupled, monitored approaches with the First Officer controlling the autopilot. The Captain will autoland or manually land the aircraft if the required visual cues are attained at or before DA/DH.

CATEGORY	I	II	IIIA
RVR	≥ 1800	< 1800 ≥ 1200* *(≤ 1000 if published as the approach minima)	< 1200 ≥ 600
DA/DH	DA ≥ 200	DH < 200 DH ≥ 100	DH < 100

Note: CAT II approaches with the published minima of RVR 1000 require an AUTOLAND approach. An AUTOLAND approach is required anytime TDZ RVR is less than 1200.

Basic Operating Rules

- Aircraft equipment requirements must be met. Refer to The Monitored Approach Briefing Guide, this section.
- No Category II / II (AUTOLAND) / IIIA ILS approaches will be made when winds (including gusts) exceed:

Headwind:	20 knots
Crosswind:	15 knots
Tailwind:	10 knots

If LLWAS or windshear with airspeed gain or loss greater than 10 knots is reported, CAT II and CAT IIIA approaches will not be flown.

Localizer Tracking

When performing an actual CAT II / IIIA ILS approach and landing, flight crews should closely monitor autoflight systems and ILS raw data during the approach to ensure proper localizer tracking. The following operating practices, when conditions permit, will significantly improve localizer tracking and provide touchdown closer to runway centerline:

- Prior to approach, check rudder and aileron trim before engaging Autopilot.
- Maintain symmetrical thrust on both engines throughout the approach.
- When air traffic control will permit, intercept the localizer at an angle not greater than 45 degrees.
- Capture the localizer not less than 8 miles from runway threshold.
- Capture the localizer at a speed no greater than V_M Flaps 5.
- Capture glideslope at or above 1,500 feet AFE.
- Aircraft should be stabilized on localizer and glideslope before passing outer marker or as soon as possible after passing final approach fix.
- Monitor ILS raw data throughout the approach.

Distortion of Localizer / Glideslope Beam

If distortion or oscillation of the localizer / glideslope beam occurs, the Autopilot system will attempt to follow the signal, resulting in undesirable aircraft response. Erratic ILS signals are easily detected by noting the raw data displays.

Note: There are restrictions on ground and air movements near Category II and III runways during low visibility weather conditions. These ILS Critical Areas are only protected by ATC when weather conditions are less than reported ceiling 800 feet and/or visibility 2 miles. Approach Control and Tower must be advised of "coupled" / "autoland" approaches on initial contact, whenever weather minimums are greater than 800/2. When in doubt of critical area protection, state your intentions. Even though critical area protection is in effect, the possibility of these areas being violated by other aircraft and/or ground vehicles is always present. This may result in guidance "beam bending" (localizer / glideslope) and the possibility of approach / runway excursion. Flight crew must diligently monitor guidance information and be prepared to immediately disconnect the Autopilot during all phases of coupled operations.

Decision Regime Performance Limits

The decision regime is from 500 feet above the TDZE to the ground. Performance limits in the decision regime are:

- Airspeed - Plus or minus 5 knots of target speed.
- Glideslope - Significant deviation not to exceed 1 dot high or low.
- Localizer - 1/3 dot right or left of CDI centered.
- Illumination of any warning / caution light not previously deemed acceptable for the approach - none allowed.

  Note: To avoid distractions or potential confusion when the aircraft is below 500 feet above touchdown zone elevation (TDZE), any initial / new warning light or warning flag that comes into view in the decision regime requires a missed approach even if that warning light or flag would be acceptable under the equipment required section of CAT II / IIIA operations. A warning light or flag that has been identified prior to the decision regime, and does not disqualify the aircraft from a CAT II / IIIA approach, is acceptable in the decision regime.

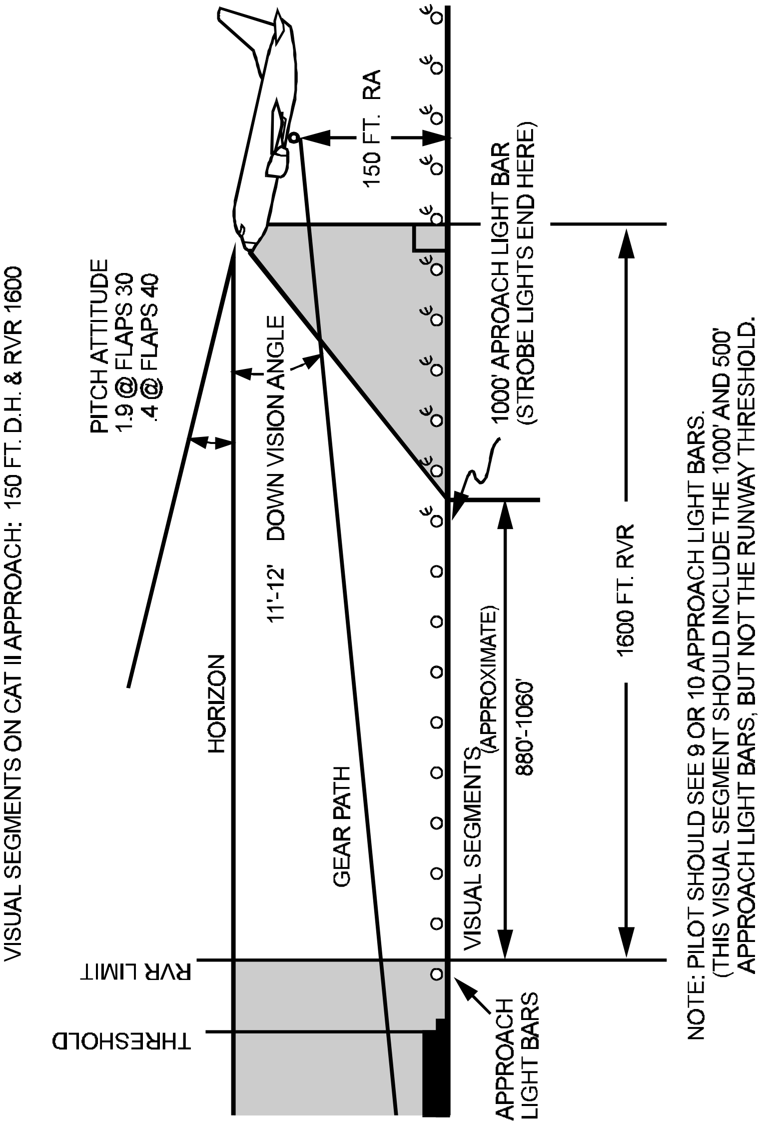
- Raw data must match up with computed data.
- Rate of Descent - Maximum of 1,000 feet per minute.
- Maximum stabilized crab angle of 10 degrees.
- GPWS activation - none allowed.

Any violation of performance limits in the decision regime mandates an immediate go-around. At or above decision height, the Captain will command and the First Officer will execute the go-around. Below decision height, the First Officer will advise of deviations beyond performance limits and the Captain will execute the go-around.

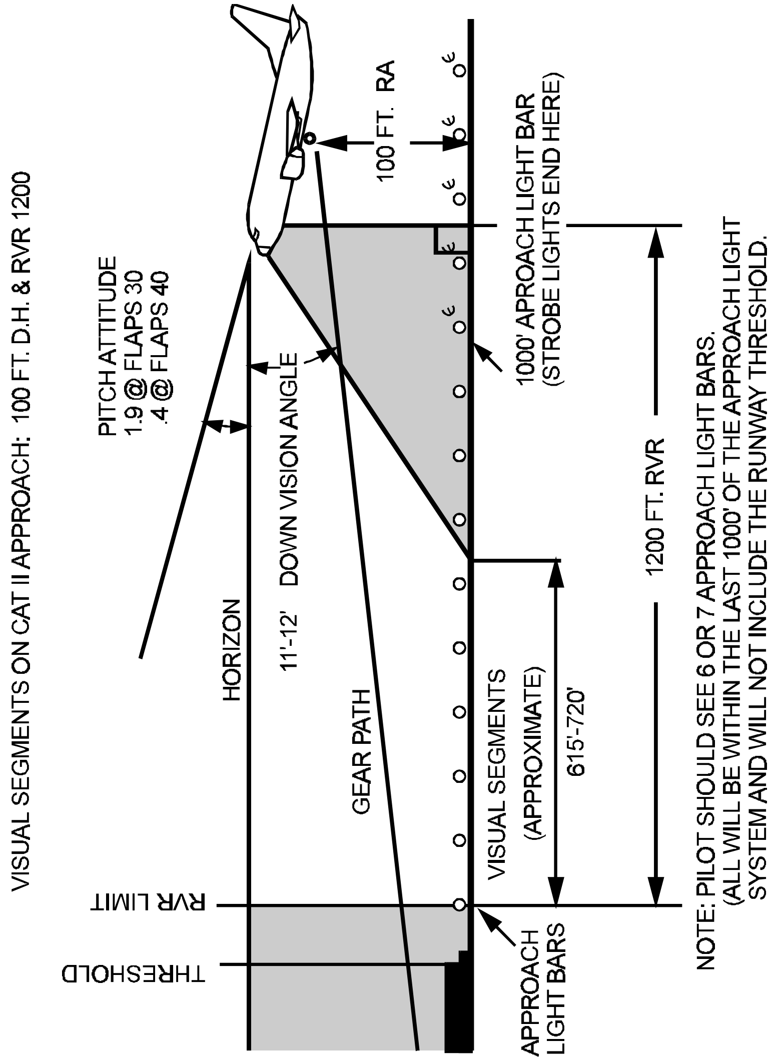
Runway Visual Range (RVR)

A CONTROLLING RVR is one that is used to determine operating minima for the approach. All RVR transmissometers that are controlling are normally required.

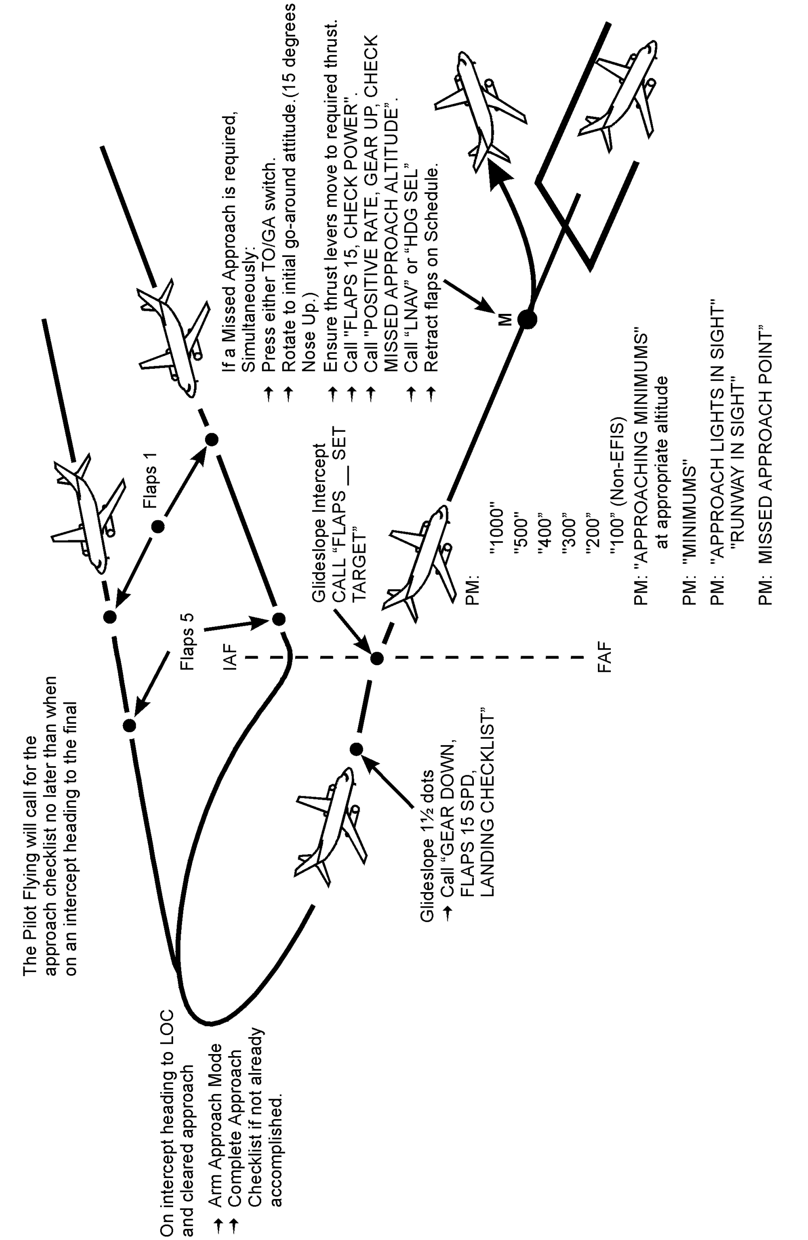
AN ADVISORY RVR is one that does not constitute minima for the approach and provides flight crew information only. Advisory RVR transmissonmeters may or may not be required, depending on the approach category and aircraft capability.


VISUAL SEGMENTS ON CAT II APPROACH: 150 FT. D.H. & RVR 1600
PITCH ATTITUDE
1.9 @ FLAPS 30
.4 @ FLAPS 40
150 FT. RA
1000' APPROACH LIGHT BAR
(STROBE LIGHTS END HERE)
11'-12' DOWN VISION ANGLE
HORIZON
GEAR PATH
VISUAL SEGMENTS
(APPROXIMATE)
880'-1060'
1600 FT. RVR
RVR LIMIT
THRESHOLD
APPROACH
LIGHT BARS
NOTE: PILOT SHOULD SEE 9 OR 10 APPROACH LIGHT BARS.
(THIS VISUAL SEGMENT SHOULD INCLUDE THE 1000' AND 500'
APPROACH LIGHT BARS, BUT NOT THE RUNWAY THRESHOLD.

737CAT2

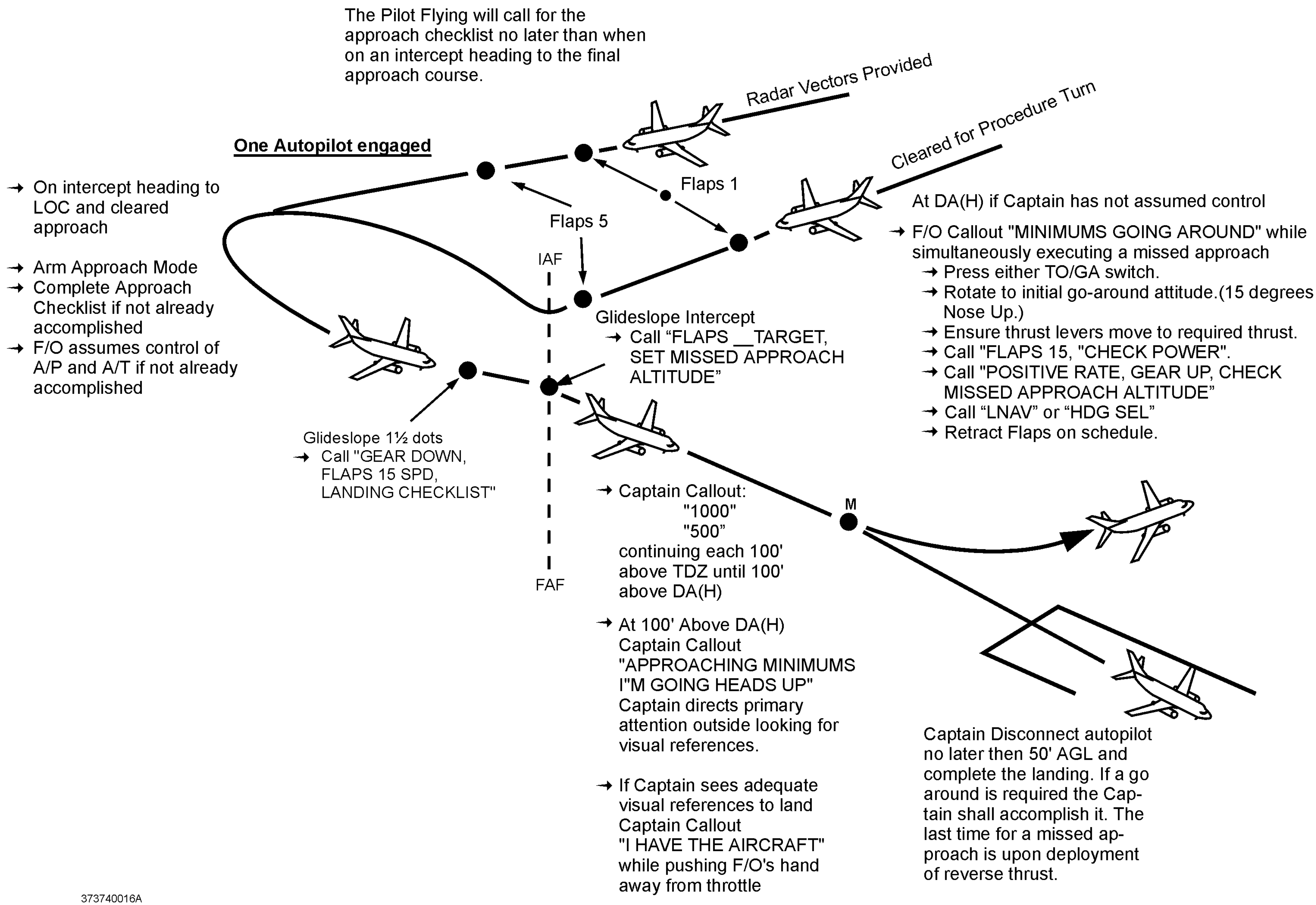

VISUAL SEGMENTS ON CAT II APPROACH: 100 FT. D.H. & RVR 1200
PITCH ATTITUDE
1.9 @ FLAPS 30
.4 @ FLAPS 40
DOWN VISION ANGLE
11'-12'
HORIZON
GEAR PATH
100 FT. RA
1000' APPROACH LIGHT BAR
(STROBE LIGHTS END HERE)
VISUAL SEGMENTS
(APPROXIMATE)
615'-720'
1200 FT. RVR
RVR LIMIT
THRESHOLD
APPROACH LIGHT BARS
NOTE: PILOT SHOULD SEE 6 OR 7 APPROACH LIGHT BARS.
(ALL WILL BE WITHIN THE LAST 1000' OF THE APPROACH LIGHT SYSTEM AND WILL NOT INCLUDE THE RUNWAY THRESHOLD.

737CAT2A

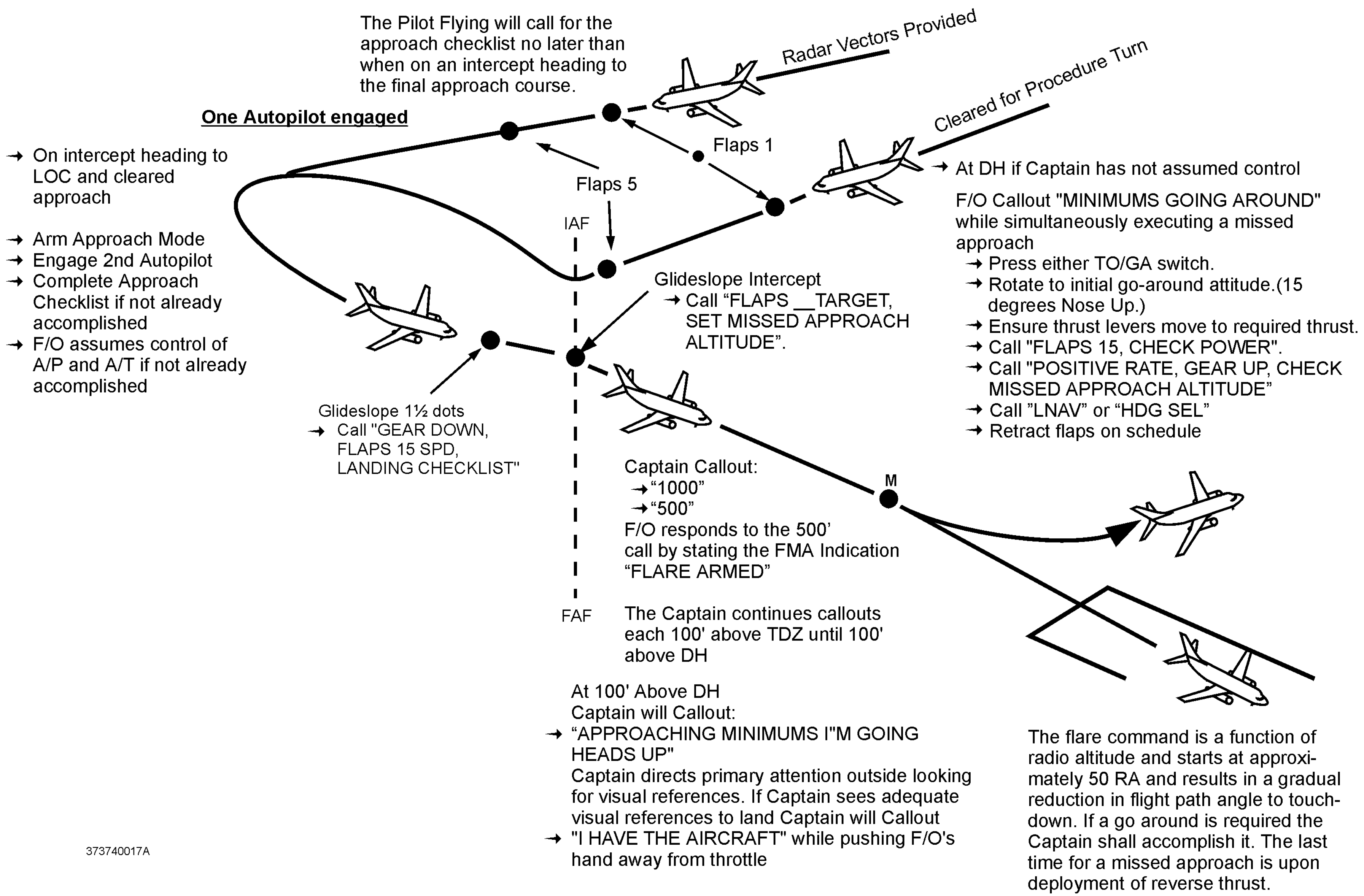


373740022A

NORMAL ILS APPROACH / UN-MONITORED



ILS CAT II OR CAT I MONITORED APPROACH



ILS CAT IIIA OR CAT II AUTOLAND

Note: The second autopilot should be engaged once the APP mode has been selected.

ILS PRECISION RUNWAY MONITOR (PRM) APPROACH

In Range

- Review Jepp 11-0 PRM instructions and planned PRM approach plate.
- The following systems must be operational:
  ILS (Cat I)
  Transponder
  Two VHF radios
- Advise ATC if unable to perform PRM approach.

Approach

- Set the PRM monitor frequency in #2 VHF radio. Adjust VHF 1 & 2 volume controls to ensure both pilots can hear both radios.
- Both pilots monitor both radios, transmit only on tower frequency.
- Unless contrary to Jepp 11-0 PRM instructions, TCAS should be left in TARA. If a TCAS RA and ATC Traffic Alert occur simultaneously, follow the RA climb / descent and execute the ATC turn instruction.

Actions In Event Of A Traffic Alert (Breakout)

Pilot Flying

- Immediately disconnect the autopilot and manually fly the aircraft to the assigned heading and altitude (descent rates greater than 1,000 FPM are not required).
- **Do not disconnect the autothrottles.**
- **Do not push TOGA.**
- **Do not change aircraft configuration (flaps or gear) until established on the new heading.**
- Autopilot may be re-engaged after established on new heading and PM confirms MCP reprogrammed.

Pilot Monitoring

- Turn both Flight Director switches OFF.
- Set the assigned heading and altitude in the MCP.
- Turn both Flight Director switches ON.
- Push LVL CHG.
- Push HDG SEL.
- Advise the PF that the MCP has been reprogrammed.

PRECISION APPROACH RADAR (PAR)

Precision Approach Radar (PAR) allows the controller to provide pilots azimuth, range, and glideslope information. An approved approach lighting system enhances the approach and allows lower landing minimums. If glideslope information is not available to the controller, the PAR reverts to a non-precision approach system (surveillance approach). Failure of azimuth and range information to the controller renders the system inoperative. PAR procedures must include instructions for lost communications procedures from the controller to the pilot. The final approach segment begins at the final approach fix where the radar glideslope begins (not less than 3 nm from the landing threshold) and ends at the decision height (minimum of 200 ft. above TDZ) where instructions to take over visually and land, or miss the approach are received.

PAR approaches provide pilots with accurate heading guidance to keep the aircraft aligned with the extended runway centerline. The controller will provide advance notice of glideslope intercept approximately 10 to 30 seconds prior to actual intercept. The published DA will be provided only if requested. If the aircraft deviates above or below the glidepath or left or right of centerline, the pilot will receive advisory information from the controller using the phraseology "slightly" or "well" above or below or left or right of desired path. Range information from touchdown is provided at least once each mile while on final approach. A pilot may expect to be issued a go-around (missed approach) if the aircraft proceeds outside specified safety zone limits, unless the runway environment is in sight. After Decision Altitude (DA), advisory course and glideslope information will be issued until the aircraft passes over the runway threshold.

In general, the approach is flown using the MCP in HDG SEL for roll and vertical speed for pitch control. The pilot will not engage LNAV or VNAV while conducting a PAR approach. Because ATC provides all azimuth, range and glideslope information, both pilots may be in the MAP mode. The approach may be built on the CDU. However, displayed LNAV/VNAV information is to be used for reference only and it is mandatory to comply with all controller instructions issued during the approach.

NON-PRECISION APPROACHES

GENERAL

A non-precision approach is any kind of instrument approach where electronic glideslope information is not provided by the primary ground based navigational aid.

FAA regulations allow modern aircraft to take advantage of onboard equipment capability to fly non-precision approaches utilizing a constant rate of descent to a decision altitude (DA), or equivalent, verses a minimum descent altitude (MDA). In many cases this affords lower minimums when using the VNAV capability of the aircraft.

- The FMC is capable of providing an accurate vertical (gradient) path to the runway when the proper information is entered.
- Most non-precision approaches are coded with a gradient path that will display on the LEGS page (GP x.xx) for the coded segments.
- The use of VNAV inside the final approach fix (FAF) requires display of a gradient path.
- If a gradient path does not exist, V/S must be used. Either manner allows the aircraft to be flown at a stabilized descent rate to minimums at which point a normal landing can be completed or a missed approach accomplished if adequate visual references are not present. This is a significantly different philosophy than the old concept of early descent to MDA and level flight to the VDP or MAP.

Note: There are some non-precision approaches that do not have a coded gradient path and are structured such that a constant rate of descent to minimums is not practical. When this is the case, a non-constant vertical rate procedure will be utilized as described later in this section.

The following policies and restrictions will apply to the execution of non-precision approaches:

- All non-precision approaches will be flown using the autopilot and autothrottles, if available.
- All constant rate descent non-precision approaches in weather conditions reported or anticipated to be equal to or less than 1 statute mile or 5000 RVR, will be flown using Continental Airlines monitored approach procedures.

Note: Procedures and calls associated with conducting a monitored non-precision approach are incorporated in this section, where necessary, and are generally consistent with procedures for a monitored precision approach.

- The preferred method to fly the path from the FAF to the runway is with VNAV. This requires display of a gradient path. If a gradient path or VNAV is not available, then V/S will be used at a constant rate from the FAF to minimums.
- Raw data monitoring and course compliance is as prescribed by the individual Approach Guidelines. Single FMC airplanes are generally restricted to non-precision approaches that are based on raw data and must abide by raw data course criteria.
- ③ Prohibited from conducting RNP-based RNAV approaches due to insufficient field-of-view alerting of an RNP exceedance. Otherwise, RNAV approaches may be flown by single FMC airplanes at IAH only.
- Lateral mode selection, LNAV or VORLOC, is as prescribed by the individual Approach Guidelines and may differ depending on aircraft type. Localizer-based front-course approaches (LOC, ILS with glideslope inoperative, and LDA) must track the raw data course with VORLOC.

APPROACH COMPONENTS

Gradient Path

- To use VNAV, a gradient path <u>must</u> exist for the selected approach and be displayed on the LEGS page.
- If a gradient path has been coded into the approach it will not display unless all PERF INIT required (blocked) fields are filled in.
- The aircraft must also have reached the FMC-entered cruise altitude to enable gradient path display and descent calculations.
- A gradient path for the <u>specific</u> approach being flown provides compliance for all published step-down fix altitudes inside the FAF.

In the case of an ILS approach with the glideslope inoperative, the FMC database-selected approach is the ILS approach and the gradient path provided is NOT specifically for the glideslope inoperative case. If step-down fix altitude restrictions exist inside the FAF, it must be determined whether or not the gradient path will comply with these restrictions (see Approach Selection, below). If unsure of gradient path compliance, utilize V/S in a manner to meet all published restrictions.

<u>Note</u>: The approach plate does not always reflect the existence of a gradient path. Use the LEGS page to make this determination. There are a small number of approaches that do not have coding of a gradient path. This can be identified by noting the missed approach (MA) point on the approach plate as beyond the end of the runway and the lack of a runway (RWxx) waypoint on the LEGS page. If this is the case V/S must be used and a rate calculated so as to provide a constant rate descent from the FAF to minimums. When a gradient path does not exist there will not be a valid PDI from the FAF altitude to minimums.

MINIMUMS

- The approach plate will reflect appropriate minimums as either a DA or MDA.
- If using a DA, set (bug) the published value on the primary altimeters.
- If using an MDA, create a derived decision altitude (DDA) by adding 50 ft. to the MDA value and bug the DDA on the primary altimeters.

The B737 aircraft has demonstrated altitude loss during go-around to be no more than 50 feet, therefore ensuring that the aircraft does not descend below the published MDA if a missed approach is initiated at the DDA. If a DA is published, it is acceptable for the aircraft to descend below the DA during the execution of the missed approach (as is the case when using a ground based electronic glideslope).

Note: Some approach plates offer a ballflag note that reads: "❶ *Only authorized operators may use VNAV DA(H) in lieu of MDA (H).*" Interpret this to mean that the published MDA may be used as a DA – the MDA is not adjusted up by 50 ft. **Continental B737 crews have authorization to utilize the ballflag note.** Existence of the ballflag note reflects that an obstacle assessment has been completed for the visual segment of the approach and that descent below the MDA during execution of a missed approach is allowed.

Currently the only approach plates publishing a DA are RNAV approaches under the column titled LNAV/VNAV. To use this DA requires display of a gradient path on the LEGS page and display of the path deviation indicator (PDI) on the Map.

RNAV approach plates also list MDA minima under the column titled LNAV. This MDA will be used, and a DDA created, when a gradient path will not display or a PDI is not available. In this event use V/S at a constant rate from the FAF to minimums.

RADIO ALTIMETER

Radio altimeter setting will be 250 ft. for non-precision approaches. This is consistent with Flight Manual guidance and is the result of research to minimize CFIT encounters / accidents. Setting the radio altimeter to 250 ft. may provide additional terrain awareness should descent below minimums occur without adequate visual cues or if descent relationship to the runway, with visual cues, is not proper.

RNP / ACTUAL (ANP)

Required Navigation Performance (RNP) criteria is the defined accuracy (mileage) requirement for phases of enroute and terminal flight and various approaches when the FMC is used as the sole means of navigation.

RNP value is controlling for RNAV, GPS, and $\boxed{7}\boxed{8}\boxed{9}$ NDB. It is also controlling for $\boxed{7}\boxed{8}\boxed{9}$ VOR approaches where raw data is not available or is not monitored.

When RNP is controlling for an approach, the ACTUAL (ANP) performance value must remain smaller than the RNP from the FAF inbound to the runway. ANP is an FMC measure of the current navigation system performance (think of this value as an FMC prediction of system accuracy).

If the ANP exceeds the RNP inside the FAF, messaging must indicate the exceedance clearly within the field-of-view and the message treated as a go-around signal. The message we receive with an RNP exceedance is **UNABLE REQD NAV PERF – RNP** and it appears on the Map.

<u>To enable this message on the Map the RNP must be manually entered</u>, even if the value is the same as the approach phase default of .5nm. To enter the required RNP, type it into the scratchpad and then line select it to the RNP field at 6L on the LEGS page. Manual entry of RNP is not required when raw data is controlling.

Refer to the RNP REQUIREMENTS table in the QRH for the appropriate setting when raw data is not controlling.

<u>Note</u>: When raw data is monitored and is controlling for an approach, if ANP exceeds RNP outside of the FAF, LNAV and/or VNAV can be used if ANP proves to be at .5nm or better (this can be evaluated by comparison to raw data sources). If in doubt, or if the error proves excessive, it is recommended that VORLOC or HDG SEL be used in lieu of LNAV, and V/S in lieu of VNAV. Use V/S a rate determined from the approach plate or Vertical Speed Reference table. Raw data should be used to help determine the FAF. If ANP exceeds RNP after passing the FAF continuing the approach with use of LNAV and/or VNAV requires that on-course parameters and a stable descent, as referenced on raw data, be maintained. If ever uncertain about the aircraft position and/or accuracy while on final approach a go-around should be initiated.

APPROACH SELECTION

- An approach procedure is selected from the CDU DEP/ARR page(s).
- At-or-above waypoint altitudes at the FAF, or outside the FAF and on the approach, should be changed to hard altitudes (i.e., change 3000A to 3000) to make descent in VNAV more predictable.

After approach selection, and modification if necessary, it is important to match the LEGS page display to your circumstances. For example: if you select an approach and extend the centerline from a given fix that has an altitude constraint, if ATC descends you below that altitude before reaching the fix, either remove the altitude constraint at the waypoint or extend the centerline from a closer-in waypoint compatible with the altitude clearance you receive.

APPROACHES WITHOUT REFERENCE TO RAW DATA

RNAV, GPS and 7 8 9 NDB approaches do not have reference to raw data. It is, therefore, a requirement that these approaches **must** be selectable from the FMC database and that the final approach segment waypoints and altitudes not be modified. Verify that approach selection, setup and appropriate RNP entry is accurate.

APPROACHES WITH REFERENCE TO RAW DATA

Approaches flown with reference to raw data for primary course compliance must be set up in the FMC in order to use VNAV. If the specific approach is available in the FMC and a gradient path exists, modification of the approach is not necessary and compliance with stepdown fix altitude restrictions inside the FAF, if indicated, is guaranteed.

If the specific approach is not available in the FMC then an overlay may be selected, such as the ILS approach when the glideslope is inoperative. In this event, the FAF altitude may have to be modified to comply with the approach plate. In addition, stepdown fix altitude restrictions inside the FAF, if indicated, will have to be evaluated to determine gradient path compliance.

Stepdown fix compliance may be evaluated in the following manner:

- Insert the named stepdown fix waypoint into the LEGS page at the appropriate point and leave the airspeed / altitude line blank.
- Close up the discontinuity.
- Line select the airspeed / altitude line for the entered waypoint.
- Evaluate the altitude readout in the scratchpad.

- After evaluation reselect the appropriate approach from DEP/ARR and restore the FAF altitude modification, if necessary. Do not reenter the stepdown waypoint.

If the gradient path is determined to comply with the stepdown, plan to use VNAV. If the gradient path does not comply with (at-or-above) the stepdown, plan to use V/S and ensure stepdown altitude compliance.

Manual Waypoint Entry

When there is no procedure available in the FMC data base, manual entry of a series of waypoints may be accomplished to define the approach routing. The waypoints may be defined by using names of waypoints or navaids in the data base. Raw data monitoring and course compliance is required. Verify the accuracy of the FMC approach creation.

VREF SELECTION

V_{REF} is selected on the APPROACH REF page for the desired final flaps. The FMC generates a Target speed by adding the V_{REF} selection to the WIND CORR line value (default of +5 knots). If reported surface winds require an additive greater than 5 knots, adjust the WIND CORR line accordingly. Check that Target speed generates on the LEGS page as the speed for the last approach waypoint (RWxx or MAxx).

USE OF VNAV

VNAV should not be engaged until on course in LNAV or on course in VORLOC with a compatible FMC course selected. The FMA must be monitored to ensure the intended mode.

The point of VNAV engagement during or in transition to the approach is dependent upon circumstances. It is not uncommon for ATC to impose a speed restriction that would be incompatible with VNAV control of the airspeed. Use of V/S or LVL CHG may be more appropriate and convenient until approaching the FAF. Coordination with ATC may be necessary to allow configuration and deceleration to Target speed prior to the FAF. Selecting VNAV between the typical configuration points of 4nm and 2nm is easily managed when earlier engagement is not feasible or convenient.

Using VNAV for descent on the gradient path from the FAF to minimums requires the setting of **zero ("0")** in the MCP altitude window. If continuing the use of VNAV from a course transition and through the final segment zero can be set when clearance for the approach is received and with VNAV PTH maintained on the FMA. If VNAV is not utilized in transition or for stepdowns outside the FAF set zero when obtaining ALT HLD at the FAF altitude and engage VNAV during the configuration process approaching the FAF. When approaching the FAF, if VNAV will not engage or cannot be maintained, ensure zero is set and plan for the use of V/S to initiate descent from the FAF.

Note: When VNAV is engaged, monitor the FMA for **VNAV PTH** annunciation and ensure compliance with approach altitudes.

With VNAV engaged the MCP speed window will be blank and VNAV will control the speed for flap selections. During configuration with VNAV engaged the "SPEED" and "TARGET" calls will be made at the appropriate time and the airspeed monitored to ensure compliance.

USE OF VERTICAL SPEED (V/S)

Vertical Speed is used as a primary mode when a gradient path does not exist or when VNAV is inoperative. Vertical Speed may also be used as a backup mode for VNAV. Planning and briefing the use of V/S as a backup may preclude the need for a go-around if difficulties with VNAV are experienced.

In many cases, the approach chart itself will provide convenient vertical speed reference for the specified gradient path. The appropriate rate is chosen based on ground speed.

If the approach plate does not provide a reference table then refer to the generic QRH reference table. This table requires entry of distance, altitude and ground speed to determine a vertical speed rate. Refer to the approach plate profile view to determine chart entry values. Distance is from the FAF to the runway threshold. Altitude is from the FAF to runway threshold (TDZE) + 50 ft. Interpolate on the chart as necessary.

Be prepared to use V/S at the determined rate from the FAF if VNAV will not engage or can not be maintained. V/S adjustments are made with reference to the PDI. Display and monitoring of the DEScent page also provides reference to the necessary V/S rate once the FMC sequences from the FAF to the final approach waypoint (RWxx or MAxx).

DISPLAYS

- The CDU displays should be set to the DEScent page on the PF side and the LEGS page on the PM side prior to the FAF.
- When the Map mode is prescribed the scale should be set to 10nm prior to the FAF for proper course monitoring.
- TERR on the EFIS control panel, if available, should be selected when near significant terrain.

Display of the DES page and LEGS page together provides both crew members with access to waypoint information and sequencing, RNP / ANP, descent anticipation, path deviation and vertical speed information.

Note: It is good practice to ensure that the LEGS page information continuously matches your flight circumstances. For example: if you have "extended the centerline" from an approach waypoint with an altitude constraint, and ATC subsequently descends you below that altitude before reaching the waypoint, modify the LEGS page to match the new conditions.

The Map display, when appropriate, provides a plan view of the approach, including final approach and missed approach routing and increases crew awareness of progress and position during the approach. Raw data information from VOR, NDB, and LOC facilities must be monitored, as appropriate.

Caution: If a disagreement between LNAV and raw data information exists, use of LNAV must be terminated and raw data information followed using HDG SEL.

Pilots must not allow themselves to become involved in excessive heads down FMC manipulation at low altitude. Raw data VOR, ILS and ADF displays should be used in the traditional manner to avoid such distractions during high workload phases of flight.

The Map is useful when the inbound course is not aligned with the runway centerline. The Map will graphically display the difference between the extended runway centerline and the published inbound course, allowing the pilot to clearly determine the alignment maneuver required, taking into account the effect of current winds.

Note: For all non-precision approaches, timing is required only if the published MAP point is time based and is not referenced as a waypoint and displayed on the EFIS Map. This is for purposes of determining the geographical point at which a turn or other constraint can be made during the missed approach and not for the determination of when to begin the missed approach procedure. The vertical portion of the missed approach will be accomplished immediately upon arrival at the DA/DDA if the required visual references for landing are not present, regardless of the time from the FAF or time remaining to the MAP.

COURSE GUIDANCE

The final segment of the non-precision approach begins at the Final Approach Fix (FAF) and ends at the Missed Approach Point (MAP). On non-precision approaches with no depicted FAF (such as on airport radio facilities), the FAF is considered to be located at the point where the aircraft is established inbound on the final approach course from the procedure turn, and where the final approach descent to MDA (DDA) may be commenced.

During the final approach segment of a non-precision approach prior to reaching DA/DDA, the following restrictions apply:

- Localizer deviation: 1 dot
- VOR course deviation: 1 dot or + / -5 deg.
- NDB: + / -5 deg.
- ANP less than RNP for approaches without reference to raw data.
- Airspeed: -5 / +10 knots of target speed
- Cross Track Error: (RNAV/GPS only) Aircraft symbol must touch the active course line using the 10-mile scale.
- Maximum rate of descent below 1000 ft. above TDZE: 1000 fpm
- Deviations from the VNAV computed path (PDI) should not exceed 1/4 scale high or 1/8 scale low.

Other than a brief deviation, any exceedance greater than the above listed parameters is indicative of an unstabilized approach and requires the execution of a missed approach. It is recognized that ATC instructions often necessitate airspeeds higher than optimum during the initial portions of an instrument approach. However, unstabilized approaches must not be continued below 1000’ above TDZE.

Note: There are a few non-precision approaches where obstacle clearance requirements have necessitated the coding of a gradient path in excess of 3.5 degrees. It is possible that at high gross weights and high-density altitudes that the aircraft will exceed 1000 fpm below 1000' above TDZE while otherwise meeting stabilized parameters. Under the circumstances, the approach may be continued assuming comfort of the crew and that the required PDI relationship is maintained.

APPROACH GUIDELINES

③ 3 5 Radios should remain in AUTO as long as possible for enhancement of the ANP value. Display and tune required raw data information no later than on an intercept heading for the final approach course.

③ The HSI vertical deviation scale serves as a PDI when the appropriate MCP HSI switch is in NAV.

Refer to the Recommended Approach Setup table, in this section, for display and mode configurations for the various aircraft types.

LOC, LDA, SDF

- These approaches are authorized for all B737 models.
- Display and tracking of the Localizer is required.
- Utilize VORLOC for tracking the localizer and VNAV for tracking the gradient path.
- When using a NAV database ILS approach selection for a glideslope inoperative approach, modify the FAF altitude, if necessary. Also, evaluate gradient path compliance if a stepdown fix is indicated inside the FAF.
- There is no RNP manual entry requirement.

BC LOCALIZER

- These approaches are authorized for all B737 models.
- Utilize LNAV for course tracking and VNAV for tracking the Gradient Path.
- The localizer raw data must be monitored and is controlling - freq. tuned, front course set, Stby in B/CRS.

  Note: There is no back course selection on the MCP, and the LOC BC signal cannot be tracked by the autopilot or flight director. If LNAV will not comply with raw data course requirements, revert to HDG SEL.
- There is no RNP manual entry requirement.
- A Derived Decision Altitude (DDA) is created and set for minimums on the barometric altimeter.

VOR

- These approaches are authorized for all 737 models.
- ③ 3 5 VOR raw data must be monitored and is controlling. There is no RNP manual entry requirement for these models. VORLOC is used for course tracking with the appropriate radio tuned and course set. VNAV is used for tracking the Gradient Path.
- 7 8 If raw data is not available manually enter an RNP of .5nm. LNAV is used for course tracking. VNAV is used for tracking the Gradient Path.
  - If raw data is not available and monitored, display of the message **UNABLE REQD NAV PERF – RNP** inside the FAF requires a go-around.
  - Raw data, if available, should be monitored on the HSI display.
- A Derived Decision Altitude (DDA) is created and set for minimums on the barometric altimeter.

NDB

- 7 8 9 Flown without reference to raw data.
  - Requires manual RNP entry of .5nm.
  - Requires selection of the specific NDB approach from the FMC database.
  - Display of the message **UNABLE REQD NAV PERF – RNP** inside the FAF requires a go-around.
- 3 3 5 NDB raw data must be monitored and is controlling.
  - No RNP manual entry requirement.
  - PM must continuously monitor the NDB aural tone on final.
- Utilize LNAV for course tracking and VNAV for tracking the gradient path.
- A Derived Decision Altitude (DDA) is created and set for minimums on the barometric altimeter.

RNAV

- The 3 is prohibited from conducting RNP-based RNAV approaches due to insufficient field-of-view alerting of an RNP exceedance.
- 3 5 Currently limited to RNP-based approaches at IAH for runway 8 and 26 only.
- Some RNAV approaches – titled RNAV (GPS) Rwy xx – may require GPS updating. Be sure to read the briefing notes on the approach plate.
- These approaches must be selected from the FMC database.
- These approaches require a manual RNP entry of .3nm, or as specified on the approach plate.
- A DA or DDA, whichever is appropriate, is set for minimums on the barometric altimeter.

Display of the message **UNABLE REQD NAV PERF – RNP** inside the FAF requires a go-around.

GPS

- These approaches are restricted to 7 8 9 with GPS updating.
- The approach must be selected from the NAV database.
- The approach requires a manual RNP entry of .3nm.
- Utilize LNAV for course tracking and VNAV for tracking the gradient path.
- A Decision Altitude (DA) or Derived Decision Altitude (DDA), whichever is appropriate, is set for minimums on the barometric altimeter.

ASR

Surveillance Approach Radar (ASR) provides the controller with azimuth and range information to a specific runway or series of runways. An approved approach lighting system enhances the approach and allows lower landing minimums. ASR procedures must include controller instructions regarding lost communications procedures. The final approach segment begins at the final approach fix and ends at the missed approach point. The pilot will be notified when approaching the FAF, when to begin descent to the MDA, and where instructions to take over visually and land or miss the approach are to be received.

MDA's are published on the applicable Jeppesen Approach Chart and the controller is required to issue the MDA when the descent notification is issued. Recommended altitudes on final will not be issued by the controller unless the pilot requests them. If the aircraft deviates to the left or right of centerline, the controller will make notification using the phraseology "slightly" or "well" to the left or right of desired track. In addition, the controller may use the phraseology "rapidly" or "slowly" when referencing the closure rate or deviation from the desired track. A pilot may expect to be issued a go-around (missed approach) if the aircraft proceeds outside the specified safety zone limits unless the runway environment is in sight. The ASR approach terminates when the pilot reports the runway in sight or the aircraft is over the missed approach point.

ASR approaches will be briefed and flown in accordance with the published ASR approach procedure. In general, the approach will be flown using the MCP in HDG SEL for roll control and vertical speed for pitch control. The pilot will not engage LNAV or VNAV while conducting the ASR approach. ATC provides azimuth and range information, therefore, both pilots may be in the MAP mode. The approach may be constructed in the CDU, but displayed LNAV and VNAV data is to be used for reference only and it is mandatory to comply with all controller instructions during the approach.

HDG SEL should be used for tracking. ATC provides all azimuth directions (and recommended altitudes on final, if requested). Use V/S for the descent. Consider selecting the appropriate RWY selection from DEP/ARR and using the runway extension (RWY EXT) function. **RWY EXT** appears after RWY selection and before pressing EXECute. It allows entry of a desired mileage. Using 6 miles will generate a RXxx waypoint 6 miles from the end of the runway and approximate a descent point from 2000 ft above TDZE. Select a mileage appropriate for the expected altitude loss.

NON-PRECISION SETUP REFERENCE	
Approach Preparation	
DEP/ARR Key	Select Approach from database and verify accuracy (including Missed Approach).
LEGS Page	Verify (GPx.xx) is available. (Approaches without a Gradient Path require use of VERT SPD.) At-or-Above Altitudes (approach portion only) – make them "Hard" altitudes. 6L: Manual entry of RNP (if raw data is not controlling). Approach plate or QRH for RNP value.
APPROACH REF Page	V_{REF} select. WIND CORR select (if other than +5kts).
CRZ Page	Verify CRZ ALT was achieved. If not, this will inhibit VNAV engagement.
ALTIMETER Setup	Barometric DA / DDA set. DDA computation is (MDA + 50 feet). (ballflag note, if appropriate) Radio Altimeter set 250 feet.
Vertical Speed Contingency	Brief the VERT SPD contingency in the event VNAV will not engage. Brief reference to the PDI. This can be accomplished from the Approach Plate or the QRH.
Radio Configuration	Radio(s) AUTO/MAN (as necessary). See Non-Precision Display Reference (Recommended).
Approach Mode	LNAV or VOR/LOC, as appropriate. See Non-Precision Display Reference (Recommended).

CONDUCTING THE APPROACH	
Map Scale	MAP scale to 10 NM on final (if appropriate).
CDU page display	PF – DESCENT page. PM – LEGS page.
MCP altitude to “0”	Prior to FAF, on course, and cleared for approach. If not in VNAV PTH wait until after ALT HLD at FAF altitude.
VNAV Engagement	On course when configuration/speed permits. VNAV PTH on FMA.
A/P Disconnect	A/P disconnect no lower than 50 ft. below DA / DDA.
A/T Disconnect	A/T disconnect no lower than 100 ft. AGL.
At Minimums	Missed approach altitude **MUST** be set during the missed approach procedure.

NON-PRECISION DISPLAY REFERENCE (RECOMMENDED)

Approach Type	7 8 9	3 5	③
RNAV	LNAV, VNAV Map-both sides (10nm scale) RNP-per chart Approach-no modifications	LNAV, VNAV Map-both sides (10nm scale) RNP-per chart Approach-no modifications (IAH RWY 8-26 only)	**N/A**
GPS	LNAV, VNAV Map-both sides (10nm scale) RNP-.3nm Approach-no modifications GPS updating	**N/A**	**N/A**
LOC/LDA/ SDF	VORLOC, VNAV Map-both sides Raw data Req'd.	VORLOC, VNAV Map-both sides PF-radio MANUAL PM-radio AUTO Raw data Req'd	VORLOC, VNAV PF-HSI VOR/ILS PM-HSI NAV PF-radio MANUAL PM-radio AUTO Raw data Req'd PDI is on PM HSI
LOC BC	LNAV, VNAV Map-both sides Raw data Req'd	LNAV, VNAV PF-Map PM-Exp. VOR/ILS PF-radio AUTO PM-radio MANUAL Raw data Req'd	LNAV, VNAV PF-HSI NAV PM-HSI VOR/ILS PF-radio AUTO PM-radio MANUAL Raw data Req'd PDI is on PF HSI
VOR	LNAV, VNAV Map-both sides (10nm scale) RNP- .5nm (w/o raw data) Approach-no modifications (w/o raw data)	VORLOC, VNAV PF- Exp. VOR/ILS PM-Map (10nm scale) PF-radio MANUAL PM-radio AUTO Raw data Req'd	VORLOC, VNAV PF-HSI VOR/ILS PM-HSI NAV PF-radio MANUAL PM-radio AUTO Raw data Req'd PDI is on PM HSI
NDB	LNAV, VNAV Map-both sides (10nm scale) RNP- .5nm Approach-no modifications	LNAV, VNAV Map-both sides (10nm scale) Radios-both AUTO Raw data Req'd	LNAV, VNAV PF-HSI NAV PM-HSI NAV Radios-both AUTO Raw data Req'd PDI is on both HSI's

Recommended CDU displays: PF – DES page. PM – LEGS page.

VERTICAL SPEED REFERENCE

CONSTANT RATE DESCENT

Vertical Speed rate required in feet per minute

Based on 140k GS		DISTANCE *											
		2	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**
A	**600**	700	560	470									
L	**700**	820	650	540									
T	**800**	930	750	620	530								
I	**900**		840	700	600	350							
T	**1000**		930	780	670	580	520						
U	**1100**			850	730	640	570	510					
D	**1200**			930	800	700	620	560	500				
E	**1300**				870	760	670	600	550	500			
*	**1400**				930	820	730	650	590	540	500		
	1500					870	780	700	640	580	540	500	
	1600					930	830	750	680	620	580	530	500
	1700						880	800	720	660	610	570	530
	1800						930	840	760	700	650	600	560
	1900							890	800	740	680	630	590
	2000							930	850	780	720	670	620
	2100								890	820	750	700	650
	2200								930	860	790	730	680
	2300									900	820	770	720
	2400									930	860	800	750
	2500										900	830	780
	2600										930	870	810
	2700											900	840
	2800											930	870

Altitude: FAF (or stepdown fix, if applicable) to TDZE + 50 ft.

Distance: FAF (or stepdown fix, if applicable) to runway threshold.

Rates are based on 140 knots groundspeed.

For **each** 10 knots slower than 140 knots subtract 40 fpm.

For **each** 10 knots greater than 140 knots add 40 fpm.

APPROACH BRIEFING AND PREPARATION

- Brief the approach as early as circumstances permit, preferably prior to top-of-descent from cruise altitude.
- Select VREF and modify the WIND CORR entry, if necessary.
- Select and modify the approach, if necessary, and verify the FMC setup, to include the missed approach, during the approach briefing.
- Plan and brief the point of LNAV or VORLOC and VNAV engagement.
- Plan and brief a vertical speed backup and reference to the PDI.
- Set minimums on the barometric altimeters and 250 ft. on the radio altimeter.
- Ensure the aircraft has reached the cruise altitude that is set in the FMC. If not, reset the cruise altitude.

The aircraft should normally be configured as follows, however a particular approach or specific ATC constraints may require minor modifications:

- The PF will call “FLAPS 1, SPEED” not later than: downwind leg on a rectangular pattern; 7 NM prior to the FAF on a straight in approach; or 3 NM prior to a procedure turn outbound.
- The PF will call “FLAPS 5, SPEED” not later than: beginning base leg on a rectangular pattern; 5NM prior to the FAF on a straight in approach; or 1 NM prior to a procedure turn point outbound.

Engaging VNAV early is encouraged and will assist in smoother flying and better monitoring of the approach. VNAV should be engaged no later than 3 miles from the FAF. Plan the approach so as to be stabilized prior to crossing the FAF in landing configuration with speed stabilized at target.

If flown as a monitored approach the first officer should assume flying duties prior to, or early in, the approach but no later than on an intercept heading or, if straight-in, no later than 4 miles outside the FAF. Ensure that the flight director master (**MA** light) is transferred to the first officer side, if necessary.

FINAL APPROACH

- At 4 miles prior to the FAF, the PF will call "GEAR DOWN, FLAPS 15, SPEED, LANDING CHECKLIST."
- Engage VNAV, if not previously selected, and check the FMA.
- Confirm MCP altitude is set to zero and the FMA indicates VNAV PTH after VNAV engagement.
- At 2 miles prior to the FAF, the PF will call "FLAPS ___ , TARGET."

The VNAV Path Deviation Indicator (PDI) indicates the vertical path. If VNAV is not engaged, establish the pre-determined V/S rate and comply with the PDI. Monitoring of the DEScent page will also indicate path deviation and V/S requirements. Deviations below a centered PDI are only acceptable if positive correction back to the VNAV path is being made. Corrections for a late initiation of descent (PDI shows the aircraft is high relative to the computed VNAV path) will be made within the following constraints:

WARNING: Descent below 1000 ft. above TDZE shall not exceed 1000 fpm, regardless of pitch mode utilized.

The planned pitch mode must be included as part of the Approach Briefing. A backup pitch mode should be briefed to follow the PDI if the planned mode is not attained. The DEScent page will reflect the V/S requirement to reach 50 ft. over the runway threshold. Use of this readout can be used to regain a centered PDI and establish stabilized parameters.

Note: Certain non-precision approaches may have a level segment from the FAF to final gradient path descent (example: LAX VOR 7 L/R). (Design constraints must keep the gradient path above a minimum angle.) This may be indicated on the approach plate profile view. In this event, the PDI (and DEScent page information) will maintain a level flight indication until gradient path descent begins.

- As the aircraft descends through 1000 ft. above the TDZE, the PM calls "1000."
- At 100' above the DA/DDA, the PM calls "APPROACHING MINIMUMS" (and if executing a monitored approach, also "I'M GOING HEADS UP"). The PM should attempt to visually acquire the runway environment. The PF should continue to direct attention to the instruments to ensure aircraft control until advised by the PM "APPROACH LIGHTS (and/or RUNWAY) IN SIGHT."

- If executing a monitored approach, the Captain will call “I HAVE THE AIRCRAFT” when adequate visual references are established and take control of the aircraft.
- When the PF leaves the DA/DDA, the PM will resume the monitoring and standard calls.

Disengage the autopilot not lower than 50 ft. below published DA or DDA.

Disengage the autothrottle prior to landing – not lower than 100 ft. AGL.

MISSED APPROACH

Upon reaching the DA/DDA, regardless of the pitch mode utilized to descend the aircraft, if the PM has not acquired the approach lights or the runway environment, he/she will call “MINIMUMS.” The PF selects TO/GA, calls “MINIMUMS, GOING AROUND,” and executes the missed approach.

Note: The autopilot will disconnect after TO/GA activation. Rotate smoothly towards 15 deg. pitch attitude and then follow flight director commands.

TO/GA maintains existing ground track. Passing 400’ AFE, select LNAV or HDG SEL as appropriate. On approaches with DA/DDA’s above 400’ AFE, select LNAV or HDG SEL/TRK SEL as appropriate after the “CHECK MISSED APPROACH ALTITUDE” call.

Accomplish the missed approach procedure. If a turning missed approach is required, accomplish the missed approach procedure through gear up before initiating the turn, unless there is a special procedure required by the approach or Jepp 10-7 page. In the event of executing a missed approach prior to the published missed approach point, initiate a climb toward the missed approach altitude; however, do not begin a turn until reaching the published missed approach point. For missed approaches that are not stored in the NAV data base HDG SEL may be required to comply with the procedure.

The MCP selected airspeed bug should remain at the final approach speed until 1000’ AFE (or special MAP altitudes). Accelerate to flap retraction speed by calling “SET TOP BUG” (or speed for the desired flap setting). Retract the flaps on schedule as the airspeed increases.

If a subsequent approach will be flown utilizing VNAV, the cruise altitude may have to be reset if the highest altitude of the published missed approach was not reached.

TRANSITION TO LANDING

Descent below DA/DDA requires visual conditions and appropriate visual cues. Accomplish a missed approach if the required visual conditions or cues do not exist for landing, or if the aircraft is not in a position to continue a stabilized descent to landing. The parameters associated with stabilized approaches apply. After the decision has been made to land, it is not appropriate to turn the flight directors off or attempt to change pitch / roll modes. This phase of the approach from DA/DDA to landing is a visual maneuver, and unnecessary changes to flight director (F/D) guidance is not desired.

Note: The F/D display will continue to reference the gradient path or V/S setting if continuing below minimums. However, adjustments to the VASI / PAPI or visual picture take precedence over F/D guidance below minimums.

NON-PRECISION APPROACHES WITH AIRCRAFT NON-NORMALS

General

VREF is selectable for flap configurations of 15, 30 or 40. VNAV will control the Target speed for any of these final flap settings. When the abnormal requires de-selection of autothrottles, it is extremely important that Target speed is maintained to preclude reversion from VNAV or V/S to LVL CHG.

In case of an abnormal that requires a final flap setting less than Flaps 15, do not use VNAV. Rather, use V/S at a pre-determined rate and monitor the PDI for compliance.

The monitored approach procedure is not authorized with an engine inoperative even thought the autopilot, in most instances, will be available. In the event an engine has failed, and the criteria exists for a monitored approach, the pilot flying the approach will also make the landing. This will prevent transfer of aircraft control at low altitudes with asymmetric thrust.

APPROACH PROCEDURES – NON-CONSTANT RATE

General

When a non-precision approach lacks sufficient information to determine a constant vertical rate from the FAF to the DA/DDA then it will be necessary to utilize the following method:

- Calculation of a VDP.
- Descent in V/S from the FAF at a sufficient rate so as to reach the MDA prior to the VDP.
- Level flight at the MDA until reaching the VDP.
- Transition from the VDP, with sufficient visual cues, to a stabilized descent to the runway.
- Maintaining level flight at MDA altitude to the missed approach point, and then executing a missed approach, if sufficient visual cues are not obtained at the VDP.

Examples of approaches that may require this method are:

- Approaches identified on the Jeppesen 10-7 page as not authorized utilizing constant vertical rate.
- ILS approaches with the glideslope inoperative that contain stepdowns inside the FAF and determination cannot be made that the ILS gradient path will meet the stepdowns.
- VOR and NDB approaches that do not define a fix / waypoint at the FAF or prior to the runway for use in determining a constant vertical rate. These approaches are easily recognized by lack of a distance reference from the FAF to the threshold on the approach plate profile view.

Aspects of this approach type that are common to constant vertical angle (rate) non-precision approaches will be referenced as “previously described.”

APPROACH GUIDELINES

- All non-precision approaches will be flown using the autopilot and autothrottles, if available. If a hand flown approach is required, the duties of each pilot will be extensively briefed.
- Vertical Speed (V/S) will be used for descent from the FAF.
- The published MDA will be used as minimums. A DDA is not created.
- Raw data will be monitored and is controlling.
- Course deviation criteria and stabilized approach parameters are as previously described.
- VREF selection is as previously described.
- Pattern and final configuration points are as previously described.

LOC

- VORLOC will be used to track the LOC course.
- 3 5 7 8 9 Map display on both sides.
- ③ HSI switches to VOR/ILS prior to VORLOC selection.

VOR

- VORLOC will be used to track the VOR course.
- 7 8 9 Map display on both sides. Course compliance is referenced on the HSI.
- 3 5 PF display on VOR/ILS (expanded or full) on final. PM display on Map.
- ③ HSI switches to VOR/ILS prior to VORLOC selection.

NDB

- 7 8 9 **Not Authorized** unless the NDB approach is selectable from the NAV database and the selection provides final approach reference from the FAF to a runway (RWxx) or missed approach (MAxx) waypoint. RNP is manually set to **.5**.
- ③ 3 5 LNAV may be used for an NDB approach only if the approach setup in the FMC provides an accurate final approach course. Otherwise, use HDG SEL with reference to ADF raw data on the RDMI.

VISUAL DESCENT POINT

The process of computing a VDP requires that you determine from the approach chart the height above touchdown. Example: IAH 15L MDA(H) 460' (362'). We can see from this example that when level at the MDA of 460' you are at a height of 362 feet above the runway. We know that on a normal 3° glidepath we descend approximately 300'/nm. Dividing 362 by 300 gives a VDP of approximately 1.2 miles from the end of the runway.

Distance from the end of the runway can be determined from DME, if available, or on the CDU if the runway waypoint (RWxx) has been selected.

Note: A VDP based on time can be determined if DME or FMC position is unavailable. Take the HAT and change it into seconds. Example: HAT 360 feet. Take the 360 and take off the last digit making it 36. It should take approximately 36 seconds to descend from the HAT to the TDZ. Simply take the total time from the FAF to the runway and subtract the 36 seconds. Example: if the time from the FAF to the runway is 2:36 subtract the :36 which gives a VDP of 2:00 after the FAF.

Approach Briefing and Preparation

- Brief the approach as early as circumstances permit, preferably prior to top-of-descent from cruise altitude.
- Select VREF.
- Select and modify the approach, if necessary, and verify the FMC setup, to include the missed approach, during the approach briefing.
- Plan and brief the point of LNAV or VORLOC engagement.
- Determine and brief a VDP as a distance and/or timing reference, as appropriate.
- Plan and brief MCP altitude selection on final and the manner in which V/S will be used to reach the MDA and transition to the runway if required visual cues are obtained by the VDP.
- Set MDA on the barometric altimeters and 250 ft. on the radio altimeters.

Final Approach

Aircraft configuration from the final approach fix should be gear down, landing flaps set, with airspeed at the target for the landing flap setting.

When inbound to the FAF with **ALT HLD** annunciated in the FMA, select MDA or the next higher 100 ft. increment in the altitude select window (i.e., for MDA of 1740, set 1800). When descent to MDA is desired, select appropriate descent rate with the V/S thumbwheel. Generally a vertical speed of 1000 - 1500 fpm will allow the aircraft to reach the MDA prior to the VDP; however, the descent rate should not exceed 1000 fpm below 1000 feet AGL. The aircraft will level off at the altitude selected. When **ALT HLD** is annunciated in the FMA, set the missed approach altitude in the altitude select window (thereby arming V/S on the FMA).

If the aircraft levels off above MDA (due to altitude select window being above MDA), and visual conditions exist, it is recommended to remain at that altitude until descent to the runway begins. If, however, the aircraft is still in IMC after level off above MDA, select 500 fpm down on the V/S thumbwheel. When the aircraft reaches MDA, press ALT HOLD on the MCP.

When at the VDP, with adequate visual cues, begin descent from the MDA to the TDZ. The autopilot must be disconnected before descending more than 50 feet below MDA. Leaving the MDA for the TDZ, establish the correct control instrument settings (PITCH and POWER) to maintain a continuous and stabilized descent.

Missed Approach

If adequate visual cues are not obtained at the VDP, maintain the MDA until reaching the missed approach point and then initiate a go-around. (Refer to Go-Around Procedures, this section.)

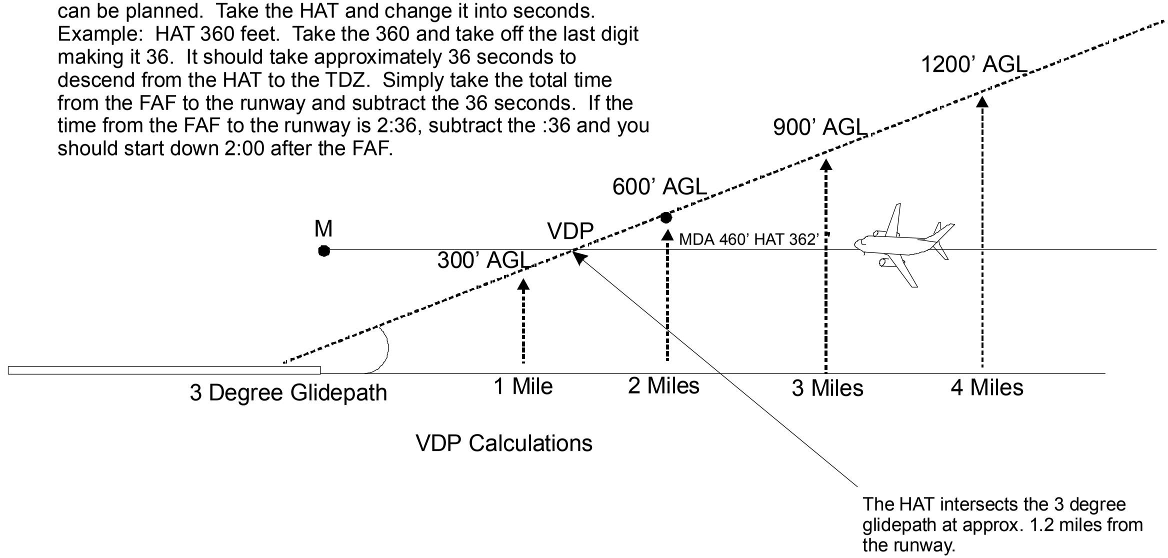
VDP CALCULATIONS

VISUAL DESCENT POINT CALCULATIONS

- Determine from the approach chart the height above touchdown. Example: IAH 15L MDA(H) 460 (362 HAT)
- Determine at what distance from the end of the runway the 3 degree glidepath intersects the HAT.
- Use this distance from the end of the runway as your VDP

Distance from the end of the runway may be available on the RMDI by reference to DME indications.

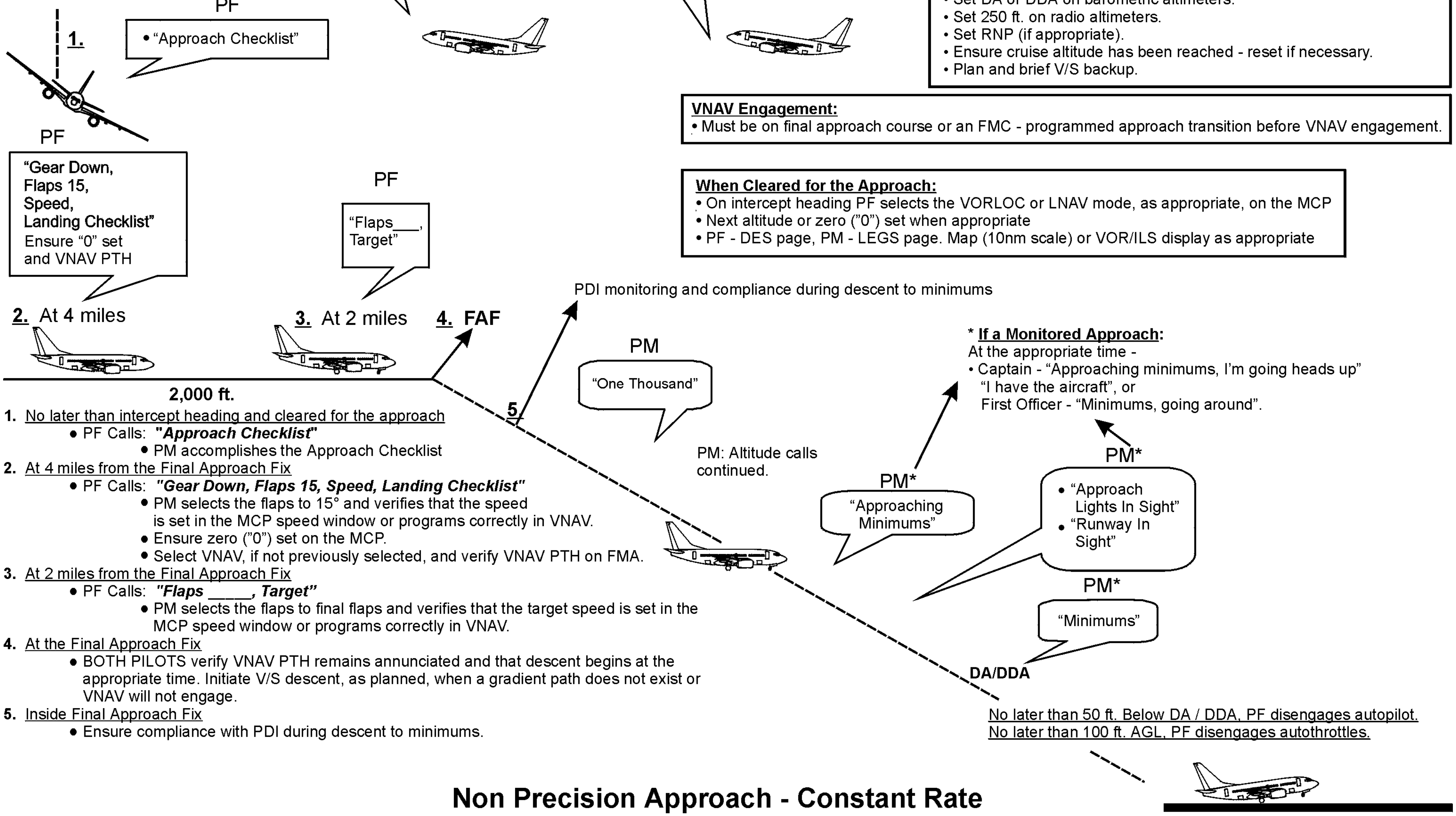
<u>Note</u>: If DME is unavailable an approximate time for the descent can be planned. Take the HAT and change it into seconds. Example: HAT 360 feet. Take the 360 and take off the last digit making it 36. It should take approximately 36 seconds to descend from the HAT to the TDZ. Simply take the total time from the FAF to the runway and subtract the 36 seconds. If the time from the FAF to the runway is 2:36, subtract the :36 and you should start down 2:00 after the FAF.



VDP Calculations

CLEARANCE

Turn left heading 030 intercept the (LOC) maintain 2,000 ft. Until established cleared (LOC) approach runway 36L



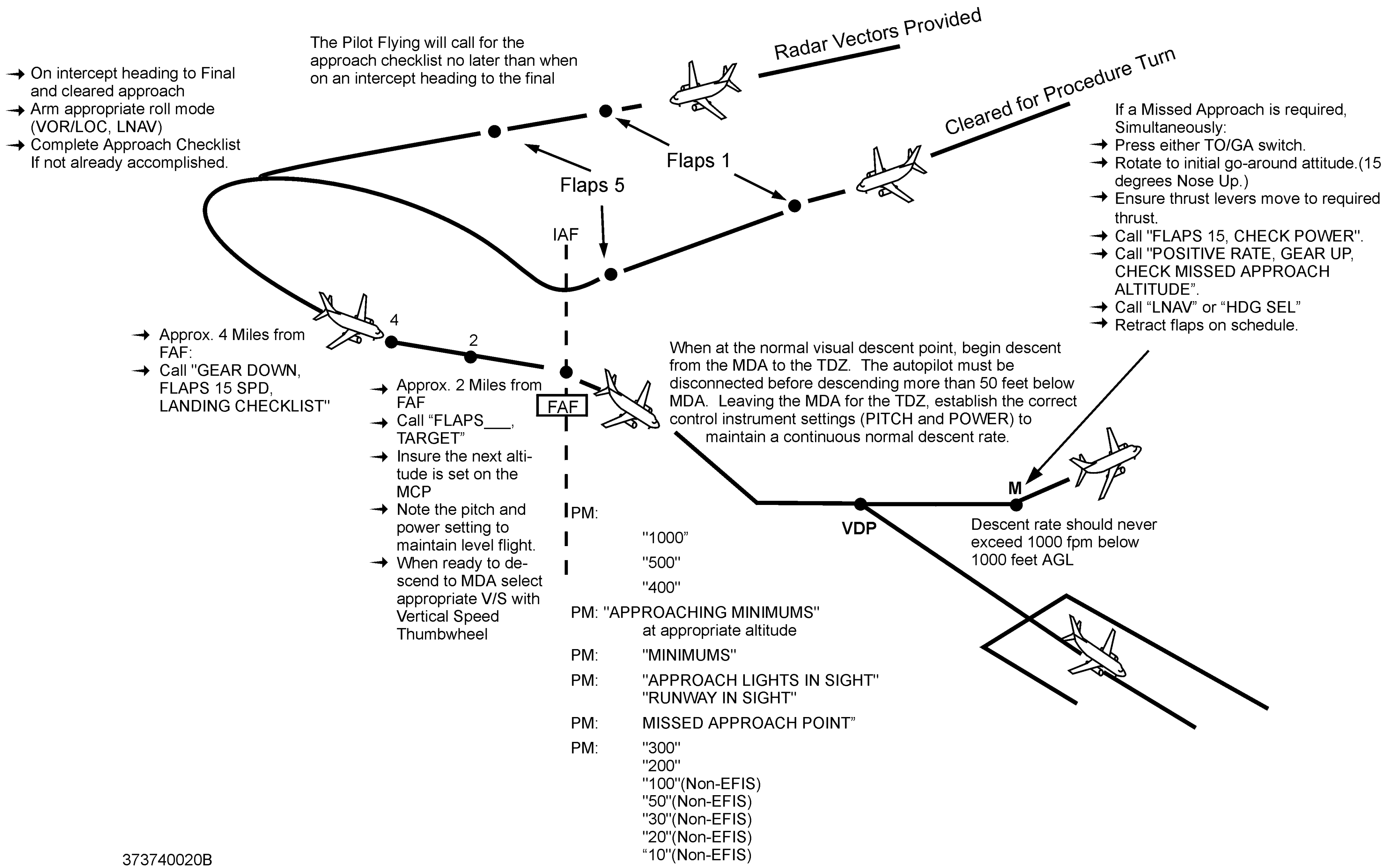
Approach Preparation:
- Approach briefed, selected and modified (if appropriate).
- Prepare for monitored approach if vis ≤ to 1 statute mile or 5000 RVR.
- Verify proper approach and missed approach displayed.
- Select VREF for desired final flaps and check WIND CORR.
- Set DA or DDA on barometric altimeters.
- Set 250 ft. on radio altimeters.
- Set RNP (if appropriate).
- Ensure cruise altitude has been reached - reset if necessary.
- Plan and brief V/S backup.

VNAV Engagement:
- Must be on final approach course or an FMC - programmed approach transition before VNAV engagement.

When Cleared for the Approach:
- On intercept heading PF selects the VORLOC or LNAV mode, as appropriate, on the MCP
- Next altitude or zero ("0") set when appropriate
- PF - DES page, PM - LEGS page. Map (10nm scale) or VOR/ILS display as appropriate

1. No later than intercept heading and cleared for the approach
   - PF Calls: ***"Approach Checklist"***
     - PM accomplishes the Approach Checklist
2. At 4 miles from the Final Approach Fix
   - PF Calls: ***"Gear Down, Flaps 15, Speed, Landing Checklist"***
     - PM selects the flaps to 15° and verifies that the speed is set in the MCP speed window or programs correctly in VNAV.
     - Ensure zero ("0") set on the MCP.
     - Select VNAV, if not previously selected, and verify VNAV PTH on FMA.
3. At 2 miles from the Final Approach Fix
   - PF Calls: ***"Flaps _____, Target"***
     - PM selects the flaps to final flaps and verifies that the target speed is set in the MCP speed window or programs correctly in VNAV.
4. At the Final Approach Fix
   - BOTH PILOTS verify VNAV PTH remains annunciated and that descent begins at the appropriate time. Initiate V/S descent, as planned, when a gradient path does not exist or VNAV will not engage.
5. Inside Final Approach Fix
   - Ensure compliance with PDI during descent to minimums.

Non Precision Approach - Constant Rate



NON-PRECISION APPROACH - NON-CONSTANT RATE

CIRCLING APPROACHES

The B737 is considered a Category D aircraft for purposes of circling approaches.

Continental Airlines Operations Specifications requires any circling approach to be conducted in weather conditions of at least 1,000' ceilings and 3 miles visibility. Therefore, if a circling approach is conducted it must be in weather conditions equal to or greater than 1000'/3, or Category D charted circling landing minimums, whichever is higher.

Maintain a configuration of gear down, flaps 15 at a speed of V_M while maneuvering at 1000 feet above field elevation or Category D circling MDA, whichever is higher. This altitude must be maintained until in position to make a normal descent to the runway. At that time, select landing flaps and reduce speed to target. Complete the LANDING checklist.

A missed approach must be made whenever an identifiable part of the airport is not distinctly visible once reaching minimums. To become established on the prescribed missed approach course, the pilot should make an initial climbing turn toward the landing runway and continue the turn until the aircraft is established on the missed approach course or as directed by the control tower.

The PM should provide maneuvering instructions and/or monitoring of altitude and airspeed as directed by the PF. Care should be taken to avoid a situation where both pilots' attention is directed out of the flight deck. When the PF begins the visual descent to the runway, the PM should closely monitor airspeed and rate of descent.

Due to the VFR weather minimums of 1000'/3 restriction, circling approaches are not specifically trained or checked.

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VISUAL APPROACH

GENERAL

A visual approach is conducted under an IFR flight plan. It allows the pilot to proceed visually to the airport without following a prescribed approach procedure. If the aircraft being followed is in sight, the pilot is responsible for visual separation from other aircraft and wake turbulence avoidance.

THRUST

Use thrust for speed control in coordination with the elevators to control attitude, rate of descent, and approach profile. Adjust thrust slowly and in small increments. Large, sudden thrust changes are indicative of an unstable approach and the related trim changes will make aircraft control more difficult. However, due to the low drag of the aircraft, close attention to speed and thrust control is necessary. A thrust increase may be required when stabilizing on speed with landing gear and flaps extended on final approach.

DOWNWIND AND BASE LEG

Fly at an altitude of 1,500 feet above the runway elevation with flaps 5 and flaps 5 V_M speed.

If a 180° turn to final is required, maintain a track parallel to the landing runway approximately 1½ miles abeam.

Prior to turning base leg:

- Extend the landing gear
- Position the flaps to 15
- Slow to V_M flaps 15 speed
- Call for the LANDING checklist.

Approximately 30 seconds after passing the landing end of the runway (about 45° off the tail):

- Commence the turn to base leg
- Adjust the thrust to descend at 600 - 800 FPM.

Prior to turning final:

- Extend landing flaps and slow to target speed.

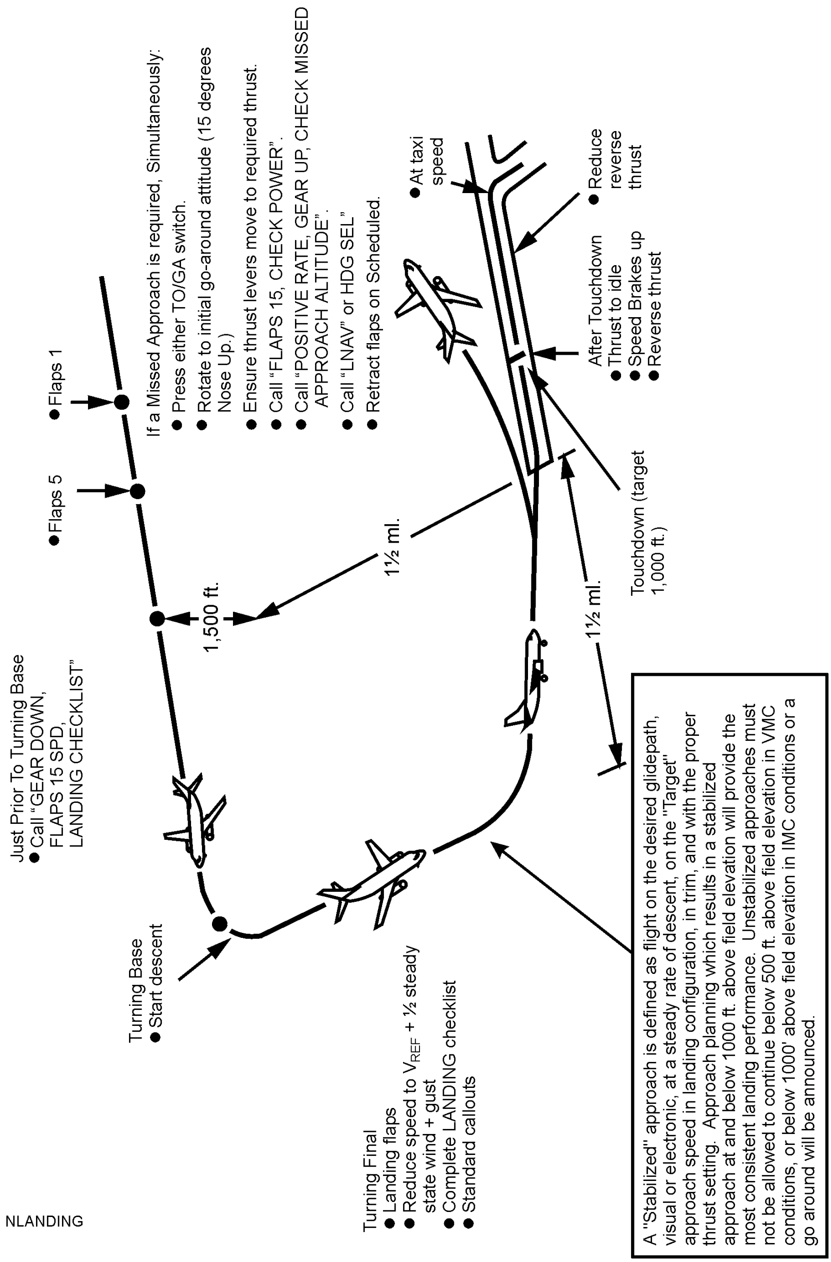
During extension to landing flaps hold the same approximate pitch attitude and anticipate trim changes.

If a large turn to final is not required, approximately 5 miles from the end of the runway and 1,500 feet AGL:

- Extend the landing gear
- Position the flaps to 15
- Slow to V_M flaps 15 speed
- Call for the LANDING checklist
- Adjust the thrust to start a descent of 600 - 800 FPM
- Extend landing flaps and slow to target speed.

FINAL APPROACH

The recommended landing glidepath profile for a visual approach is approximately 2½ to 3 degrees. Once the final approach is established, the aircraft configuration remains fixed and only small adjustments need be made to maintain glidepath and runway alignment. Thrust changes should only be made to hold target speed and the desired rate of descent (approximately 600 to 800 feet per minute). Retrim the stabilizer as necessary to maintain a zero elevator force. The approach must be flown using “stabilized approach” parameters. (See LANDING PROCEDURES for more information.)



VISUAL APPROACH AND LANDING

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GO-AROUND PROCEDURES

GENERAL

A go-around <u>will</u> be initiated if:

- Continuation to a safe landing is not possible at the DH/DA/DDA/MDA or MAP for the approach flown.
- A landing cannot be safely accomplished within the touchdown zone.
- At any point in the approach the pilot feels that safety may be compromised if the approach is continued.

<u>WARNING</u>: Any “TERRAIN,” “PULL UP,” or configuration warning that occurs or continues below 500’ AFE mandates a go-around, regardless of flight conditions.

If the decision is made to go-around during a circling approach or visual maneuvering, the missed approach specified for the approach procedure utilized to get to the airport must be followed. To become established on the prescribed missed approach course, make an initial climbing turn toward the landing runway and continue the turn until established on the missed approach course.

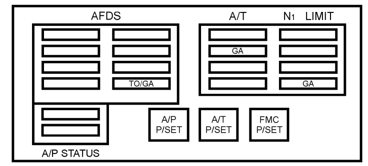
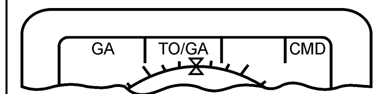
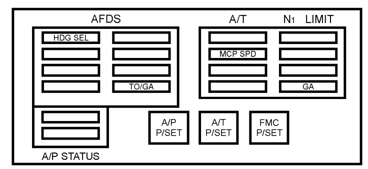
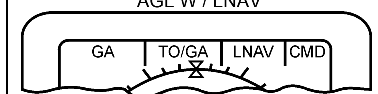
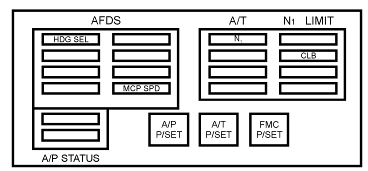
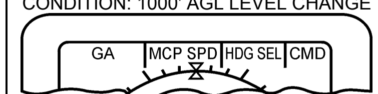
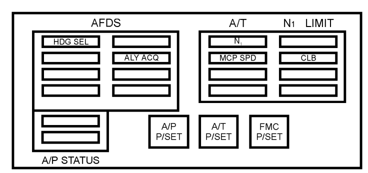
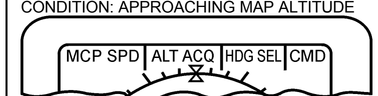
GO-AROUND PROCEDURE

The following chart defines the go-around procedure. It is based on a go-around from a coupled approach. In the event the approach was manually flown with a flight director, the same procedure may be utilized. However, the thrust levers must be positioned manually (if autothrottles are also disengaged). In the event of a raw data go-around, flight director guidance will not be available. Initially rotate to 15 degrees nose up (two engines) and manually advance the thrust levers. In any situation where manual thrust lever operation during a go-around is required, initially advance thrust to full go-around power.

Do not use an intermediate power setting.

During initiation of a missed approach maneuver, sufficient airspeed margin exists to justify immediate retraction of the flaps from the landing setting to the missed approach setting prior to any acceleration above target speed. This is because V_{REF} for the landing flap setting is equal to or greater than V_2 for the missed approach flap setting. Target speed includes a minimum additive of 5 knots to V_{REF}, therefore any missed approach initiated from target speed guarantees V_2 + 5 for the missed approach flap setting. Bank angle must be limited to 15 degrees until attaining V_{REF} + 15. The first white bug above the internal (target) bug is approximately V_2 + 15 for the go-around flap setting. If necessary, normal 25 - 30 degree banks can be utilized for maneuvering at the missed approach flap setting.

AUTO GO-AROUND CHART FROM DUAL CHANNEL APPROACH

PHASE OF FLIGHT	PILOT FLYING: DUTIES / CALLOUTS	PILOT MONITORING: DUTIES / CALLOUTS	③ FMA DISPLAY	3 5 7 8 9 FMA DISPLAY	NOTES - SINGLE CHANNEL
Initiation	Simultaneously: • Press either TO/GA switch. • Rotate to initial go-around attitude. (15 degrees Nose Up.) • Ensure thrust levers move to required thrust. • Call "FLAPS 15, CHECK POWER." • Call "POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE."	• Check for TO/GA Pitch Mode. • Monitor N_1 Limit and assist PF with thrust setting as required. • Position flaps and gear on command and monitor configuration. • Call "POSITIVE RATE." • Call Missed Approach to ATC. • Verify or set Missed Approach Altitude.	CONDITION: AT TO/GA ACTIVATION 	CONDITION: AT TO/GA ACTIVATION 	• Both FD Switches must be on to engage the Pitch Mode in TO/GA. (Initial pitch 15 degrees Nose Up.) • When TO/GA is engaged, the Autopilot disengages. • The A/T Mode changes from MCP SPD to GA initially for nominal thrust to achieve a climb rate of up to 2000 fpm. A second press of the TOGA switches changes the A/T Mode to N_1 and the thrust increases to the maximum GA N_1 Limit. • Speed command will automatically set the maneuvering speed for the flap position in the G/A pitch mode.
400' AGL	• Call for the desired Roll Mode (LNAV or HDG SEL) <u>Note</u>: It is not practical to attempt to use the LNAV Roll Mode during a Go-Around unless the MAP waypoints have been entered on the CDU prior to the approach.	• Select desired Roll Mode. • Ensure correct FMA annunciation. • Assist and monitor as required to execute the MAP.	CONDITION: 400' AGL W / LNAV 	CONDITION: 400' AGL W / LNAV 	• When TO/GA is engaged as the Pitch Mode, the roll steering commands will maintain track. • Above 400 ft. AGL, the desired Roll Mode may be selected.
1000' AGL	• Call "FLAPS 5, CLIMB POWER, LVL CHG, SET TOP BUG." • Adjust pitch as indicated by F/D, begin acceleration, and clean up.	• Retract Flaps on command. • Select N_1, LVL CHG, and V_M flaps 0 on command. Back up PF during MAP to ensure airspeed and NAV procedure compliance.	CONDITION: 1000' AGL LEVEL CHANGE 	CONDITION: 1000' AGL LEVEL CHANGE 	• If the autothrottles are engaged during a Go-Around, selection of N_1 or LVL CHG may result in an increase in power. Consideration may be given to leaving the Pitch Mode in TO/GA if climbing to a relatively low missed approach altitude.
Approaching Missed Approached Altitude	• Continue with Normal Takeoff Procedures.	• Assist PF with Normal Takeoff Procedures.	CONDITION: APPROACHING MAP ALTITUDE 	CONDITION: APPROACHING MAP ALTITUDE 	

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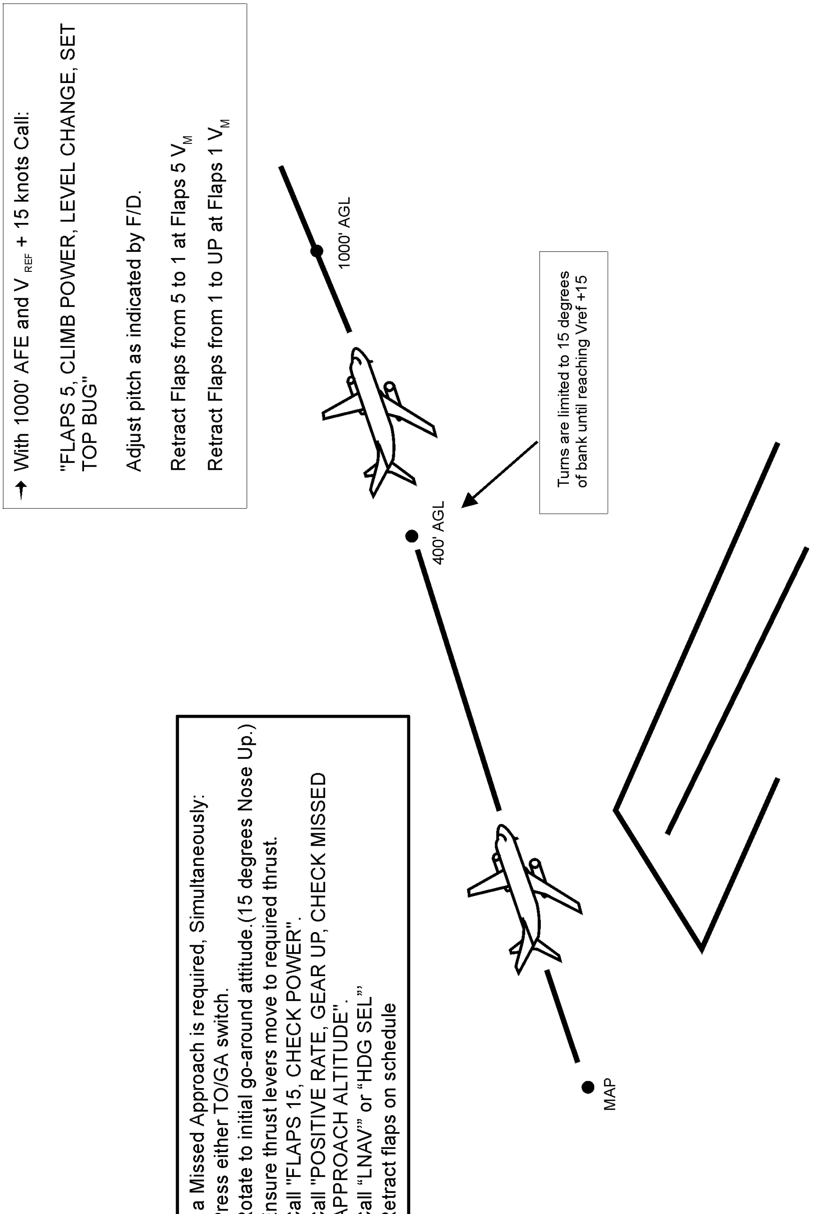

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NORMAL GO-AROUND

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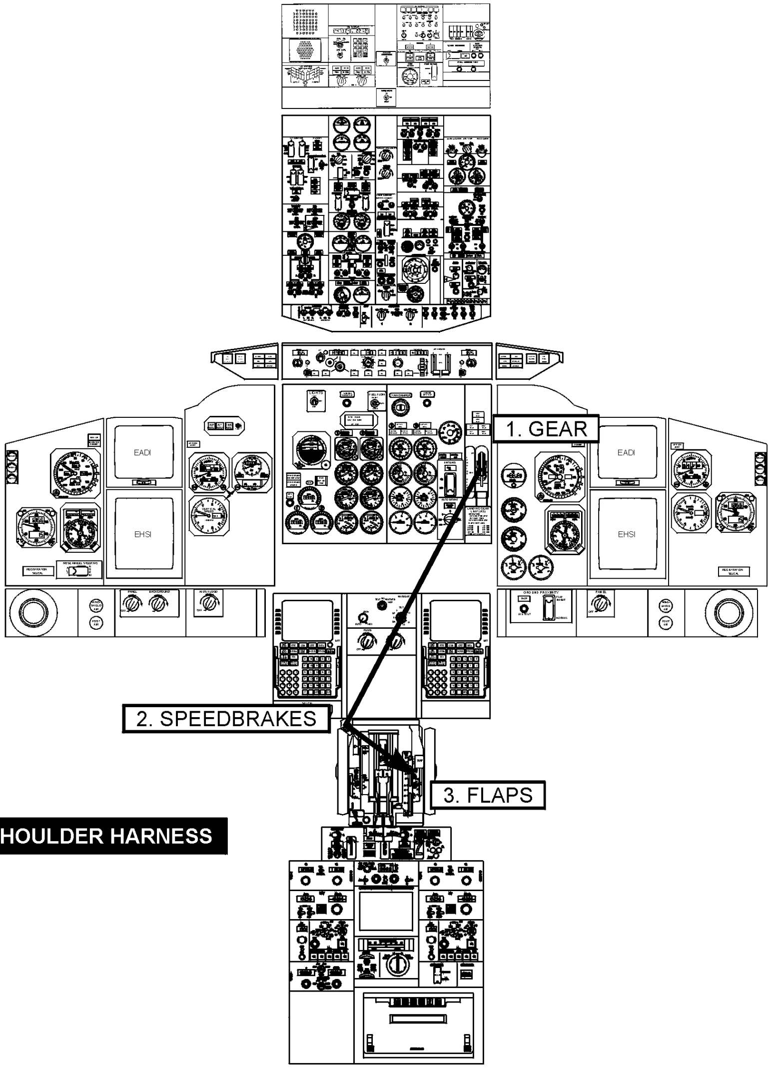
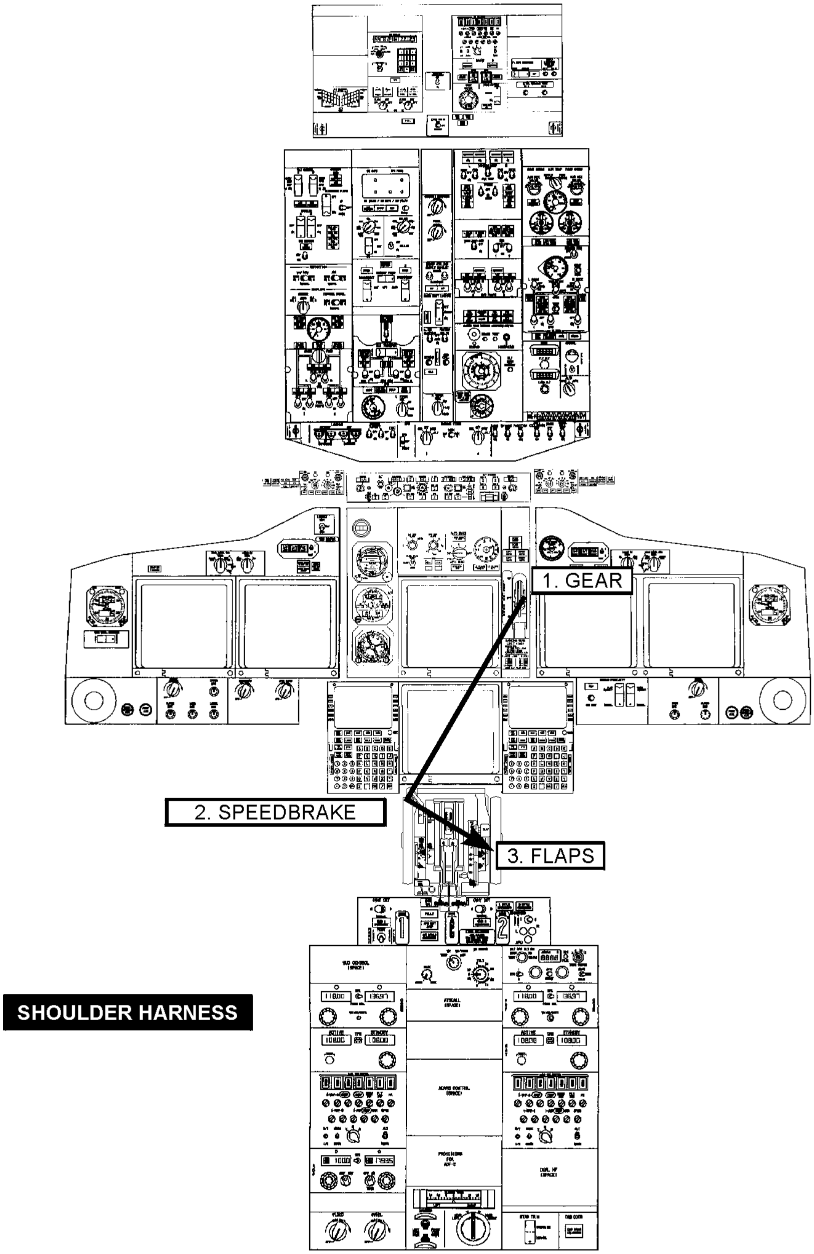
3 3 5 LANDING FLOW



SHOULDER HARNESS

7 8 9 LANDING FLOW



LANDING

The Pilot Flying will call for the LANDING checklist in conjunction with the "GEAR DOWN" call on all normal landings. The flaps should be in the final landing configuration prior to the completion of the last item on the checklist.

PM CHALLENGE	LANDING	PM RESPOND
Speedbrake		**ARMED**
Gear		**DOWN, 3 GREEN (PM, PF)**
Flaps		**____ GREEN LIGHT**

PM Challenge **PM Respond**

Speedbrake..ARMED

The Captain normally arms the speedbrake for landing.

Place the speedbrake lever in the ARMED position and observe that the green **SPEEDBRAKE ARMED** light is illuminated. If the amber **SPEEDBRAKE DO NOT ARM** is illuminated, disarm the speedbrake, and use manual speedbrake for landing. A performance penalty must be considered when using manual speedbrake.

Gear...DOWN, 3 GREEN (PM, PF)

The gear handle should be in the down detent, 3 green down and locked lights illuminated, and gear unsafe lights extinguished.

Flaps.. _____, GREEN LIGHT

Verify the flap position indicator corresponds to the flap handle position selected for landing. The green light verifies that leading edge devices are correctly positioned.

Shoulder Harnesses (Flow)...ON

Each flight crewmember shall, during takeoff and landing keep their **shoulder harness** fastened.

LANDING PROCEDURES

LANDING FLAP SELECTION

A flap 30 configuration is recommended for most landings because it is more operationally efficient, less noisy, and offers better approach - climb performance. All B737 flights are dispatched for a flap 30 landing. A flap 40 landing should be considered for the following situations:

- Short runways
- Slippery runways
- Reduced ceiling and visibility approaches
- Occasional proficiency practice.

FINAL APPROACH

Optimum and consistent landing performance is achieved through the use of a stabilized approach as referenced in Approach Procedures.

Once landing flaps have been established, target speeds (under stable air conditions) will be V_{REF} + 5 knots. However, the decrease in wind velocity approaching the surface of the earth has the effect of a decrease in aircraft velocity. Consequently, caution must be exercised to prevent airspeed bleed off and increased sink rate during the last stage of the approach.

When the autothrottle is used throughout approach and touchdown (Autoland Operations), position the internal bug to V_{REF} + 5 knots, regardless of wind speed. The autothrottle design features include automatic gust compensation. Therefore, it is not necessary to set gust or wind strength corrections on the speed selector. The system will handle the normal wind conditions encountered during the final approach and landing. However, flight crews must be alert for any unusual or extreme windshear conditions and be ready to take manual control of the aircraft to complete the approach and landing or execute a go-around.

In all cases other than a Dual-Channel approach and autolanding with **FLARE** annunciated on the FMA, the autothrottle must be disconnected prior to:

- Non Autoland Precision Approaches: No lower than 50 ft. AGL.
- Non Precision or Visual Approaches: No lower than 100 ft. AGL.

The characteristics of the Autothrottle Landing Flare Retard Mode are not intended, nor are they predictable enough, for landing with manual aircraft control inputs.

When the autothrottle is disconnected, at any point prior to touchdown, it is imperative the target speed reflect the full wind correction. The target speed will be determined by adding ½ the reported wind and all the gust not to exceed plus ③ 3 5 7 20 knots 8 9 15 knots to V_{REF}. The minimum target speed will be V_{REF} + 5 knots.

VISUAL AIM POINT

The pilot should aim for a constant angle relationship with the 1,000 feet mark on the runway, coordinating pitch attitude and power changes. As the end of the runway disappears under the nose, maintain this stabilized attitude and power setting until the flare point is reached.

The pilot should restrain himself from the tendency to dive at the runway when breaking clear of the clouds at low altitude under instrument conditions, or as the end of the runway disappears under the nose in visual flight conditions. The high rates of sink that develop with this maneuver are not readily apparent on either the airspeed indicator or the vertical speed indicator and may not be noticed until the flare point.

THRESHOLD HEIGHT

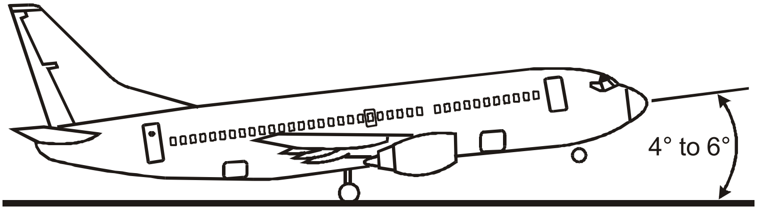
Threshold height is a function of glide path angle and landing gear touchdown target. During a typical 3° visual approach, with a 1,000 foot touchdown, the main landing gear will cross the threshold at approximately 50'. Special attention must be given to establishing a final approach that will assure safe threshold clearance and gear touchdown at least 1,000' down the runway. Recommended standard callouts will assist the pilot in determining a proper profile.

The main landing gear touchdown points, shown on the ILS and Visual Approach Approximate Touchdown Point diagrams in this section, assume no flare.

For Category I ILS installations, a transition from the ILS glideslope to a visual glideslope should be made between decision height and 100'. A visual aim point approximately 1500' down the runway will provide a 40 to 60 foot threshold clearance and a touchdown point about 1200 to 1300' down the runway.

The Radio Altimeter is biased to accurately indicate the height of the lowest part of the main wheels above the terrain. Therefore, the Radio Altimeter is very valuable in determining wheel height. The GPWS-activated annunciation's of radio altitude from 100' to 10' AGL, along with visual cues, will give the PF a good assessment of the final stages of his/her approach, flare, and landing.

FLARE AND LANDING



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Good landings are preceded by well flown, stabilized approaches.

Unstabilized approaches are the main cause of tail strike and near tail strike landings.

Do not make rapid power or pitch changes low to the ground. Landing speeds slower than planned V_{REF} will result in higher than normal pitch attitudes, and reduced tail clearance.

Pilots should observe the following during landing:

- The arming of the speed brake is required, if operable.
- Maintain a minimum of V_{REF} + 5 knots to start of flare.
- Do not trim while in the flare or after touchdown. This can cause rapid or unexpected increases in pitch attitude.
- Do not "hold the aircraft off" striving for a smooth landing. Speed decay, a higher touchdown attitude and reduced tail clearance will result.
- Do not allow aircraft pitch to increase after touchdown.
- Immediately after touchdown, initiate reverse thrust and smoothly"fly"nose wheel onto runway by relaxing aft control column pressure.

During a visual approach, the main landing gear should cross the runway threshold at 50 feet. Main gear touchdown will occur just beyond 1,000 feet, assuming the glidepath angle is 3 degrees.

Do not deviate from the glidepath in an attempt to touchdown sooner.

Crossing the threshold, shift the visual sighting point to approximately ¾ of the way down the runway length, while maintaining descent. This will assist in determining the flare point.

Initiate the flare when the main gear is approximately 15 feet above the runway. After a hard or bounced landing, pilots should do a post flight inspection for any damage. Remember, tail strike damage upon landing will occur approximately 12 feet forward of the tailskid indicator. Please refer to the table below:

Aft Fuselage Contact: Wheels on runway, struts compressed (**landing**).

B737-300	11.0 degrees
B737-500	12.0 degrees
B737-700	12.2 degrees
B737-800	9.2 degrees
B737-900	8.3 degrees

Caution: Tail strike and near tail strike landings have occurred in a flaps 40 configuration that resulted in a hard or bounced landing.

CROSSWIND LANDING

There are three accepted methods used in performing an approach to a landing in a crosswind. They are the crab, sideslip and a combination of the two. In crosswind conditions, the crosswind crab angle should be maintained to touchdown on very slippery runways. Allowing the aircraft to touch down without removing the crab angle will reduce drift toward the downwind side of the runway on wet or icy runways. Auto spoilers and autobrake will operate sooner when all main gear touch down simultaneously, thus establishing main gear crab effect sooner and reducing pilot workload.

CRAB CROSSWIND TECHNIQUE

The objective of the crab crosswind technique is to maintain wings level throughout the approach, touchdown and landing roll. On final approach, a crab angle is established with wings level to hold the aircraft on the desired course. Application of downwind rudder is started just prior to touchdown to eliminate the crab and align the aircraft with the runway centerline.

As the rudder is applied, the upwind wing will sweep forward, developing roll. Hold the wings level by simultaneous application of lateral control into the wind. The touchdown is made with cross controls. The lateral control input can be held nearly constant during touchdown and the start of the landing roll.

A properly performed maneuver will result in the rudder and lateral controls being positioned in the correct position for the start of the crosswind landing roll.

SIDESLIP CROSSWIND TECHNIQUE

The objective of the sideslip crosswind technique is to hold the aircraft longitudinal axis aligned with the course and runway centerline during the final phase of the approach and touchdown.

The initial phase of the sideslip method utilizes the crab method to correct for wind drift.

The final phase of the landing approach is made on course with the aircraft's centerline aligned on or parallel to the runway centerline. Downwind rudder is used to align the longitudinal axis parallel to the desired track as lateral control is applied into the wind to prevent wind drift. Thus, a steady sideslip is established to hold the desired course. Retain to touchdown.

A properly coordinated maneuver will result in nearly fixed rudder and lateral control positions during the final phase of the approach, touchdown, and start of landing roll.

CRAB AND SIDESLIP COMBINED

In the event the crosswind component necessitates a large bank or crab angle, it may be necessary to combine the crab method with the sideslip method.

Touchdown is made by a slight increase in downwind rudder as lateral control is changed to level the wings. Touchdown may be made with the upwind wheels touching down first. Lower the downwind and nose wheels to the runway, and apply aileron into the wind.

With any method, the control requirements at touchdown and start of landing roll are the same. Use speedbrakes, brakes, and reverse thrust normally after touchdown.

BOUNCED LANDING

In the event of a bounced landing:

- Hold or re-establish normal landing attitude
- Add thrust as necessary to control the sink rate
- Do not push over, as this may cause a second bounce and possibly damage the nose gear.

Should a high hard bounce occur:

- Initiate an immediate go-around
- Apply go-around thrust and use normal go-around procedures. A second touchdown may occur during the go-around.
- Do not retract the landing gear until a positive rate of climb is established and called by either pilot.

Caution: Tail strike and near tail strike landings have occurred in a flaps 40 configuration that resulted in a hard or bounced landing.

SPEEDBRAKE

The speedbrake should be armed to extend automatically. Both pilots should monitor speedbrake extension after touchdown. If automatic extension fails, the Captain should immediately extend them manually.

Note: Unless the speedbrake is raised after touchdown, braking effectiveness may be reduced initially by as much as 60% since very little weight will be on the wheels and brake application may cause rapid anti-skid modulation.

Caution: To protect as much as possible from tail strike during landing, the PF must make certain that the landing attitude does not increase after touchdown.

REVERSE THRUST

Immediate initiation of reverse thrust at main gear touchdown and full reverse thrust will allow the autobrake system to reduce brake pressure to the minimum level, thus minimizing brake and tire wear and keep brake temperatures in the normal range.

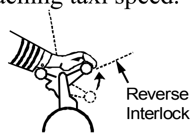
The importance of establishing the desired reverse thrust level (approximately 80% N_1) as soon as possible after touchdown to minimize brake temperatures and tire and brake wear and to reduce stopping distance on very slippery runways cannot be overemphasized.

Since the autobrake system senses deceleration and modulates brake pressure accordingly, the proper application of reverse thrust will result in reduced braking for a large portion of the landing roll.

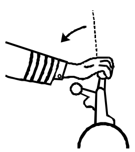
<u>Note</u>: When using only minimum reverse thrust with autobrake, the brake energy requirements will almost double, resulting in high brake temperatures.

At main gear touchdown, rapidly raise the reverse thrust levers and move them aft to the interlock, then to the reverse thrust detent. Modulate reverse thrust as required and avoid exceeding engine limits. Conditions permitting limit reverse thrust to 82% N_1 for passenger comfort. When required, the maximum allowable go-around N_1 may be used.

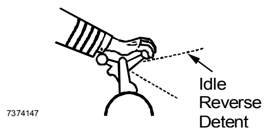
At approximately 80 knots, gradually reduce reverse thrust so as to be at no more than idle reverse when reaching taxi speed.



At Touchdown
Up & Aft Rapidly To Interlock. Maintain
Light Pressure On Interlock.



After Reverse Interlock
Release:
Normal Reverse Until 80 Knots.



AUTOBRAKE

The autobrake system will be used, if available, for all landings. For autobrake selection criteria refer to IN-RANGE checklist.

Note: Check that the **AUTOBRAKE DISARM** light is not illuminated. If illuminated, the autobrake system is inoperative.

The aircraft nose will pitch down as the autobrake system activates and the nose wheels can be eased onto the runway by a small elevator input.

Steer the aircraft with the rudder pedals. Differential braking will terminate autobraking.

During the landing roll, use manual braking if the deceleration is not suitable for the desired stopping distance.

Release the autobrakes by applying manual brake pressure or by positioning the speedbrake lever in the down detent.

The transition to manual braking should be verbalized with the call "MANUAL BRAKES."

The aircraft speed at which the transition from autobrake to manual braking is made varies with aircraft deceleration and stopping requirements. For runway conditions that produce good deceleration, the transition from autobrake to manual brakes should be made at about 80 knots. The transition speed should be closer to a safe taxi speed on very slippery runways or when runway length is limited.

MANUAL BRAKING

After deploying the spoilers, and with the nose gear on the ground, apply wheel brakes. Make this first brake application with only light braking. Apply just enough brakes to feel their effectiveness and to check operation. On a normal landing with the touchdown near the 1,000 foot point, only light braking need be used to complete the stop.

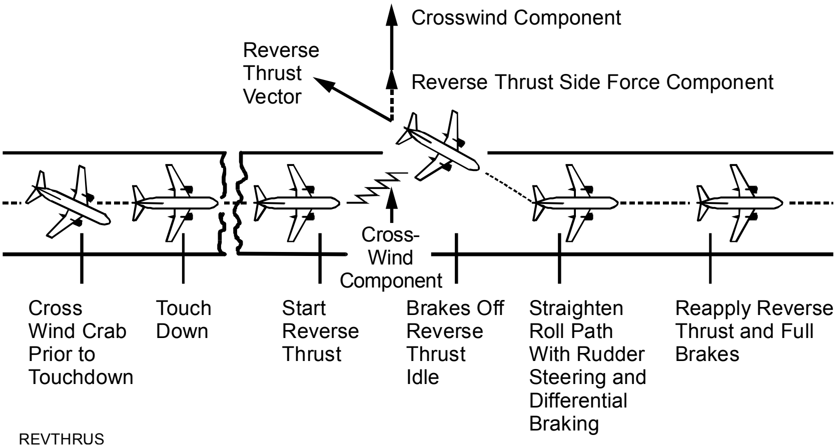
It is estimated that manual braking techniques frequently involve a four to five second delay between main gear touchdown and brake pedal application even when actual conditions reflect the need for a more rapid initiation of braking. This delayed braking can result in the loss of 800 to 1,000 feet of runway. Directional control requirements for crosswind conditions and low visibility may further increase the above delays as can the distraction arising from a malfunctioning reverser system.

The anti-skid system will stop the aircraft for all runway conditions in a shorter distance than is possible with either anti-skid off or brake pedal modulation. The anti-skid system adapts pilot applied brake pressure to runway conditions by sensing an impending skid condition and adjusting the brake pressure to each individual wheel for maximum braking effort.

When brakes are applied on a slippery runway, several skid cycles will occur before the anti-skid system establishes the right amount of brake pressure for the most effective braking. If the pilot modulates the brake pedals, the anti-skid system is forced to readjust the brake pressure to establish optimum braking. During this readjustment time, braking efficiency is lost.

Due to the low available braking coefficient of friction on extremely slippery runways at high speeds, the pilot is confronted with a rather gradual buildup of deceleration and may interpret the lack of an abrupt sensation of deceleration as a total anti-skid failure. The natural response might be to pump the brakes or turn off the anti-skid. Either action will degrade braking effectiveness.

REVERSE THRUST AND CROSSWIND



This diagram shows a directional problem during a landing rollout on a slippery runway with a crosswind. As the aircraft starts to weather vane into the wind, the reverse thrust side force components adds to the crosswind component and drifts the aircraft to the downwind side of the runway. Main gear tire cornering forces available to counteract this drift will be at a minimum when the anti-skid system is operating at maximum braking effectiveness for existing conditions. To correct back to the centerline, reduce reverse thrust to idle reverse and release the brakes.

This will minimize the reverse thrust side force component without the requirement to go through a full reverser actuating cycle, and provide the total tire cornering forces for realignment with the runway centerline. Use rudder steering and differential braking, as required, to prevent over correcting past the runway centerline. When re-established near the runway centerline, apply maximum braking and reverse thrust to stop the aircraft.

On slippery runways, control capability will vary with runway surface condition, aircraft loading, and pilot technique. The following represent reasonable "Maximum Crosswind Component Guidelines" and are not considered limiting. These crosswinds have been determined by analysis and have not been sustained by demonstration. A range of values is given to account for variations in slipperiness that can be encountered within the qualitative runway surface descriptions and for varying pilot technique.

RUNWAY CONDITION	CROSSWIND COMPONENT
Wet, No Standing Water	15 to 25 kts.
Icy, Slush, or Standing Water	5 to 15 kts.

Landing Summary

In summary, the pilot should check runway conditions prior to approach. The aircraft should be flown before touchdown in a manner that will minimize the total landing distance and use as much of the total runway as possible without risking a "Short" landing. During the approach, the pilot should:

- Arm the autobrake system, if available, by selecting desired deceleration.
- Arm speedbrake.
- Plan for touchdown 1000 feet from the threshold.
- Stay on the recommended glide path.
- Maintain close control over the approach speed to keep it at the speed recommended for existing conditions.
- Make the necessary corrections for windshear and gust.
- Fly the aircraft onto the runway at the desired point even if the speed is high. The majority of long landings and tail scrapes during landings are the result of holding the aircraft off the runway for a smooth touchdown.
- Make certain that aircraft is not allowed to "Pitch Up" after touchdown. Fly the nose down to the runway.

For detailed discussion of landing procedures on wet or slippery runways, see LANDING ON WET OR SLIPPERY RUNWAYS in this section.

After touchdown and during landing roll, the following procedures are accomplished during normal deceleration.

PILOT FLYING	PILOT MONITORING
Throttles - Idle.	
Check speedbrake lever full up.	Check speedbrake lever - full up.
If autobrake are used and the **DISARM** light illuminates or if deceleration is not normal brake manually.	
Reverse Thrust - Initiate. Without delay, raise both reverse thrust levers to the interlock, then to the reverse thrust detent. Modulate reverse thrust as required and avoid exceeding engine limits. Conditions permitting, limit reverse thrust to 82% N_1 for passenger comfort.	Monitor **REVERSER UNLOCKED** lights for normal indication. Engine Instruments - monitor. Advise Pilot Flying of any engine limit being approached, exceeded or any other abnormalities.
At approx. 80 knots, gradually reduce reverse thrust to be at idle reverse when reaching taxi speed.	Call out "80 KNOTS."
At approximately normal taxi speed, slowly move the reverse thrust levers to the full down position.	Observe **REVERSER UNLOCK** lights extinguished.
Release autobrake by applying a light pedal force and announce "MANUAL BRAKING."	Call "MANUAL BRAKING" if not announced.
	The Captain will assume control of the aircraft with engines in idle reverse, no later than when the aircraft leaves the runway centerline, and announce "I HAVE THE AIRCRAFT."

WARNING: After reverse thrust has been initiated, a full stop landing must be made.

Caution: The nose wheel steering (tiller) should not be used above normal taxi speeds (20 knots).

REJECTED LANDING

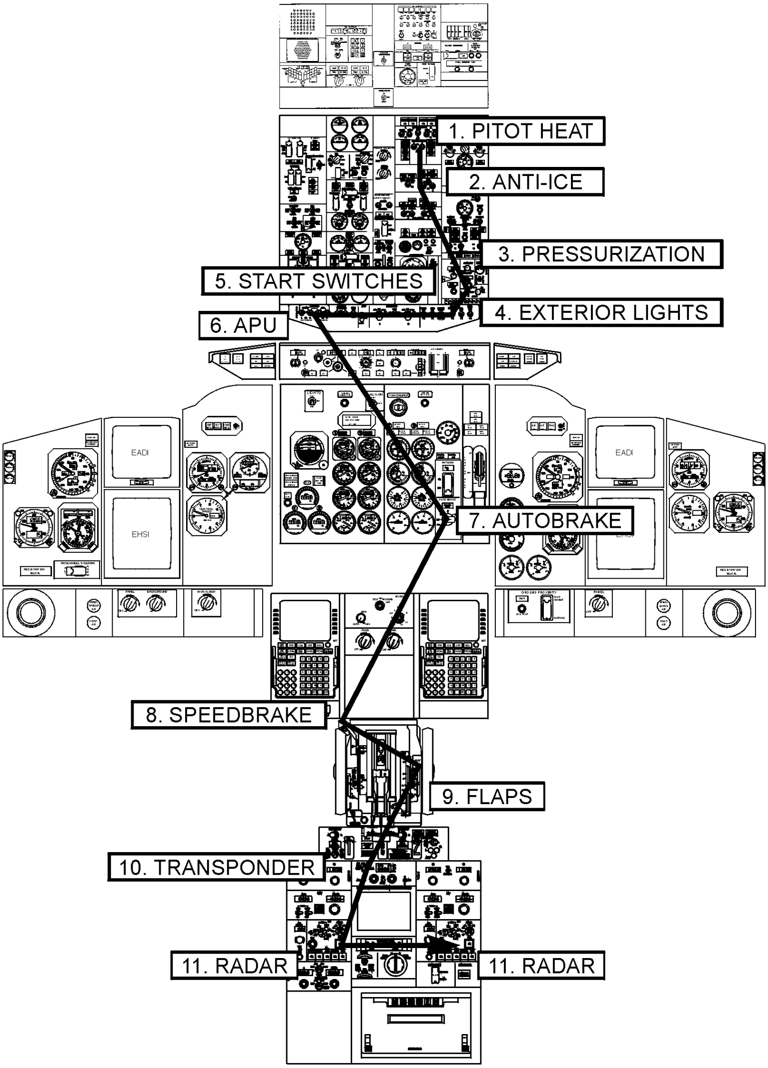
The Rejected Landing procedure is identical to a go-around.

- Set thrust and select flaps 15 while rotating to go-around attitude.
- Retract the landing gear only after a positive rate of climb is established and called by either pilot.
- Retract the flaps on the normal flap retraction schedule.

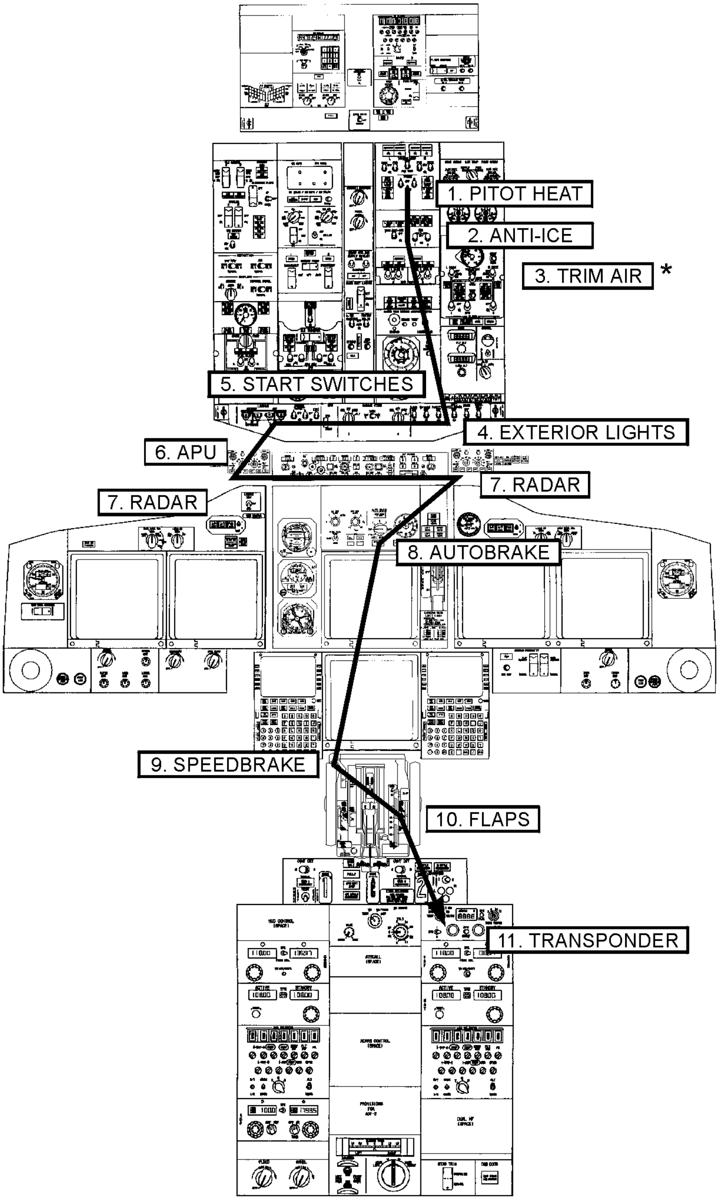
Speedbrakes will retract and autobrake will disarm as the throttles are advanced for a rejected landing initiated after touchdown.

WARNING: Do not attempt go-around after reverse thrust has been initiated. Five seconds are required for a reverser to stow in the forward thrust position and a possibility exists that a reverser may not stow in the forward thrust position.

③ 3 5 AFTER LANDING FLOW



7 8 9 AFTER LANDING FLOW



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AFTER LANDING

The After Landing flow is accomplished by the First Officer only after the checklist has been called for by the Captain. The Captain will call for the AFTER LANDING Checklist when time permits and clear of all active runways. At the Captain's discretion, the checklist may be accomplished if a significant taxi period or hold is encountered after clearing the landing runway and before crossing other active runways. The First Officer will verify that all items have been accomplished, and will report "AFTER LANDING CHECKLIST COMPLETE." The First Officer will not read the challenges and responses aloud. In the event any individual item(s) are not accomplished, the First Officer will bring those items to the attention of the Captain.

F/O CHALLENGE	AFTER LANDING (Silent)	F/O RESPOND
Anti-Ice		**(AS REQUIRED)**
Trim Air Switch (If Installed)		**OFF**
Pressurization		**(AS REQUIRED)**
Start Switches		**OFF**
APU		**(AS REQUIRED)**
Exterior Lights		**(AS REQUIRED)**
Autobrake		**OFF**
Speedbrake		**DOWN DETENT**
Flaps		**UP**
Radar		**OFF**
Transponder		**STBY**

F/O Challenge **(Silent)** **F/O Respond**

Anti-Ice .... (AS REQUIRED)

Pitot heat, cowl anti-ice and wing anti-ice are turned off except under icing conditions.

Window heat is normally left on at through-flight stations.

8 9 Trim Air Switch (If Installed)... OFF

After landing, turn the trim air switch OFF prior to the first power transfer (normally during taxi in).

Pressurization.. (AS REQUIRED)

If the aircraft is equipped with the analog pressurization controller, place the Flight / Ground switch to GRD.

Start Switches...OFF

APU ....(AS REQUIRED)

If APU use is anticipated, start the APU and connect the APU generator to the busses.

Exterior Lights ....(AS REQUIRED)

Daylight: The following lights will remain **ON**.

- **POSITION**
- **ANTI COLLISION**

Darkness: The following Lights will remain **ON**.

- **POSITION**
- **ANTI COLLISION**
- **LOGO**

Use **TAXI** and/or **RUNWAY TURNOFF** lights as necessary.

Autobrake...OFF

Speedbrake...DOWN DETENT

Normally the Captain will stow the speedbrake handle.

Flaps ....UP

Flaps will be retracted unless landing / taxiing in snow, ice, or slush. In that case, do not retract beyond flaps 15 until maintenance inspection of the inboard flap wells confirms no accumulation.

Radar ....OFF

Transponder..STBY

WARNING: For any aircraft with predictive windshear, any mode except STBY allows the radar to operate in the windshear mode creating a radiation hazard to personnel on the ground. This hazard exists even if the radar mode is selected to OFF or TEST.

AFTER LANDING NOTES

The AFTER LANDING checklist must be accomplished prior to engine shutdown, and the required cooling times must be observed.

Engine cool down prior to shutdown:

- 1 minute - minimum.
- 3 minutes - recommended.

Single engine taxi is authorized after landing. The AFTER LANDING checklist must be accomplished prior to engine shutdown, and the required cooling times must be observed.

③ 3 5 During hours of darkness with APU OFF, leave the #2 engine running until commencing the turn into the gate. Right side cabin lighting (#2 Gen Bus) would otherwise be lost.

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GATE ARRIVAL PROCEDURES

GENERAL

When conditions permit, single engine taxi to the gate is recommended. The Captain will NORMALLY ensure that #2 engine is shut down a minimum of 30 seconds prior to reaching parking spot.

Upon arrival of aircraft at station, the assigned safety man will guide it to the normal parking location.

PARALLEL PARKING

The safety man is responsible to ensure that aircraft, personnel and equipment at gate behind are safe from injury or damage from jet blast before giving clearance signal for aircraft to taxi into forward gate. The safety man must advise high lift truck operators at immediate gate behind to lower truck bed and hold aircraft out of forward gate until bed on truck has been lowered.

J-LINE PARKING (REFER ALSO TO OPERATIONS MANUAL)

The safety man will assume a position at the base of the J-Line, assisting the Captain in aligning the nose wheel. When the aircraft is signaled to turn, the safety man will assume a position on the left side of the aircraft 45 degrees to the flight deck and walk the aircraft to its final position.

It is most important that the aircraft continue on a straight line for approximately 10 feet after the last turn is completed. This ensures that all wheels are in line and that the stress placed on the landing gear is relieved.

NOSE-IN PARKING

Nose-In Without Mechanical Aids - The safety man will provide appropriate signals to the flight deck from a position which affords 100% visibility by the flight deck. The signals will relate solely to wheel alignment and stop (refer to Operations Manual).

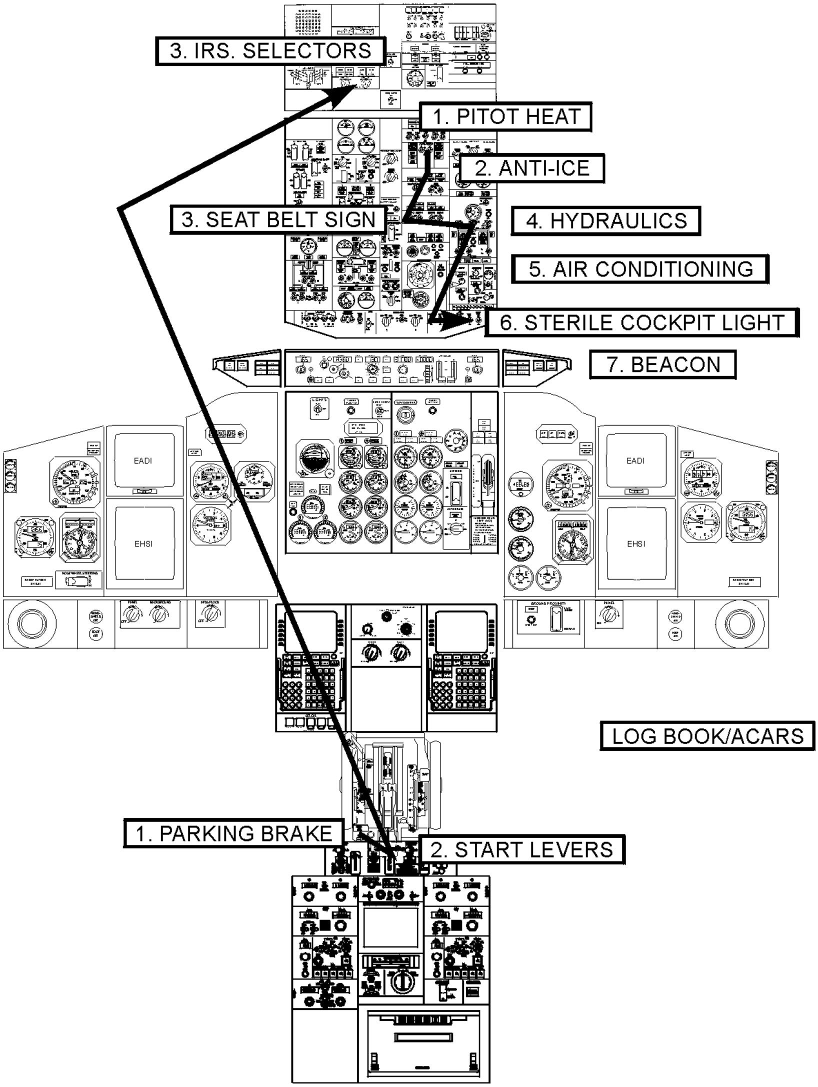
Nose-In With Mechanical Aids - Once ramp clearance has been ascertained by either the ramp supervisor or his designated alternate, a visual signal will be activated to advise the flight deck that parking activity may commence. At no time, then, will ground personnel be directly involved in the parking of the aircraft itself.

After the aircraft has come to a complete stop, an agent will insert wheel chocks firmly both fore and aft of either the inboard main wheel assemblies or the nose wheel tires. After the chocks are inserted, a hand signal will be given to the crew to release the brakes.

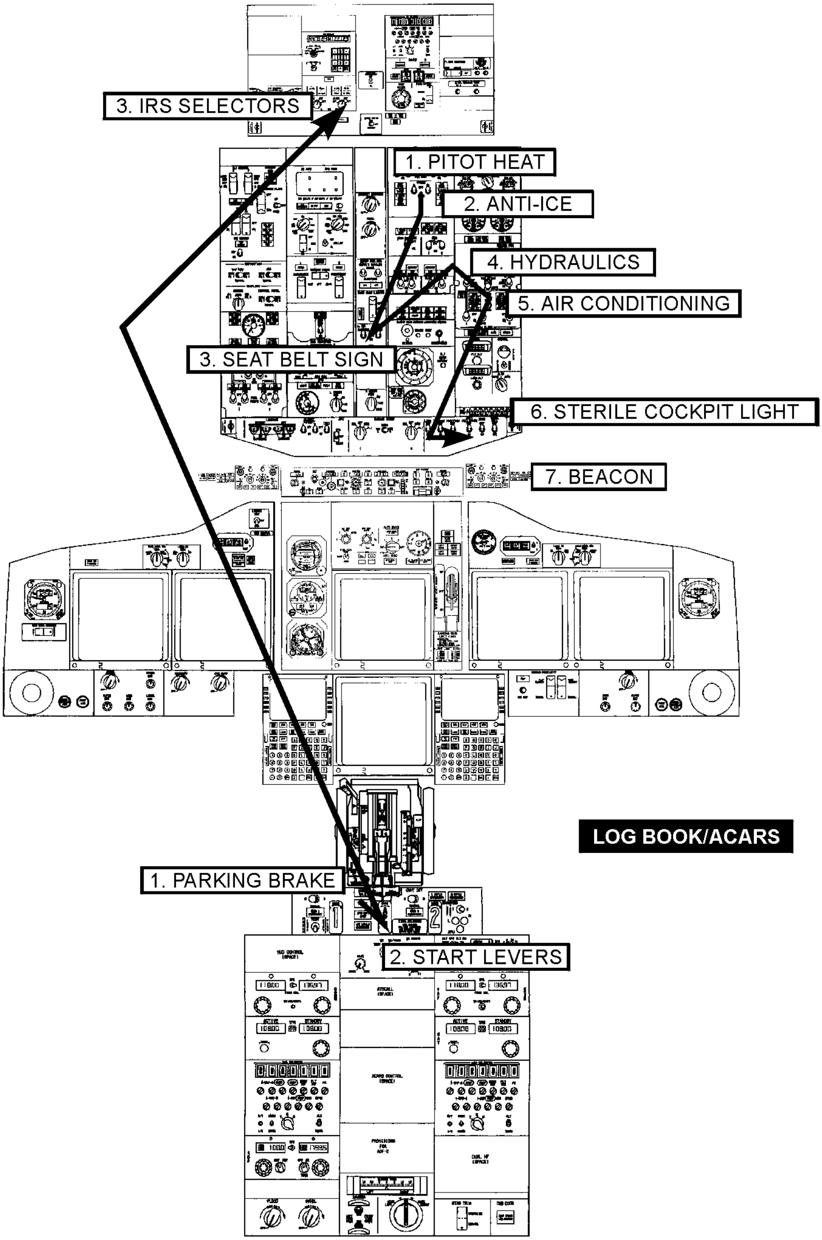
BRAKE AND TIRE CONSIDERATIONS

Certain combinations of high altitudes, high landing weights, and high temperatures may cause excessive brake and tire heating during the landing. For information on minimum turnaround times, consult the charts in Performance, Section 5.

③ 3 5 PARKING FLOW



7 8 9 PARKING FLOW



PARKING

The PARKING flow should be initiated after the aircraft comes to a stop at the gate or parking spot and the engines are shut down. After the flow is complete, the Captain will call for the PARKING checklist.

F/O CHALLENGE	PARKING	CAPT. RESPOND
Parking Brake		**(AS REQUIRED)**
Start Levers		**CUTOFF**
Pitot Heat / Anti-Ice		**OFF**
Hydraulic System		**SET**
Beacon		**OFF**
Log Book / ACARS		**COMPLETED**
IRS Selectors		**OFF**

F/O Challenge **Capt. Respond**

Parking Brake.................(AS REQUIRED)

Initially set parking brake when at a full stop. After all engines are shut down and the appropriate signal has been received from ground service personnel that the wheels are chocked, release the parking brake.

Start Levers.................CUTOFF

The Captain will shut down the engine(s) upon arrival in the final park position and monitor engine instruments to ensure that a complete shutdown has occurred.

Caution: Prior to shutdown, the engine should be operated below 35% N_1 (preferably at idle) for a period of 3 minutes (absolute minimum of 1 minute) following touchdown or until arriving at the gate, whichever occurs first.

Pitot Heat / Anti-Ice.................OFF

The First Officer will insure that the pitot heat, engine anti-ice, and wing anti-ice are turned off.

Seat Belt Sign (Flow).................OFF

The First Officer will turn the seat belt sign OFF when he observes the parking brake set, and the engines being shut down unless the Captain requests otherwise.

Hydraulic System ....SET

Both electric hydraulic pump switches are normally turned OFF; however, if conditions dictate, one may be left ON to function as a gust lock.

Air Conditioning (Flow)...SET

Evaluate air conditioning requirements and configure pneumatics appropriately.

<u>Caution</u>: Possible supply duct manifold damage may occur when APU air and ground preconditioned air are being supplied to the aircraft simultaneously.

To avert possible damage to the ducting system(s) the following procedures will be followed:

- If preconditioned air is supplied after gate arrival, the APU bleed air switch and air conditioning pack switch(es) **<u>must</u>** be turned OFF.
- If preconditioned air is not supplied after gate arrival, the APU bleed air switch and air conditioning pack switch(es) **<u>must</u>** be turned OFF prior to the last pilot leaving the flight deck. Passenger comfort should always be a consideration before this is accomplished.

Sterile Cockpit Light (Flow)..OFF

Beacon ....OFF

Log Book / ACARS ....COMPLETED

Actual FOB will be recorded in the logbook after each leg.

For ETOPS / LRN flights, record IRS data in the logbook as described in Section 3-1.

Complete ACARS Post-Flight Report:

The POST FLIGHT REPORT is not available until after the In event.

After all the required information has been entered, touch SEND to queue the In Report message and return the display to the screen from which the POST FLIGHT REPORT was called.

SEND has no effect if any required information is missing.

If the POST FLIGHT REPORT is not sent, the **FIELD LOCKED** message will appear when an attempt is made to initialize the system for the next flight.

IRS Selectors .... OFF

Caution: Center tank fuel pumps must be OFF unless personnel are available on the flight deck to monitor low-pressure lights.

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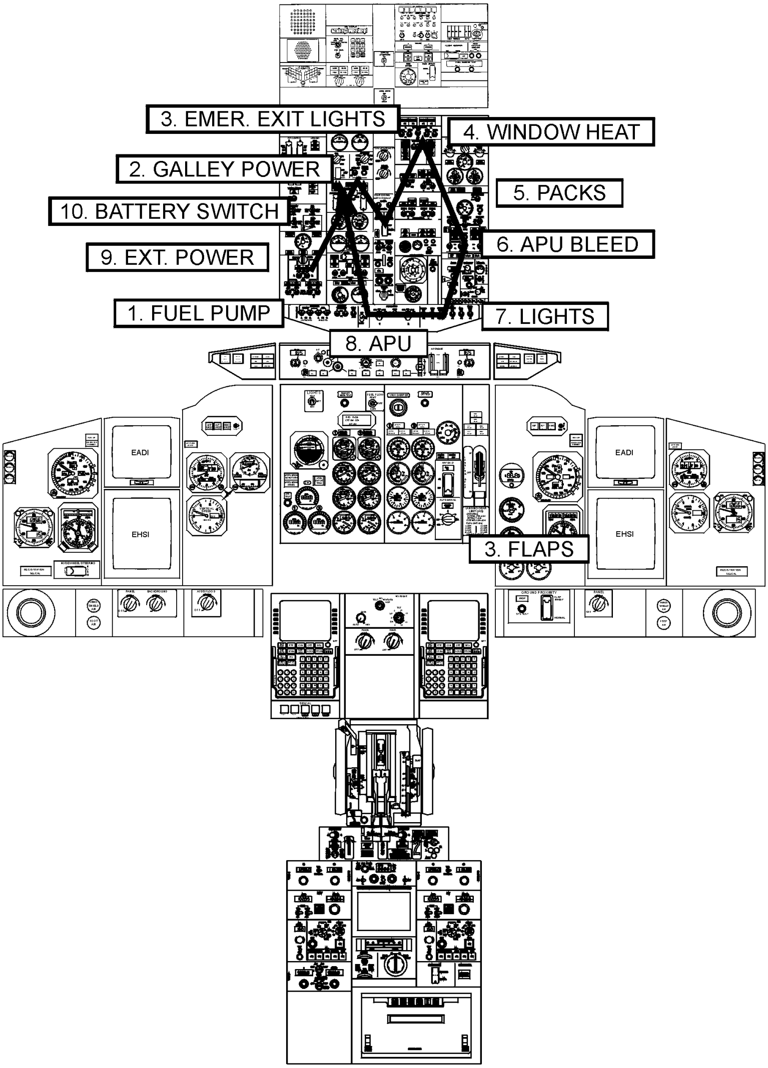
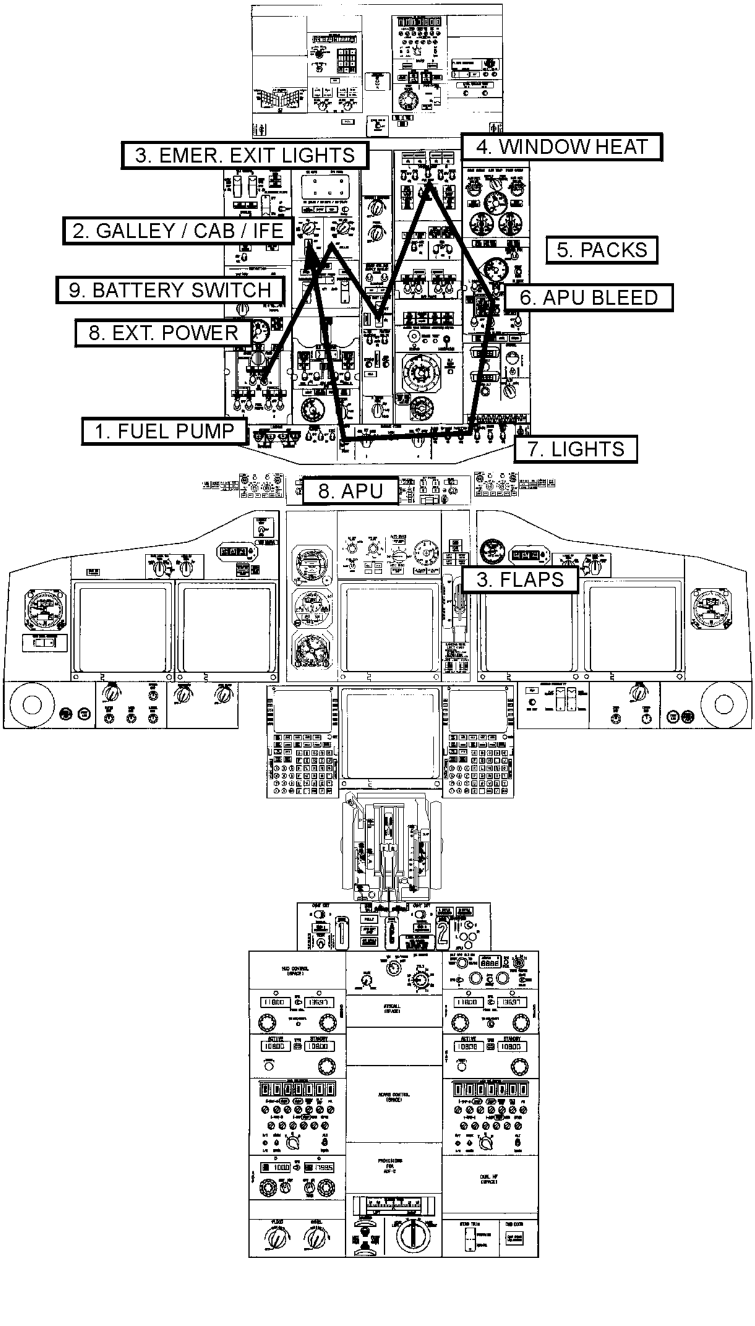
③③⑤ TERMINATION FLOW



7 8 9 TERMINATION FLOW



TERMINATION

The following Termination procedure / checklist will be accomplished by the combined crew, EITHER PILOT CHALLENGE – EITHER PILOT RESPOND. The TERMINATION checklist should be completed whenever:

- The aircraft is to be left unattended for a significant period of time.
- When turning the aircraft over to Maintenance or station personnel for an overnight.
- When overnighting at a non-maintenance station.

EITHER PILOT CHALLENGE	TERMINATION	EITHER PILOT RESPOND
Fuel Pumps		**OFF**
Galley or Cab/Util		**OFF**
IFE/Pass Seat (If Installed)		**OFF**
Emergency Exit Lights		**OFF**
Window Heat		**OFF**
Packs		**OFF**
APU Bleed		**OFF**
Lights		**OFF**
APU/EXT Power		**(AS REQUIRED)**
Battery Switch		**(AS REQUIRED)**

Either Pilot Challenge **Either Pilot Respond**

Fuel Pumps .... OFF

If the APU will remain running, provide positive fuel pressure by leaving one boost pump on as appropriate.

Center tank fuel pumps must be OFF unless personnel are available on the flight deck to monitor low-pressure lights.

Galley or Cab/Util .... OFF

7 8 9 **IFE/Pass Seat (If Installed) .... OFF**

Emergency Exit Lights .... OFF

Do not disarm the **EMERGENCY EXIT** lights until all passengers have deplaned.

Window Heat .... OFF

Packs .... OFF

Pneumatics are normally configured for termination with both packs OFF and engine bleeds ON.

APU Bleed .... OFF

Ensure that the APU operates for at least one minute with no pneumatic load prior to shutdown.

Lights.. OFF

Turn off exterior and interior lights as appropriate, leave **NAV** lights **ON** if the aircraft will remain powered.

APU/EXT Power.. (AS REQUIRED)

Configure the electrical system as required. Normally leave the electrical system powered. Use of external power is preferable to operation of the APU. Consideration should be given to depowering the electrical system if the aircraft will be left unattended as a precaution to prevent depletion of the battery should the external power fail.

If overnight maintenance available, leave the aircraft powered if requested by Maintenance. Use of external power is preferable to APU operation.

If overnight at a non-maintenance base, shut down the APU, wait 20 seconds for the door to close, and turn battery switch OFF. If external power is available, it may be connected and used to power lights in the cabin by selecting the ground service switch at the forward flight attendant station to ON.

At the request of Maintenance or station personnel, the APU may be left running and the electrical system fully powered.

Battery Switch.. (AS REQUIRED)

Configure the electrical system as required for ground operations. Under normal situations, use of external power and shutting down the APU should be accomplished.

Consideration should be given to depowering the electrical system if the aircraft will be left unattended, as a precaution should the external power fail.

Depower the electrical system except for the ground service bus if needed by ground personnel. This will be accomplished by:

- 7 8 9 De-select external power, if connected. (This will de-power the Transfer busses.)
- Select the ground service bus at the Flight Attendant station.
- Turn off the Battery Switch.

At the request of Maintenance or station personnel, the APU may be left running and/or the electrical system fully powered.

OVERNIGHT PARKING AT NON-MAINTENANCE STATION

Procedures for overnighting an aircraft at a non-maintenance station are as follows:

- When the flight crew is aware that a non-maintenance station will be used to overnight the aircraft, the last maintenance station that is passed through should be notified of any condition or fault that may affect the following morning's departure.
- Upon termination of a flight at a non-maintenance station, the flight crew must contact Maintenance Control and advise them of any maintenance problems of a serious nature or if servicing is required. A serious problem is defined as one that would ground the aircraft or cause it to be in violation of the minimum equipment list (MEL) or configuration deviation list (CDL).
- If high winds are forecast park aircraft into wind or forecast wind.
- Inform Maintenance Control of existing fuel load in the event ballast fuel is necessary.
- Prior to leaving the aircraft, a walk-around inspection should be conducted by one of the crewmembers.

Terminal operations should provide additional securing of the aircraft which includes at least closing all the doors and installing chocks.

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SUPPLEMENTARY PROCEDURES

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM

TCAS II is installed and interfaced with the aircraft's transponder, weather radar system(s) and IVSI's to provide the flight crew with graphic air traffic displays as a backup to visual collision avoidance, application of "right of way" rules, and Air Traffic Control (ATC).

To effectively work, timely and reliable crew response to TCAS advisories is essential. Delayed crew response or reluctance of a flight crew to adjust flightpath as advised by TCAS due to ATC clearance provisions, fear of later FAA scrutiny, or other factors could significantly decrease or negate the protection afforded by TCAS.

General

Unless otherwise specified, pilots are expected to operate TCAS while in flight in all airspace, including oceanic, international, and foreign airspace. TCAS operation should be in the TA/RA mode except as otherwise required.

The 5 or 10 mile TCAS RANGE should be selected for takeoff. During climb, the range should be incrementally increased to allow optimum traffic display. The selected range is often dependent on the traffic situation and density. The 40 nm selection is normally optimum for cruise flight. During descent, the range may be incrementally adjusted downward as the aircraft approaches and enters the terminal environment. During both climb and descent, ABOVE or BELOW may be selected to "clear" the airspace into which the aircraft is climbing or descending. This action affects only the display of traffic and does not effect the TA/RA.

Deviation From Assigned Clearance

Deviation from a clearance in response to a <u>TA only</u> is not authorized unless the traffic is acquired visually and the pilots determine that evasive action is required in accordance with normal "see and avoid" practices. Such evasive action will be reported as due to <u>visual</u> contact with the traffic.

Deviation from a clearance in response to an <u>RA</u> is authorized only to the extent required to follow the RA display guidance. If the RA requires maneuvering contrary to right of way rules, cloud clearance rules, or other criteria, pilots are expected to follow the TCAS RA guidance. Deviation from rules, policies, procedures, or limitations should be kept to the minimum necessary to comply with TCAS guidance.

Pilot Response To Traffic Alerts (TA)

The flight crew should respond immediately to TA's by attempting to establish visual contact with the traffic. Continue to clear for other traffic during the search for the alert traffic. If the traffic is acquired visually, continue to maintain or attain safe separation in accordance with current FARs and good operating practices. Do not alter the aircraft's flight path based solely on a TA without visual confirmation of the need to do so. Maneuvering based solely on a TA, in an effort to pre-empt an RA, is not authorized.

Pilot Response To A Resolution Advisory (RA)

The TCAS software design is such that the triggering of an RA indicates a real threat of collision. Therefore, an immediate and correct response to an RA is mandatory unless overriding safety concerns exist. Correct response to an RA is indicated even if the crew believes they have the traffic in sight, due to the possibility of misidentification of the target traffic.

Preventative RA

Respond to a preventative RA by monitoring aircraft vertical speed to ensure that it does not enter the red area. Normally, compliance with preventative RA's can be accomplished without deviation from the assigned clearance; however, if deviation is required, it is authorized. All crewmembers should attempt to acquire the traffic visually.

Corrective RA

Respond immediately to corrective RA's by altering the aircraft's flight path as indicated. Use positive control inputs similar to those expected in response to an ATC clearance incorporating the term "immediately." Do not maneuver in a direction not specified by the RA display. TCAS is aware of other aircraft in the vicinity and in many instances, TCAS to TCAS coordination may have occurred. The Pilot Flying should dedicate his direct attention to accurately flying the aircraft in accordance with the RA commands. Respond immediately and decisively to increase, decrease, and reversal commands. Initial response delayed over 5 seconds, or response to subsequent modified (increase or reversal) guidance delayed over 2½ seconds will compromise separation. The other crewmember(s) as well as any flight deck observers, should attempt to obtain visual contact with the traffic if possible.

Caution: Turns are not authorized to avoid traffic unless the traffic has been visually acquired and positively identified.

Respond to an RA as specified by the warning. TCAS does not track just one target, but monitors the airspace around the aircraft. When it issues an RA, it has taken all surrounding Mode S or Mode C traffic into account. Excessive maneuvering is not appropriate or advisable and only tends to increase the possibility of interference with other traffic, needlessly exaggerates any ATC clearance deviation, and nullifies TCAS to TCAS maneuver coordination. From level flight, proper response to an RA typically results in an overall altitude deviation of 600 feet or less. A Climb or Descend RA requires that a vertical speed of 1500 fpm be established and maintained. The use of vertical rates in excess of 1500 fpm is neither required nor desirable due to the possibility of large altitude deviations. There is no situation that requires a climb or descent to the next higher or lower cruising altitude or flight level. Be alert for a "downgrade" of the RA indication, and begin to reduce deviations as soon as possible. Attempt to comply with as much of the current clearance as possible during the RA. For example, continue to fly the ground path specified in the current clearance, if possible, while altering the vertical path in response to the RA. Promptly and smoothly return to the current ATC clearance when the TCAS message, "CLEAR OF CONFLICT," is heard.

If a TCAS RA maneuver is contrary to other critical flight deck warnings such as stall, windshear, or ground proximity, then such warnings are to be respected. In the case of simultaneous audio alarms from TCAS and other systems, GPWS and windshear warnings are given higher priority; the TCAS system goes to TA ONLY and the IVSI flags indicate **RA OFF**.

ATC Considerations

WARNING: Do not accept a controller instruction to disregard a TCAS RA.

In responding to a TCAS RA that directs a deviation in assigned altitude, communication with the controlling ATC facility is required as soon as practicable after responding to the RA. Turns to avoid traffic are never TCAS initiated. Therefore, if a turn is made, it must be done based on conventional "see and avoid" practices, after the traffic is acquired visually. The turn should be reported to the controller as being a result of the pilot's visual evaluation of the situation.

Controllers have a much more complete view of the air traffic situation than TCAS allows. Try to refrain from "second guessing" ATC or asking for special handling based on the potentially incomplete traffic information available on the TCAS display.

Operation In TA ONLY Mode

When operating in the TA ONLY mode, a TCAS equipped aircraft will appear to another TCAS aircraft as “Mode C Only.” In addition to inhibiting RA’s in the TA ONLY mode, TCAS to TCAS coordination does not occur. These issues, along with the fact that few general aviation aircraft are TCAS equipped, mandate that use of the TA ONLY mode be limited to situations of operational necessity. Use of TA ONLY may be indicated in one or more of the following circumstances:

- During takeoff towards known nearby traffic, which is in positive visual contact, and which would cause an unwanted RA. Reselect TA/RA as soon as possible.
- During parallel approaches when the other aircraft has been positively identified visually (VMC) or by the controller (IMC).
- In visual conditions when flying in known close proximity to other aircraft.
- During emergencies and in-flight failures that severely limit aircraft performance or control to the point that ability to respond to an RA is in doubt.
- In response to specific Company guidance regarding areas or operations identified as having a verified and significant potential for unwarranted RA’s.

Operational Limitations

TCAS does not alter or diminish the pilot’s basic authority and responsibility to ensure safe flight. Since TCAS does not respond to aircraft which are not transponder equipped or aircraft with a transponder failure, TCAS alone does not ensure safe separation in every case. Other aircraft may not be able to maneuver due to equipment malfunctions. Further, TCAS RA’s may, in some cases, conflict with flight path requirements due to terrain, such as an obstacle limited climb segment or an approach to rising terrain. Since many approved instrument procedures and IFR clearances are predicated on avoiding high terrain or obstacles, it is particularly important that pilots maintain situational awareness and continue to use good operating practices and judgment when following TCAS RA’s. TCAS does not diminish the flight crew’s responsibility for outside visual scan and “see and avoid” vigilance.

TCAS may occasionally issue an RA against an aircraft that has legal separation. This may be the result of one aircraft maneuvering, or in the case of 500' VFR - IFR separation, due to either or both aircraft being only slightly off altitude. TCAS uses a target's existing and previous vertical speed to predict separation. It is not aware of traffic's intention to level off at an altitude above or below its own altitude. For this reason, an RA can be issued prior to such a level off.

TCAS is only required to track aircraft within 14 miles; outside of this range targets may be intermittent. Non-transponder or inoperative transponder aircraft are invisible to TCAS. Traffic with a transponder, but without altitude reporting, will not generate an RA. Mode C only transponder are not capable of coordinating responses. The TCAS aircraft assumes that the Mode C aircraft will not change its flight path.

Required Reports

Submit a Captain's Irregularity Report whenever response to an RA requires deviation from an assigned clearance. Submit Aviation Safety Reporting System (ASRS) reports at the crew's discretion. Report areas or operations that result in a high number of TA's or unwanted RA's via Captain's Flight Information Report.

The following table identifies the possible AURAL ALLERTS with the applicable VERTICAL RESTRICITON or VERTICAL MANEUVER.

RESOLUTION ADVISORY	AURAL ALERTS	VERTICAL RESTRICTION / MANEUVER
PREVENTATIVE ADVISORY	“MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED”	Promptly and smoothly maneuver to the new vertical speed depicted.
CLIMB	“CLIMB, CLIMB”	Initiate required vertical maneuver within 5 seconds from the time the RA is posted.
DESCENT	“DESCEND, DESCEND”	Promptly and smoothly establish the descent vertical speed depicted.
VERTICAL SPEED RESTRICTED (climbing or descending)	“ADJUST VERTICAL SPEED, ADJUST”	Promptly and smoothly adjust to the new vertical speed indicated.
ANY WEAKENING OR SOFTENING OF AN RA	“ADJUST VERTICAL SPEED”	Any weakening or softening of an RA.
CROSSOVER CLIMB	“CLIMB, CROSSING CLIMB” “CLIMB, CROSSING CLIMB”	Directs a climb and informs pilot that a safe vertical separation will result in climbing through intruder's altitude.
CROSSOVER DESCENT	“DESCEND, CROSSING DESCEND” “DESCEND, CROSSING DESCEND”	Directs a descent and informs pilot that a safe vertical separation will result in descending through intruder’s altitude.
PREVENTATIVE ADVISORY	“MONITOR VERTICAL SPEED”	Preventative advisory
MAINTAIN EXISTING VERTICAL SPEED	“MAINTAIN VERTICAL SPEED, MAINTAIN”	Maintain existing vertical speed.
MAINTAIN EXISTING VERTICAL SPEED WHILE CROSSING THREAT’S ALTITUDE	“MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN”	Maintain depicted vertical speed while crossing threat’s altitude.
CHANGE FROM A DESCENT TO A CLIMB	“CLIMB – CLIMB NOW” “CLIMB – CLIMB NOW”	Initiate the change from a descent to a climb maneuver within 2.5 seconds.
CHANGE FROM A CLIMB TO A DESCENT	“DESCEND – DESCEND NOW” “DESCEND – DESCEND NOW”	Initiate the change from a climb to a descent maneuver within 2.5 seconds.
RA CLEARED	“CLEAR OF CONFLICT”	Return promptly to the previous ATC clearance.

Note: The ABOVE / BELOW altitude display limits for traffic are as follows:
- ABOVE (climb phase) 9000 feet above; 2700 feet below
- NORMAL (enroute phase) 2700 feet above; 2700 feet below
- BELOW (descent phase) 2700 feet above; 9000 feet below

GROUND PROXIMITY WARNING SYSTEM

Warnings

GPWS warnings of "TERRAIN," "PULL UP," or any configuration warning require an immediate response by the flight crew. Without delay, perform CFIT Recovery Maneuver.

WARNING: Any "TERRAIN," "PULL UP," or configuration warning that occurs or continues **below 500' AFE** **mandates a go-around, regardless of flight conditions**. Refer to GPWS Warning / CFIT Recovery Maneuver procedures this section.

Note: If a warning occurs **above 500' AFE** when flying under daylight VMC conditions, and positive visual verification is made that no hazard exists and that aircraft configuration is correct, the warning may be regarded as cautionary and the approach may be continued.

Alerts

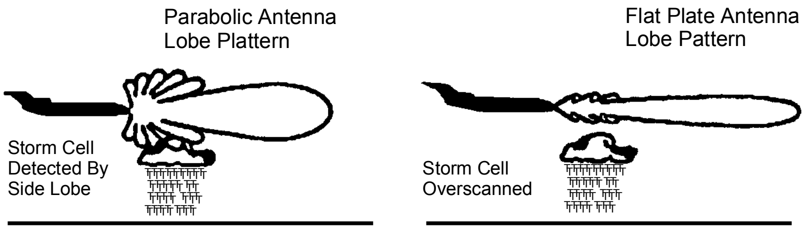
GPWS alerts of "DON'T SINK," "SINK RATE," "GLIDESLOPE," or "BANK ANGLE" require immediate response by the flight crew. The PF must take immediate action to correct the flight path.

WEATHER RADAR

General

The requirements for weather radar for dispatch are stated in the aircraft Minimum Equipment List. If the radar becomes inoperative in flight, the flight may not enter a known or forecast thunderstorm area unless the Captain is satisfied that thunderstorms can be avoided visually. If already in a thunderstorm area when the radar becomes inoperative, the flight will avoid thunderstorms visually, or if this is impossible, slow to recommended turbulence penetration speed and take the shortest course out of the area consistent with safety.

Continental aircraft are equipped with an X-Band weather radar receiver / transmitter using a flat-plate antenna. The flat-plate antenna produces a narrow beam (3.0°) without any significant sidelobes. For optimum performance, more tilt adjustment will be required than with the older parabolic type antenna which produces numerous sidelobes as shown in the diagram below.



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Note: On 3 5 7 8 9 aircraft with the RDR-4B-0418 Control Panel installed, each pilot has a separate tilt control for their EHSI radar display. As the radar simulates a sweep in one direction, it looks at the Captain's tilt control and sends the appropriate return data to the Captain's EHSI. On the simulated return sweep, the radar looks at the First Officer's tilt control and sends the appropriate return data to the First Officer's EHSI.

Resolution

There are several factors which affect the resolution of the radar system.

Range

Increasing range will decrease the radar return. The system compensates for this by automatically varying the system gain with range, thereby giving as accurate a return as possible at varying ranges.

Attenuation

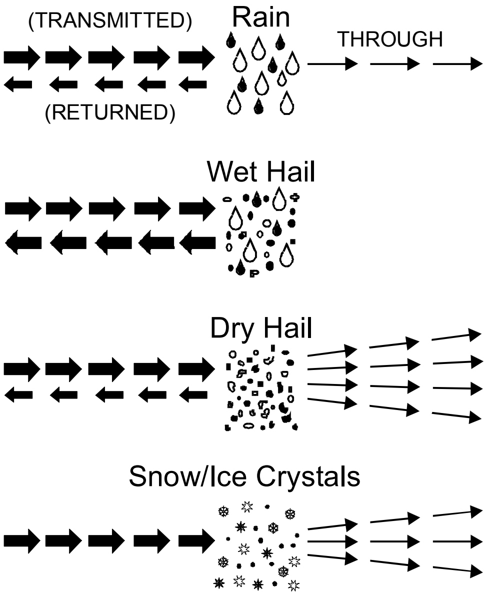
Intervening precipitation and increasing range tend to attenuate the beam. The radar compensates for precipitation or range attenuation, so that the correct color is displayed on the indicator. This feature, called penetration compensation, allows more accurate presentation of storm cells even when viewed through intervening rainfall.

Caution: Although this special circuitry compensates for areas of precipitation, weather radar should not be used for penetration of thunderstorm areas where the precipitation between aircraft and target is moderate to heavy.

The storm behind the storm may not be displayed under extreme attenuation conditions. Do not penetrate strong targets assuming there is nothing behind it. If the ground cannot be painted behind the storm, then the attenuation compensation is not effective due to extremely high attenuation.

Nature Of Target

Storm targets differ in their ability to return a signal. Precipitation tends to absorb part of the transmitted signal and "masks" targets behind heavy precipitation areas.



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As the tilt control is used to sweep a storm target, the return may change color, not due to a change in precipitation rate, but to the type of precipitation target encountered.

Gain Control And Turbulence

Normally the radar may be opposite to that previously encountered on other aircraft. AUTO is the normal position, however manual gain control is available in all modes.

Turning the gain knob clockwise increases the gain until, fully clockwise, the gain is at the maximum (MAX) setting. The variable gain control may be used to reduce the receiver's sensitivity to aid in determining the relative intensity of multiple thunderstorms and embedded cells.

Caution: Manual gain settings of maximum, 9 and 8 will somewhat enhance radar receiver sensitivity, but as the gain is reduced there is a chance that all radar displays will be eliminated.

Selecting the TURB position causes all weather targets (precipitation and turbulence) to be displayed. Turbulence detection is limited to the first 50 NM regardless of the range selected. It will be displayed in magenta on the indicator superimposed over the weather information. This feature allows the detection of storm related turbulence by measuring the doppler shift of detected particles. Precipitation must be present for this mode to operate. Clear air turbulence (CAT) will not be detected. Manual gain is available in TURB mode, but should have no effect on turbulence targets.

Selecting the WX position will cause all precipitation targets to be displayed. Detectable weather will be displayed in three colors: red, yellow, and green.

Inflight Operations

Antenna Tilt Operations

Takeoff And Landings:

Operations below 10,000 feet usually require a tilt setting of 2 - 3 degrees upward tilt. This will provide target detection up to 40 NM without excessive ground returns and eliminate frequent tilt adjustment. The tilt setting should be adjusted as necessary to optimize target display. A solid ground return between 35 to 40 NM ensures targets within 35 NM will be detected. If tilt settings below 4 degrees are used for takeoff, some ground return will be detected until passing 5,000 feet AGL. This is due to minor sidelobes. Set of 7 degrees up initially for takeoff.

Middle Altitudes (Near 20,000 Feet):

Antenna tilt settings should be roughly 0 degrees or slightly down. For over land operation, adjust tilt control until a small arc of ground return appears at the outer edge of the display. Storm cells displayed between half scale and the outer edge of the display should be monitored; tilting the antenna down and alternate range setting as necessary to avoid overscanning as you approach these cells.

Higher Altitude (Around 35,000 Feet):

At longer ranges it will be difficult to obtain ground targets at the outermost area of the display due to the curvature of the earth. Over water or if ground returns cannot be obtained at outer edge, use the following cruise tilt angles:

Target Range (NM)	Approximate Tilt Angle (Degrees)	
	Over Land	Over Water
160	2 Down	3 Down
80	3 Down	5 Down
40	5 Down	8 Down

As targets move past the half-way position, adjust antenna tilt angle and range setting as necessary to avoid overscanning. Detection of targets closer than 20 NM may be difficult as the large tilt down settings being used may result in excessive ground clutter and/or more distant storms not being detected.

Storm Height

Most formulas and charts used to determine storm heights are complex as a result of the accuracy of calibration and the curvature of the earth. However, the following is a method that estimates the top of the detectable moisture (radar top) and is independent of calibration and curvature problems:

While scanning for storm targets, the most effective tilt angle of the antenna depends upon the altitude of the aircraft and the selected range. Once a storm is detected by varying the tilt angle (see previous table), decrease the tilt until the ground return touches the center of the storm and note the tilt angle displayed on the radar indicator. Now increase the tilt until the storm disappears and again note the tilt angle. The difference of these two settings is important and eliminates the need of calibration corrections. Multiplying this tilt difference figure times the distance of the storm from the aircraft equals the storm height above ground level (i.e., a five degree difference of a storm at fifty miles equals a storm height of 250 or 25,000 feet AGL).

Recall the radar top is only the top of the moisture return and not the top of the cloud. Experience has shown that an additional 10,000 to 15,000 feet must be added to the radar top to ensure total clearance of the storm area.

Overwater Operating Procedures

- Do not use MAP mode for weather detection.
- Limit the use of 320 NM range to MAP mode. Weather detection is marginal beyond 220 NM.
- Use 160 NM range for weather surveillance with tilt down 3 degrees and expect some sea clutter at the outer limits (i.e., above 120 NM).
- As weather is detected, range down to 80 NM then 40 NM using tilt to determine the “radar tops.” Radar tops should be avoided by approximately 10,000 to 15,000 feet. Circumnavigate if required.
- Periodically return to 160 NM to re-examine the “big picture.”

ENGINE OPERATION DURING SEVERE PRECIPITATION

Flights should be conducted to avoid moderate to severe thunderstorm activity by over flight or circumnavigation. To the maximum extent possible, moderate to heavy rain / hail should also be avoided. Weather radar, pilot reports, and flight crew observations may be used by the flight crew to determine when moderate to heavy rain / hail / sleet is anticipated.

Should flight in moderate to heavy rain / hail / sleet be encountered or anticipated:

- Avoid rapid throttle movements to prevent engine stall or flameout.
- Do not make rapid thrust changes in extremely heavy precipitation unless excessive airspeed variations occur.
- If thrust changes are necessary, move the throttle very slowly.
- Avoid changing thrust lever direction until engines have stabilized at a selected setting.

CONTROLLED FLIGHT INTO TERRAIN (CFIT)

Controlled Flight Into Terrain (CFIT) represents a significant threat to aviation safety. Flight crews often correlate CFIT with mountainous terrain. However, CFIT encounters have occurred in non-mountainous, relatively flat terrain. CFIT accidents and incidents have occurred during departure, but overwhelmingly, the majority of these encounters occur during the descent, approach and landing phases of flight. CFIT encounters can be prevented by increased awareness and the use of established procedure should a GPWS warning / alert occur.

Air Traffic Control

Flight crews need to have a clear understanding of ATC's role and responsibility in terrain separation. The responsibility for terrain separation rests solely with the flight crew. ATC assumes the flight crew is aware of the surrounding terrain.

Caution: MEA's and MOCA's offer protection while remaining on a published airway. When requesting or accepting a "present position direct to" clearance, terrain clearance can only be assured by remaining at or above the applicable GRID MORA.

Challenge or refuse ATC instructions when those instructions are not clearly understood, questionable, and/or conflict with the flight crew's assessment of aircraft position relative to terrain. The Air Traffic Control tab found in the Jeppesen Airway Manual provides a concise description of JAA (Joint Aviation Authorities) and other foreign state's ATC system rules and procedures. Where applicable, differences from ICAO standards and procedures are also presented.

Automation

To minimize the exposure to a CFIT encounter while using automation, a highly disciplined approach to FMS operating procedures and associated techniques should be employed. Use automation on a level consistent with flight dynamics that reduces workload, enhances monitoring effectiveness, and increases situational awareness. Accomplish FMS programming in periods of low workload. FMS programming requires teamwork to insure proper loading, verification and execution. EFIS displays should be used in a manner that provides useful information. When too much information is presented on EFIS displays, the opportunity for confusion or distraction exists.

Monitor course and altitude information referencing raw data while utilizing the appropriate charting when maneuvering in the terminal area. If VNAV descent profiles are used, supplement those calculations with manual calculations for comparison.

Preparation

Review the approach / departure procedures with applicable transitions, noting the altitude information and any unusual navaid / fix configurations that may cause confusion about distance to go, step-down altitudes, or course contingencies. The Pilot Monitoring (PM) must immediately verbalize potentially confusing or non-standard situations to the Pilot Flying (PF).

WARNING: Prior to beginning a departure / arrival in mountainous terrain, all appropriate SIDS, STARS, enroute charts, and approach charts will be out and readily available. The Captain will brief prior to descent in mountainous terrain all GRID MORAs, MEAs, MOCAs and transition levels so as to include position of high terrain along the route.

Preparing for complex instrument procedures requires thorough briefing and preparation. Approaches with multiple step down fixes, pose increased difficulty and greater exposure to a CFIT encounter.

Whether flying a precision or non-precision approach, apply the proper unit of measure to altimeter settings (i.e., inches of mercury vs. millibars). When executing a non-precision approach, set the barometric altimeter bug to the published MDA. Set the radio altimeter to 250 ft. to provide additional terrain awareness should an inadvertent or premature descent from the MDA occur.

CFIT Recovery Maneuver

Accomplish the following maneuver for any of these conditions:

- Activation of the "PULL UP" or "TERRAIN TERRAIN PULL UP."
- Activation of the "TERRAIN AHEAD PULL UP" warning.
- Other situations resulting in unacceptable flight toward terrain.

PILOT FLYING	PILOT MONITORING
• Call: "MAX THROTTLE, CHECK SPEEDBRAKE." Rapidly perform the following: • Disconnect autopilot. • Disconnect autothrottle. • Aggressively apply maximum throttle (mechanical stops). • Retract speedbrakes. • Simultaneously roll wings level and rotate to an initial pitch attitude of 20°. • If terrain remains a threat, continue rotation up to the pitch limit indicator (if available) or stick shaker initial buffet.	• Assure maximum thrust. • Confirm speedbrake stowed. • Verify all required actions have been completed and call out any omissions.
• Do not change gear or flap configuration until terrain separation is assured. • Monitor radio altimeter for sustained or increasing terrain separation. • When clear of terrain, slowly decrease pitch attitude and accelerate.	• Monitor vertical speed and altitude. • Call out any trend toward terrain contact.

Note: Aft control column force increases as the airspeed decreases. In all cases, the pitch attitude that results in intermittent stick shaker or initial buffet is the upper pitch attitude limit. Flight at intermittent stick shaker may be required to obtain a positive terrain separation. Smooth, steady control will avoid a pitch attitude overshoot and stall.

Note: Do not use flight director commands.

WINDSHEAR AVOIDANCE AND RECOVERY PROCEDURES

The first and foremost rule is to avoid windshear. As enhanced detection and guidance capabilities become available, the pilot must not perceive these aids as providing the capability to penetrate windshear.

These aids are intended to be used for avoidance only, in the same manner as radar is used as an aid in avoiding thunderstorms.

Microburst Windshear Probability Guidelines

Observation	Probability of Windshear
Presence Of Convective Weather Near Intended Flight Path	
• With Localized Strong Winds (tower report or observed blowing dust, rings of dust, tornado-line features, etc.)	HIGH
• With Heavy Precipitation (observed or radar indications of contour, red or attenuation shadow)	HIGH
• Onboard Windshear Detection System Alert (Reported or Observed)	HIGH
• With Rainshower	MEDIUM
• With Lightning	MEDIUM
• With Virga	MEDIUM
• With Moderate Or Greater Turbulence (reported or with radar indications)	MEDIUM
• With Temperature/Dew Point Spread Between 30 And 50 Degrees Fahrenheit	MEDIUM
PIREP of Airspeed Loss Or Gain	
• 15 Knots Or Greater	HIGH
• Less Than 15 Knots	MEDIUM
LLWAS Alert / Wind Velocity Change	
• 20 Knots Or Greater	HIGH
• Less Than 20 Knots	MEDIUM
• Forecast Of Convective Weather	LOW

Note: These guidelines apply to operations in the vicinity (within 3 miles of the point of takeoff or landing along the intended flight path below 1,000 feet AGL) and the clues should be considered cumulative. If more than one is observed, the probability is increased. The hazard increases with proximity to the convective weather. Weather assessments should be made continuously.

Takeoff Precautions

Airports Without Terminal Doppler Weather Radar

If the preceding conditions exist and PIREPS indicate a windshear of 15 knots or greater with increasing intensity, delay departure 30 minutes.

If the preceding conditions exist and PIREPS indicate a windshear of less than 15 knots with diminishing intensity, delay departure 15 minutes.

Airports With Terminal Doppler Weather Radar

A MICROBURST ALERT or WINDSHEAR ALERT will be issued by the tower in conjunction with a clearance to a specific runway. If the clearance does not contain an alert, the flight crew may assume that no alert exists at the present time.

If a WINDSHEAR ALERT accompanied by a reported gain of airspeed is issued, the crew may take off but be alert for sudden airspeed increase. If airborne the pilot should adjust pitch attitude smoothly to maintain desired airspeed but should not "chase" large rapid airspeed fluctuations.

If a WINDSHEAR ALERT accompanied by a reported loss of airspeed, or a MICROBURST ALERT is received, a takeoff should not be attempted. If either alert is received during takeoff prior to 100 knots the takeoff should be aborted. If either alert is received after 100 knots the takeoff may be aborted or continued at Captain's discretion after considering runway available, gross weight and related meteorological conditions.

Windshear Avoidance Techniques

1. Select the longest suitable runway that avoids suspected areas of windshear. The choice of a suitable runway involves consideration of exposure to obstacles after liftoff and crosswind and tailwind limitations.
2. Maximum rated takeoff thrust should be used.
3. Use flight director.
4. Takeoff flaps should be set at 5 degrees unless limited by obstacle clearance and/or climb gradient. Flaps 5 settings result in better performance against windshear encountered on the runway. Flaps 1 setting offers better performance when encountering an airborne windshear. Flaps 5 is recommended as it covers a larger range of conditions.
5. Use increased airspeed at rotation when available. To compute the increased rotation airspeed:
   - Determine the V_1, V_R, and V_2 speed for the actual aircraft gross weight and flap setting. Set airspeed bugs to these values in the normal manner.
   - From the automated runway analysis, pre-departure papers determine the runway limit weight for the selected runway. Then determine V_R for that weight (field length limit V_R).
   - If the field length limit V_R is greater than the actual gross weight V_R, (almost always the case) use the higher V_R (up to 20 knots in excess of actual gross weight V_R) for takeoff. Airspeed bugs should <u>not</u> be reset to the higher speeds.
   - Rotate to normal initial climb attitude at the increased V_R and maintain this attitude. This technique produces a higher initial climb speed which slowly bleeds off to the normal climb speed.

<u>WARNING</u>: If windshear is encountered at or above the actual gross weight V_R, do not attempt to accelerate to the increased V_R, but rotate without hesitation. If windshear is encountered at or near the actual gross weight V_R and airspeed suddenly decreases, there may not be sufficient runway left to accelerate back to normal V_R. If there is insufficient runway left to stop, initiate a normal rotation at least 2,000 feet before the end of the runway, even if airspeed is low. Higher than normal attitudes may be required to lift off in the remaining runway. Aft body contact may occur.

- Throttles may be advanced to the mechanical stops.
- If increased airspeed was not used prior to liftoff, accelerating to higher than normal airspeed after liftoff is not recommended. Reducing pitch attitude at low altitude to accelerate might produce a hazard if windshear is encountered.

Once the takeoff is initiated, the flight crew should be alert for airspeed fluctuations. If significant airspeed variations occur below V_1 the takeoff should be aborted if sufficient runway remains.

Caution: Accelerate / Stop distances are computed assuming a normal acceleration to V_1. Airspeed fluctuations may cause the aircraft to achieve V_1 at a point farther down the runway than anticipated. Therefore, the aircraft may not be able to stop on the runway.

Approach Precautions

Due to configuration and power settings, aircraft are the most vulnerable to windshear effects during the approach and landing phase of flight.

Airspeed losses and excessive sink rates should be immediately responded to by the flight crew since the aircraft may not be able to recover from a situation that has been allowed to progress unchecked.

A stabilized approach should be established no later than 1,000 feet AGL to improve windshear recognition capability.

1. Select minimum normal landing flap consistent with the field length.
2. The target airspeed bug should be set based on the surface winds in the usual manner.
3. During the approach, the pilots should continuously monitor airspeed loss reports from other aircraft ahead or the tower if equipped with Terminal Doppler Weather Radar.
4. The reported airspeed loss should be added to V_{REF} and if this value is in excess of target airspeed the pilot should increase to and maintain this speed. (The target bug should remain set based on the surface wind additive only.)
    - If the reported airspeed loss, when added to V_{REF} results in a speed less than target airspeed, maintain target airspeed.

5. Airspeed additive due to reported airspeed loss should be maintained to touchdown; however, the aircraft should not be allowed to "float" beyond the touchdown zone.

WARNING: Increased touchdown speeds increase stopping distance. An additional 20 knots at touchdown can increase stopping distance by as much as 25%.

Vertical speed should be closely monitored. If the descent rate required to maintain the glidepath is significantly different than expected (based on groundspeed and descent slope) continuance of the approach may not be a safe course of action.

Caution: At airports equipped with Terminal Doppler Weather Radar, a missed approach should be executed if the MICROBURST ALERT or a WINDSHEAR ALERT, accompanied by a reported airspeed loss of greater than 20 knots, is received.

An increase in airspeed and ballooning above the glideslope may be first indications of a windshear. Do not make large thrust reductions. This increase in performance may be followed soon by a rapid airspeed loss and an additional loss of performance due to a downdraft. The pilot may choose to accept this initial airspeed gain anticipating an equal or greater loss.

Recovery Maneuver

The following actions are recommended whenever flight path control becomes marginal below 1000 feet AGL on takeoff or approach. As guidelines, marginal flight path control may be indicated by deviations from target conditions in excess of:

- ± 15 knots indicated airspeed
- ± 500 FPM vertical speed deviation from normal
- ± 5 degrees pitch attitude change
- ± 1 dot glideslope displacement
- Unusual throttle position for a significant period of time.

Exact parameters cannot be established. In certain situations where significant rates of change occur, it may be necessary to go-around before any of the above are exceeded. The determination to begin the recovery procedure is subjective and based on the pilot's judgment of the situation.

If flight path control becomes marginal at low altitude, initiate the windshear recovery maneuver without delay. If ground contact appears imminent, either pilot calls "MAX THROTTLE." Accomplish the first three steps simultaneously:

- Disengage the autopilot and autothrottles.
- Aggressively advance throttles to mechanical stops to ensure maximum thrust is obtained with minimum delay. This max throttle setting is recommended until positive indications of recovery are confirmed. Positive indications of recovery include:

  A. Altimeter and IVSI indicate level flight or a climb; and
  B. Airspeed stable or increasing; and
  C. Aural, visual warnings cease (stick shaker, windshear warning).

  Note: If positive indications of recovery are confirmed while advancing the throttles to the mechanical stops, the power setting for continuous recovery to normal flight parameters may be limited to maximum rated thrust (i.e., go-around thrust) to avoid unnecessarily exceeding engine limitations.

- Rotate initially toward a 15 degree pitch attitude at normal rotation rate. Stop rotation immediately if stick shaker or buffet should occur. Roll wings level if in a turn to provide maximum lifting force.

  Note: With the flight director in the takeoff mode, the command bars will provide correct flight path guidance during a windshear encounter on takeoff.

- Monitor vertical speed, attitude, and altitude. If the aircraft develops a sink rate, increase pitch attitude smoothly and in small increments to achieve zero or positive vertical path. Always respect stick shaker and use intermittent stick shaker as the upper limit for pitch attitude.
- Do not change flap, gear, or trim position until terrain contact and/or loss of airspeed is no longer a factor.

  Note: After liftoff or initiation of a go-around, adjust pitch to achieve a positive vertical flight path. Although exact criteria cannot be established, a target pitch attitude of 15 degrees should provide a positive vertical path. Keeping a positive or zero rate of climb is the major objective. Airspeeds below normal must be accepted at least temporarily. Control pitch attitude in a smooth, steady manner to avoid overshooting the attitude at which stall warning is initiated. Heavy and unusual control column forces (up to 30 lbs.) may be required.

Speed is the least important item. If the pilot attempts to regain lost airspeed by lowering the nose, the combination of decreasing airspeed and decreasing pitch attitude produces a high rate of descent. Unless this is countered by the pilot, a critical flight path control situation may develop rapidly.

- The pilot not flying should focus attention on vertical path, altitude, and pitch attitude. Inform the Pilot Flying of impending and negative vertical speeds by a callout of "SINK RATE." The Pilot Flying should focus attention on pitch attitude and flying the aircraft.
- Windshear ends when the tailwind component stops increasing.

Crew Coordination

The Pilot Flying should focus attention on flying the aircraft. In a windshear encounter, appropriate action should be taken in response to callouts.

The Pilot Monitoring should focus attention on airspeed, vertical speed, altitude, pitch attitude, glidepath deviation and thrust. If significant deviations should occur, call them out immediately. In a windshear encounter, the Pilot Monitoring should call aircraft trends such as "CLIMBING" or "SINKING" accompanied by radio altitude (AGL).

Pilot Reports

As soon as possible, report the encounter to the tower or controlling agency. The aircraft following might not have the performance required to recover from the same windshear encounter. The windshear may also be increasing in intensity making flight through it even more dangerous.

The pilot report should contain the following information:

- Specifically state either GAIN or LOSS of airspeed.
- Magnitude of GAIN or LOSS.
- Altitude at which shear was encountered.
- Location of shear with respect to runway in use.
- Aircraft type.
- Use the term PIREP to encourage rebroadcast of the report to other aircraft.

Critical remarks establishing severity such as .. MAXIMUM THRUST REQUIRED, ...ALMOST CONTACTED TERRAIN, etc. are also helpful.

Windshear Enhanced Flight Directors

The B737 windshear recovery enhancement system includes a detection and a guidance system. Each system operates independently of the other.

A windshear condition is detected using comparisons of angle-of-attack, IRS accelerations, and airspeed from the air data computer. The minimum windshear intensity which activates a warning is dependent upon flap position, radio altitude, and phase of flight (takeoff or approach). The windshear alert does not annunciate shears of the type which require only routine piloting effort. As a result, the alerting signal is considered a warning level and specific crew actions are expected.

The GPWS provides the aural and visual alerting signals or windshear conditions. The actual warning consists of two-tone siren followed by the words "WINDSHEAR, WINDSHEAR, WINDSHEAR." The actual warning is activated only once during a windshear encounter. The visual warning is provided by illumination of the **WINDSHEAR** lights on the Captain's and First Officer's instrument panel (Non-EFIS aircraft). On EFIS aircraft the **WINDSHEAR** warning annunciation is on the Captain's and First Officer's EADI. The lights remain illuminated until a safe airspeed has been re-established after the windshear has dissipated. The windshear warnings take priority over all other GPWS modes.

On takeoff, the alert is enabled at rotation and remains enabled up to 1,500 ft. radio altitude.

On approach, the alert is enabled at 1,500 ft. RA and remains enabled until touchdown.

The Flight Director was chosen as the guidance system because it is simple, displayed on the ADI, and pilots use it on a routine basis. The windshear recovery enhancement flight director will provide proper flight, path guidance only when operating in the TOGA pitch mode (i.e., with **TOGA** annunciated). The control inputs for the guidance come from vertical speed, airspeed and angle of attack. When using the windshear recovery enhanced flight guidance system, the command guidance control laws are:

- V/S Greater than 1200 fpm - The F/D will maintain a minimum of cursor speed.
- V/S Less than 1200 fpm and Down to 600 fpm - As the V/S decreases, the F/D command will slowly adjust from speed control to pitch control so that at 600 FPM the F/D will command 15 degrees pitch and disregard airspeed.

- V/S 600 fpm Down to 0 fpm - The F/D will slowly adjust from 15° pitch toward optimum pitch (the angle of attack for stick shaker minus 2 degrees).
- V/S Less than 0 fpm - The F/D will maintain the angle of attack for stick shaker minus 2 degrees.
- When the aircraft departs the windshear environment, the flight director will smoothly transition back to the normal takeoff or go-around mode.

Takeoff

Normal takeoff procedures include the use of flight directors and use of the TOGA mode. Consequently, if windshear is encountered on takeoff, the F/D will command proper flight path guidance, as determined by the control laws above.

Approach

Approaches are generally made with the flight directors ON. When the flight director is ON, the command guidance is to maintain either vertical path or level flight. In either case, there is no windshear guidance. Even in windshear conditions, the F/D will command a return to vertical path up to the point of 25° pitch and reaching full stall conditions. To achieve windshear recovery enhancement flight guidance, the aircraft must be flown in the TOGA pitch mode.

By depressing either TOGA button, the F/D command bars will provide proper flight path guidance. The F/D command bars come into view or remain in view, regardless of ON/OFF switch position.

Standard Recovery Procedure For Takeoff / Approach Windshear

1. Press either TOGA button while applying maximum throttle.
2. Follow the flight director guidance.
3. Resume standard windshear procedures.

   Note: TOGA cannot be selected above 2,000 ft. RA.

   Note: When a takeoff is made with the F/D off, windshear flight director guidance will become available if the TOGA button is depressed after accelerating past 80 kts. If the F/D switch remains OFF, the command bars will bias out of view when the pitch mode changes to ALT ACQ. There will be no pitch command to level off at MCP altitude.

   Note: With the red warning lights illuminated and maintaining F/D pitch commands, all other GPWS warnings are inhibited (i.e., “PULL UP” or “TOO LOW - GEAR,” etc.).

PREDICTIVE WINDSHEAR

The following procedural chart applies to the predictive windshear system. Continental policy is to avoid all windshear and other hazardous weather.

Note: Windshear alerts are inhibited on the ground above 100 KIAS to 50 feet AGL.

Phase of Operation	Warning Alert	Caution Alert	Advisory Alert	System Failure
Before Takeoff	Advise ATC of the location of the Warning Alert. Delay takeoff until the warning is no longer present.	Advise ATC of the location of the Caution Alert. At the Captain's discretion, delay the takeoff, or takeoff and maneuver to avoid the hazard.	Advise ATC of the location of the windshear hazard. After takeoff, maneuver to avoid the windshear hazard area.	Use other means of windshear avoidance in accordance with published FAA windshear recovery guidelines.
Takeoff: Prior to 100 kts.	Reject the takeoff. Advise ATC of the location of the windshear hazard.	Assure maximum rated thrust is applied. Continue the takeoff, and advise ATC of the hazard and maneuver around the hazard.	Assure maximum rated thrust is applied. Continue the takeoff, and advise ATC of the hazard, and maneuver around the hazard.	Same as above.
After Takeoff	Assure maximum rated thrust is applied. If the windshear is penetrated, utilize windshear recovery procedures. Advise ATC of the hazard.	Assure maximum rated thrust is applied. If the windshear is penetrated, utilize windshear recovery procedures. Advise ATC of the hazard.	Continue the climb out and monitor the windshear hazard. Advise ATC of the hazard.	Same as above.
During Approach	Initiate a normal go-around. If the windshear hazard is penetrated, utilize windshear recovery procedures. Advise ATC of the hazard.	At the Captain's discretion, maneuver around the windshear hazard if a safe stabilized approach can be continued after the maneuver, or initiate a normal go around.	Continue the approach, monitor the location of the windshear event. Advise ATC of the hazard.	Same as above.

* * * *

TURBULENCE

<u>WARNING</u>: Severe turbulence should be avoided if at all possible. If severe turbulence cannot be avoided, a descent 4000 feet below optimum altitude is recommended to increase buffet margin.

The two major concerns when encountering turbulence are minimizing structural loads imposed on the aircraft and avoiding extreme, unrecoverable attitudes.

Autopilot

If turbulence is light to moderate, it is best to use the autopilot. If turbulence is greater than moderate, the autopilot may be used as long as its operation is monitored with the following precautions.

- Autopilot CWS use is recommended. Maintain heading and altitude by manual autopilot controls.
- Monitor pitch trim activity and be prepared to disengage if sustained trimming occurs.

FMC

<u>Note</u>: The FMC will provide a recommended thrust setting and airspeed for turbulence penetration.

The most important objective is to obtain an initial thrust setting close to the correct one. Once the proper thrust setting for the recommended penetration speed is achieved, it is undesirable to make thrust changes during severe turbulence. Large variations in airspeed and altitude can occur in severe turbulence.

Airspeed

The maximum turbulent airspeed is 280 KIAS or ③ 3 5 Mach .73, 7 8 9 Mach .76 whichever is lower. Below 15,000 feet, a turbulent airspeed of 250 KIAS may be used if the aircraft gross weight is less than the maximum landing weight. These speeds should be maintained as they provide the optimum tradeoff between buffet margin and structural loading. Slower speeds reduce the buffet margin, increase drag, and increase the out-of-trim condition due to fluctuations in airspeed. Lower speeds also increase the potential for turbulence to cause an extreme, unrecoverable attitude.

Sizable and rapid airspeed variations will likely occur depending on the severity of the turbulence but it is considered highly undesirable to chase airspeed either with elevator or throttle manipulations. Moderate variations, either above or below, are of minor consequence since some of the fluctuation of the instruments is a result of the turbulence itself and does not represent a real change in the aircraft's speed or altitude.

Attitude

The natural stability of the aircraft will work in a direction to minimize the loads imposed by turbulence. The pilot should rely on this natural stability and not become too greatly concerned about pitch attitude variations. Rapid and large aileron control inputs are permissible to hold the wings level, but pitch attitude must be controlled using only small to moderate elevator control inputs to avoid overstressing aircraft structure. Elevator control should be applied smoothly in a direction to resist motions away from the desired attitude, and the elevator should be returned to neutral when the aircraft is progressing toward the desired attitude.

Pitch attitude should be controlled solely with the elevator, never with stabilizer trim. An updraft or downdraft, which might tempt the pilot to change trim, can be expected to reverse itself in the next few seconds. If trim has been applied to counter the first draft, the second draft (which will likely be in the opposite direction) will exaggerate the out-of-trim condition. It is therefore considered desirable to leave the stabilizer trim alone in severe turbulence.

Thrust

Note: Use speedbrakes to slow if necessary. Adjust throttles only as necessary to avoid excessive airspeed variations. Use smooth power changes and maintain thrust as high as practicable. Do not chase airspeed.

Large variations in airspeed and altitude are almost certain to occur in severe turbulence. Set thrust to maintain the recommended penetration speed in level flight and minimize thrust changes.

Altitude

Large variations in altitude are almost certain to occur in severe turbulence due to high velocity updrafts and downdrafts. Report the turbulence to ATC and advise them of the potential for altitude deviations. Altitude control is secondary to the need to avoid excessive structural loads or reduced buffet margin. Altitude should be allowed to vary as required to avoid excessive control input and maintain altitude. Descend as necessary to improve buffet margin.

Turbulence encounters at high altitudes (or during high-speed cruise at intermediate altitudes) may produce high speed buffeting. High speed buffet, while disconcerting, is not as hazardous as overcontrolling the aircraft. Such an occurrence should not be misinterpreted as a low speed stall, since an unaccompanying rapid pushover for recovery might aggravate the buffet situation by increasing the airspeed. Severe turbulence encounters at high altitude have caused load factors as high as 2.5 G-forces. If the recommended attitude control procedures are followed, excessive load factors need not be imposed. The potential for high-speed buffeting in severe turbulence is greater at higher altitudes. Climbing to avoid an area of expected severe turbulence increases the chance of buffeting if turbulent region cannot be completely topped.

Structural

Flap extension in an area of known turbulence should be delayed as long as possible because the aircraft can withstand higher gust loads in the clean configuration. Diversion to another airfield is the best policy if severe turbulence persists in the area.

Procedure Summary

In a brief form, the procedures for flight in severe turbulence are summarized as follows:

Airspeed - Recommended turbulence penetration airspeed is 280 KIAS or ③ 3 5 MACH .73, 7 8 9 Mach .76 whichever is lower. At 15,000 feet and below, a turbulent airspeed of 250 KIAS may be used if the aircraft gross weight is less than the maximum landing weight. Do not fly less than minimum maneuvering speed for existing configuration. Severe turbulence will cause large and rapid variations in indicated airspeed. Do not chase airspeed.

Attitude - Maintain wings level and smoothly control pitch attitude. Use attitude indicator as the primary instrument. In extreme drafts, large attitude changes may occur. Do not use sudden large elevator control inputs.

Stabilizer - Maintain control of the aircraft with the elevators. After establishing the trim setting for penetration speed, do not change stabilizer trim.

Altitude - Allow altitude to vary. Large altitude variations are possible in severe turbulence. Sacrifice altitude in order to maintain the desired attitude and airspeed. Do not chase altitude.

PHASE OF FLIGHT	AIRSPEED
Climb	280 KIAS .73 Mach ③ 3 5 .76 Mach 7 8 9 (whichever is lower)
Cruise	Use FMC recommended thrust settings. If the FMC is inoperative, refer to the Unreliable Airspeed page in Section 5 for approximate N1 settings that maintain near optimum penetration airspeed.
Descent	.73 / 280 ③ 3 5 .76 / 280 7 8 9 (whichever is lower) If severe turbulence is encountered at altitudes below 15,000 feet and the aircraft gross weight is less than the maximum landing weight, the aircraft may be slowed to 250 knots in the clean configuration.

Note: If an approach must be made into an area of severe turbulence, delay flap extension as long as possible. The aircraft can withstand higher gust loads in the clean configuration.

COLD WEATHER OPERATIONS

Predeparture Check

This check will determine the need for deicing. This check is usually accomplished by the flight crew during the normal walkaround inspection completed at the gate. Qualified ground personnel may also determine the need for aircraft deicing without the flight crew present.

The predeparture check is a check of critical aircraft surfaces to ensure that they are free of any adhering ice, snow, slush, or frost. Critical aircraft surfaces include the following:

- Wings - Takeoff with light coatings of frost, up to 1/8 inch (3mm) in thickness on lower wing surfaces due to cold fuel is permissible. However, all leading edge devices, all control surfaces, and all upper wing surfaces must be free of snow, ice, slush, and frost.
- Fuselage - Thin hoarfrost is acceptable on the upper surface of the fuselage provided all vents and ports are clear. Thin hoarfrost is a uniform white deposit of fine crystalline texture, which is thin enough to distinguish surface features underneath, such as paint lines, markings, or lettering.
- Tail
- Control Surfaces
- Engine Inlets
- Landing Gear and Gear Doors, Wheels and Brakes
- Air Conditioning Inlets / Exits and Outflow Valves
- Air Data Sensors, Stall Vanes, Pitot Tubes and Static Ports

If these aircraft surfaces are not free of any adhering ice, snow, slush or frost, the aircraft must be deiced prior to departure.

In many cases, it may be necessary to start the engines and/or taxi to another location prior to deicing the aircraft. In situations such as this, it is permissible to start the engines and proceed to the deicing area with an accumulation of snow and/or ice on the aircraft. However, in no case will an aircraft taxi for takeoff without first ascertaining that the critical aircraft surfaces are free of any adhering ice snow, slush, or frost.

Ice, Frost And Snow Removal

Federal regulations prohibit takeoff when frost, snow or ice is adhering to critical aircraft surfaces. These regulations are based on the “clean” aircraft concept which requires a pretakeoff contamination check to ascertain that critical aircraft surfaces (wings and control surfaces) are “clean” (free of adhering ice, frost or snow formations) and to determine that any formations not adhering to critical surfaces will blow off in the early stages of takeoff roll.

Deicing / Anti-Icing

Aircraft de-icing / anti-icing when required, will be accomplished in accordance with the Continental GMM Section 06-14.

When freezing precipitation conditions exist, a two step deicing / anti-icing procedure will be used. The first step, deicing, is the removal of contaminates from the aircraft using diluted Types I, II or IV fluids or, at locations so equipped, by use of an Infrared (IR) de-ice system. When an Infrared system is used, aircraft will be taxi / towed to the entrance of the IR hangar where ground personnel will marshal or ground tower will guide the aircraft into the hangar.

Note: The IR system software limits the maximum temperature during aircraft de-icing to 120° F.

The second step, anti-icing, is a separate fluid application to protect against ice, snow, slush or frost adhering to critical aircraft surfaces. Diluted Type 1 or 100% Type II or IV fluids are used for anti-icing.

When freezing precipitation conditions do not exist and are not anticipated, a one step, deicing, procedure will be used to remove any contaminates that may have adhered to the aircraft during a previous exposure to freezing precipitation.

Aircraft may be deiced / anti-iced with the engines and/or APU shutdown or operating. In either case the air conditioning supply switches and APU air switch should be selected off to prevent fumes from entering the cabin through the air conditioning system.

After completion of deicing / anti-icing, run engines and APU for approximately one minute with the air conditioning supply switches and APU air switch selected off to ensure that all deicing / anti-icing fluid has been cleared from the engines and APU. Consider making an announcement advising passengers that a trace of odor may be sensed but it is a normal condition of deicing.

Post Deicing / Anti-Icing Inspections

After the final anti-icing fluid application, personnel qualified in ground deicing inspection procedures will inspect critical aircraft surfaces to ensure that they are free of ice, slush, snow, or frost. Critical aircraft surfaces are listed in this section under Predeparture Check.

After completion of the inspection, the flight crew will be notified via radio or interphone communication that deicing / anti-icing and inspection procedures have been completed. This notification must contain the following four elements:

SAE Fluid Type:	I, II or IV
Fluid Mixture:	100/0 = 100% Fluid / 0% Water, 75 / 25 = 75% Fluid / 25% Water, 50 / 50 = 50% Fluid / 50% Water
Local Time:	(Hours/Minutes) of the beginning of the final anti-icing fluid application
Employee Number:	Of qualified person certifying that the deicing / anti-icing and inspection procedures were accomplished.

After receipt of this information, the flight crew will make the following aircraft logbook entries:

Block (2)	Aircraft Fleet Number
Block (3)	Flight Number
Block (4)	Employee Number of Captain
Block (5)	Station
Block (6)	Day of Month
Block (7)	Month
Block (8)	Aircraft anti-iced, type fluid, fluid mixture, local time (hours/minutes) of the beginning of the final anti-icing fluid application, employee number of qualified person certifying that the deicing / anti-icing and inspection procedures were accomplished in accordance Continental GMM Section 06-14 and is released for flight. (e.g., "Aircraft Deiced, Type I / 50/50 / 0830 / 38802")

Note: The above notification and subsequent logbook entry are only required when freezing precipitation conditions exist. The situation may occur where the aircraft was exposed to freezing precipitation several hours prior to its next scheduled departure, such as an RON. The weather at departure time is such that no freezing precipitation conditions exist. In this situation the aircraft requires deicing only to clean any adhering ice, snow, slush or frost that may have previously accumulated on the aircraft. The aircraft does not have to be anti-iced because freezing precipitation conditions do not exist. In this case, post deicing inspection procedures will be accomplished, however the flight crew does not have to be notified and the logbook entry is not required.

Pretakeoff Contamination Check

After completion of the post deicing preflight inspection and only when freezing precipitation conditions exist, if the aircraft is not airborne within 5 minutes of the beginning of the final application of anti-icing fluid (time reported), a pretakeoff contamination check is required. The pretakeoff contamination check, when required, must also be accomplished within 5 minutes of the commencement of the takeoff roll.

A pretakeoff contamination check is a close visual check by a qualified flight deck crewmember or qualified ground personnel, of wing surfaces, leading edges, engine inlets, and other critical surfaces of the aircraft that are in view either from the flight deck or cabin (whichever provides maximum view). If surfaces have not been treated with FPD (Freezing Point Depressant) fluid, evidence of melting snow and possible freezing is sought. Also, evidence of any ice formation that may have been induced by taxi operations is sought. If the aircraft has been treated with FPD fluids, evidence of a glossy smooth and wet surface is sought. If, as a result of these checks evidence of ice, snow, slush or frost formations is observed, the aircraft should be returned for additional deicing.

The crewmember should perform the pretakeoff contamination check from the best vantage point available under the current conditions of the aircraft. There is no best vantage point under all conditions.

The aircraft must be parked and not in motion for the entire time that the flight deck crewmember is not at his or her station.

In some cases, it may become necessary to unseat passengers in the vicinity of the overwing vantage point area to conduct the pretakeoff contamination check. The flight deck crewmember making the check must ensure that all unseated passengers are reseated with seatbelts fastened before returning to the flight deck.

The exterior surface areas that may be viewed from inside the aircraft are deiced or anti-iced first so that during the pretakeoff contamination check it can be determined that other areas of the aircraft are clean since areas deiced or anti-iced first will generally freeze first.

In the darkness of night, the crewmember should use wing and other aircraft illumination lights on the outside of the aircraft. All lighting inside the cabin should be dimmed to improve the visibility through the cabin windows. The crewmember may, where practical, call upon the assistance of qualified ground personnel. If under any circumstance, the pilot in command cannot ascertain that the aircraft is clean, takeoff should not be attempted.

The decision to takeoff, following pretakeoff contamination check remains the responsibility of the pilot in command.

Anti-Icing Fluid Holdover Times

Holdover time is the estimated time an application of an anti-icing fluid will prevent the adherence of frost, ice, snow, or slush on the treated surfaces of an aircraft. Holdover time is obtained by anti-icing fluids remaining on the aircraft surfaces. Holdover time begins when the final anti-icing application commences, and expires when the anti-icing fluid applied to the aircraft wings, control surfaces, engine inlets, and other critical surfaces loses its effectiveness.

Due to their properties, SAE Type I fluids form a thin liquid wetting film, which provides limited holdover time, especially in conditions of freezing precipitation.

SAE Type II and IV fluids contain a pseudoplastic thickening agent, which enables the fluids to form a thicker liquid wetting film on external aircraft surfaces. This film provides a longer holdover time, especially in conditions of freezing precipitation.

The "Guidelines to Holdover Times" table gives an indication as to the time frame of protection that could reasonably be expected under conditions of precipitation. However, due to the many variables that can influence holdover, these times should not be considered as minimums or maximums, as the actual time of protection may be extended or reduced, depending upon the particular conditions existing at the time.

Holdover Times

The responsibility for the application of this data remains with the user.

Caution: This Table is for use in departure planning only, and should be used in conjunction with pre-takeoff contamination check procedures.

Caution: The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity and jet blast reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than OAT.

Caution: SAE Type I, II, and IV Fluids used during ground deicing / anti-icing are not intended for and do not provide protection during flight.

Note: For domestic operations using Types II or IV Fluid, Continental Airlines may use a diluted mixture for the first step of a two step (deice, then anti-ice) procedure, but uses only a 100% mixture of Type II or Type IV fluid for the second step (anti-ice).

Note: Takeoffs in conditions of moderate and heavy freezing rain are not approved. In lieu of an intensity report (ATC, ATIS, METAR, TAF, etc.) the following may be used to estimate the intensity of the freezing rain:

- **Light:** Scattered drops that, regardless of duration, do not completely wet an exposed surface, up to a condition where individual drops are easily seen.
- **Moderate:** Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces.
- **Heavy:** Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

Guidelines to Holdover Times

Times in Hours : Minutes

Information contained here in is applicable to light to moderate conditions only.
Takeoff in heavy icing conditions prohibited.

Weather Conditions	OAT ° CELSIUS	Type Fluid I	II			IV		
		****	**50%**	**75%**	**100%**	**50%**	**75%**	**100%**
Frost * ***	Above 0°	:45	4:00	6:00	12:00	4:00	6:00	18:00
	0° to -3°		3:00	5:00	8:00	3:00	5:00	12:00
	-4° to -14°							
	-15° to -25°							
Freezing Fog * ***	Above 0°	:12 to :30	:15 to :30	:25 to 1:00	:35 to 1:30	:15 to :35	1:05 to 1:45	1:05 to 2:15
	0° to -3°	:06 to :15						
	-4° to -14°			:20 to :55	:20 to 1:05		:25 to :50	:20 to 1:20
	-15° to -25°				:15 to :20			:15 to :40
Snowfall & Snow Grains *	Above 0°	:06 to :15	:05 to :15	:15 to :40	:20 to :55	:05 to :20	:20 to :40	:35 to 1:05
	0° to - 3°	:06 to :15		:15 to :30	:20 to :45	:05 to :15	:20 to :35	:30 to :55
	-4° to -14°	:06 to :15		:15 to :25	:15 to :35		:15 to :25	:20 to :40
	-15° to -25°				:15 to :30			:15 to :30
Rain & Cold Soaked Wing	Above 0°	:02 to :05		:05 to :25	:05 to :40		:05 to :35	:10 to :50
Freezing Drizzle **	-3° & Above	:05 to :08	:05 to :15	:20 to :45	:30 to :55	:10 to :20	:30 to :50	:40 to 1:00
	-4° to -10°			:15 to :30	:15 to :45		:15 to :30	:20 to :45
Light Freezing Rain	-3° & Above	:02 to :05	:05 to :10	:10 to :20	:15 to :30	:05 to :10	:15 to :30	:25 to :40
	-4° to -10°				:10 to :30		:10 to :20	:10 to :25
Snow pellets, ice pellets, moderate & heavy freezing rain, hail & heavy snow	**CAUTION:** No Holdover time guidelines exist.							

* Type II and IV fluids may be used below -25°C, provided the freezing point is at least 7°C below the OAT. No holdover times exist.

** If positive identification of freezing drizzle is not possible: Use holdover time for "Light Freezing Rain."

*** Long ground stops with high humidity may cause an unacceptable dilution at the actual OAT.

**** SAE Type I fluid / water mixture is selected so that the Freezing Point of the mixture is at least 10°C below OAT.

Engine Start

When parked on a slippery area, make sure that chocks are applied both in front and behind the nose and main wheels prior to starting the engines. Chocks may not hold on slippery areas unless they are sanded. If chocks are not available for start, use sand or similar material and clear the aircraft for potential movement.

Cold components such as gyros, gauges, actuators, etc., may function slower than normal until reaching operating temperatures. Instrument flags may take longer than normal to retract.

Before starting engines, ensure engine cowl inlet and exhaust areas are clear of any excess de-icing fluid and/or ice accumulations. Use of de-icing solutions for removal of engine inlet ice should be kept to the minimum required.

Engine and wing anti-ice should be turned on as soon as icing conditions are encountered after engine start. Engine start switches are to be placed in CONT.

During all cold weather starts, it is recommended that engines be warmed up at idle, or at thrust settings normally used for taxi, for five minutes before advancing throttles to takeoff thrust.

Start engines in a normal manner. Be aware of the following:

- If the engine has been cold soaked for three or more hours at ambient temperatures less than –40° C, do not start or motor the engine. Maintenance personnel should accomplish appropriate procedures for adverse weather starter servicing.
- If ambient temperature is below –35° C (-31° F), allow engine to idle two minutes before changing thrust lever position.
- If N_2 RPM increase is not observed, exterior heat must be applied.
- Up to three and one-half minutes may be allowed for oil pressure to reach the minimum operating pressure. During this period, the **LOW OIL PRESSURE** light may remain illuminated, pressure may go above the normal range, or the **FILTER BYPASS** light may illuminate. Operate the engine at idle thrust until oil pressure returns to the normal range.

Taxi-Out

Cowl and wing anti-ice must be on during all ground operations when icing conditions exist or are anticipated, with or without de-icing fluid applied.

Note: If engine and wing anti-ice are required during ground operations, taxi with engine bleed air switches ON and APU bleed air switch OFF to ensure bleed air for wing anti-ice.

If the aircraft has been deiced:

The control column will be smoothly and slowly cycled from the full aft to the full forward position a minimum of three times to minimize the residual fluids in the balance bay during flight.

7 8 Per Airworthiness Directive 2002-08-20 / AMOC 120S-02-907:

"After ground deicing / anti-icing of the horizontal stabilizer using Type II or Type IV fluids, airspeed must be limited to 270 KIAS until the flight crew has been informed that applicable maintenance procedures have been accomplished that would allow exceedance of 270 KIAS. Once the applicable maintenance procedures have been accomplished, exceeding 270 KIAS is permissible only until the next application of Type II or Type IV deicing / anti-icing fluids."

Note:

- Aircraft is restricted to a maximum of 270 KIAS after Type II or Type IV fluid application. No MACH restriction.
- Flight Plan Release (amended if required) displays 270-knot restriction.
- Restriction remains in effect for all flights until elevator tab surfaces are cleaned of Type II or Type IV fluids.
- It has been determined that Type I fluid does not affect the flight controls of the aircraft. If **only** Type I fluid is used for deicing / anti-icing, the speed restriction is not applicable.

Caution: Flight Crews will evaluate the need to land at the nearest suitable airport if in-flight vibrations (**ELEVATOR TAB LIMIT CYCLE OSCILLATION**) occur as a result of de-icing.

All engines must be operating on ice, snow, or slush-covered surfaces. When on slippery surfaces, make sure the parking brakes are released prior to commencing taxi. When power is applied, the aircraft may slide forward even though the brakes are set.

Exercise caution when commencing taxi, as ramp areas may be especially slippery due to aircraft servicing, de-icing, etc. Avoid high thrust settings when taxiing, especially when leaving the ramp area. If aircraft response to throttle movement is slow while on snow or slush, allow a few seconds for the aircraft to respond before applying more throttle. Advance power only as necessary to start the aircraft moving, then retard the throttles smoothly to idle or to the minimum thrust necessary to maintain appropriate taxi speed.

Taxi with flaps up. With flaps extended, the flap carriages, fore flap and aft flap tracks are subjected to slush and water from main gear wheels. The jackscrew fairings on the ends of each flap are subject to filling with slush, as are the leading edge slat tracks.

Taxi speed should be as slow as practical on slippery surfaces and should be especially slow when approaching turns or stopping areas. Lead turns by as much as possible considering taxiway width. Nosewheel steering and braking action may both be affected by lack of traction on slick and frozen surfaces; the slower the speed, the better the traction. Avoid excessive nose gear steering deflection. Surface conditions may vary between taxiways and parking areas due to sanding and de-icing. Expect taxiways on bridges or other elevated areas to be more susceptible to ice formation than adjacent areas. An icy surface may be covered by a layer of snow. Melting ice or snow may cause rapid changes in traction. It is essential that the taxi speed be kept low enough that the aircraft can be stopped in the space available. Reverse thrust may be used if necessary to assist in stopping.

Taxi slowly on contaminated taxiways to prevent snow and slush from impinging on wheel wells, flaps, and engines. Do not taxi through areas of deep snow or deep slush. A crowned, slippery taxiway or a slick crosswind taxiway may cause sideways slipping or weathervaning into the wind. Taxi as close as possible on the centerline and avoid large nose steering inputs. Be aware of snow banks, as extended flaps are particularly susceptible to damage from such hazards. Be alert for obscured runway, taxiway, or ramp markings and lights.

The nose steering wheel should be exercised in both directions during taxi to permit the circulation of warm hydraulic fluid through the steering cylinders. This will minimize the lag encountered in steering during low temperatures.

When moderate to severe icing conditions are present during prolonged ground operation, periodic engine run-up to as high a thrust setting as practical (70% N_1 recommended) should be made at 30-minute intervals for approximately one minute duration.

If a clear, dry run-up area is available during taxi or on the ramp, make a preliminary power run on the clear dry area in order to prevent an abort which may occur if check is made on a slick runway.

The shortest possible route to the point of takeoff should be used to conserve fuel and minimize the amount of ice fog generated by the jet engines. This fog may delay takeoff by lowering the visibility below takeoff minimums.

Caution: Use extreme caution when taxiing over ice-covered taxiways or runways, as excessive speed or high crosswinds may start a skid. Attempt all turns at reduced speed.

Taxi speed should be kept as slow as possible to reduce the chance of the nose gear tires throwing snow and slush up to the ram air inlet area.

WARNING: If the flaps are left up during taxi to avoid slush and ice, the taxi checklist will be completed after flaps are in the takeoff position.

Caution: When operating the wing flaps during low temperatures, the flap position indicators and leading edge device annunciator should be monitored for positive movement. If the flaps should stop, the flap control lever should be placed immediately in the same position as indicated.

Exterior Deicing

Flaps .... AS REQUIRED

Prevents ice and slush from accumulating in flap cavities. Flaps should be up, if possible.

Start Levers .... AS REQUIRED

If engines are running, do not operate above idle thrust.

Stabilizer Trim .... FULL NOSE DOWN

Set stabilizer to the APL NOSE DOWN limit to prevent deicing fluid and slush run-off from entering the stabilizer balance panel cavity. Trim the aircraft to the electrical APL NOSE DOWN LIMIT. Then continue trimming manually to the APL NOSE DOWN LIMIT.

WARNING: To avoid personal injury, ensure that the stabilizer trim wheel handle is stowed prior to using electric trim.

Pack Switches .... OFF

Engine & APU Bleed Air Switches .... OFF

Reduces the possibility of fumes entering the air conditioning system.

Note: Deicing may occur at various locations such as at the gate or at remote locations prior to takeoff. Because of this, checklist usage will vary due to the circumstance.

- Should deicing occur at the gate, the normal BEFORE START, AFTER START and TAXI checklists will be accomplished in their normal sequence.
- Should deicing occur at a remote location with the engines shut down, the normal BEFORE START and AFTER START checklists will be accomplished in their normal sequence then, once deicing was complete, the DELAYED ENGINE START and TAXI checklists will be accomplished.

- - - - - AFTER DEICING IS COMPLETE - - - - -

Control Column .... CYCLE

The control column will be smoothly and slowly cycled from the full aft to the full forward position a minimum of three times to minimize the residual fluids in the balance bay during flight.

7 8 Per Airworthiness Directive 2002-08-20 / AMOC 120S-02-907:

"After ground deicing / anti-icing of the horizontal stabilizer using Type II or Type IV fluids, airspeed must be limited to 270 KIAS until the flight crew has been informed that applicable maintenance procedures have been accomplished that would allow exceedance of 270 KIAS. Once the applicable maintenance procedures have been accomplished, exceeding 270 KIAS is permissible only until the next application of Type II or Type IV deicing / anti-icing fluids."

Note:

- Aircraft is restricted to a maximum of 270 KIAS after Type II or Type IV fluid application. No MACH restriction.
- Flight Plan Release (amended if required) displays 270-knot restriction.
- Restriction remains in effect for all flights until elevator tab surfaces are cleaned of Type II or Type IV fluids.
- It has been determined that Type I fluid does not affect the flight controls of the aircraft. If **only** Type I fluid is used for deicing / anti-icing, the speed restriction is not applicable.

Caution: Flight Crews will evaluate the need to land at the nearest suitable airport if in-flight vibrations (**ELEVATOR TAB LIMIT CYCLE OSCILLATION**) occur as a result of de-icing.

Stabilizer Trim .... RESET FOR TAKEOFF

Engine & APU Bleed Air Switches .... AS REQUIRED

Wait at least 1 minute after completion of de-icing before turning any bleed air switches on.

Pack Switches .... AS REQUIRED

If engines are running, pack switches should be Auto.

Flaps .... AS REQUIRED

Note: Accomplish all normal checklists.

Note: When freezing precipitation conditions exist and the aircraft is not airborne within 5 minutes of the beginning of the final application of anti-icing fluid, a pre-takeoff contamination check is required. If de-icing is required, reaccomplish this checklist.

Note: If moderate icing conditions are present, takeoff roll must be preceded by a static run-up to 70% N_1 and stable engine operation observed prior to brake release. If the aircraft starts to slide on ice or snow during engine power check, release brakes and begin takeoff roll. Continue engine check during early part of takeoff roll.

* * * *

Before Takeoff

Prior to takeoff, recheck flight controls and trim for freedom of movement. Use caution when taxiing onto the runway for takeoff. The approach end of the runway may be more slippery than other areas due to melting and refreezing of snow or ice following previous takeoffs. In addition, painted surfaces and normal accumulation of fuel, oil, and rubber are made more slippery when coated with moisture (i.e., water or slush).

Takeoff

Check latest field conditions prior to takeoff. Slush and snow conditions change rapidly. A runway is contaminated when more than 25% of the required field length, within the width being used, is covered with ¼ inch or more of slush or wet snow, or 2 inches or greater of dry snow.

- Slush is snow saturated with water that splatters when firmly stepped on.
- Wet snow is compactable and will stick together as in a snowball.
- Dry snow is light powdery snow that can be blown about freely. Snow not considered dry will be considered wet.
- Icy runway is a runway covered with cold ice or wet melting ice. Temperatures rising above 0°C, initial pavement temperatures above 0°C, or solar radiation can produce wet melting ice. Melting ice or hard packed snow with a melting or water-covered surface may have poor to nil braking action capability.

A reduced thrust takeoff is not permitted when the runway is contaminated by water, ice, slush, or snow.

On contaminated runways use higher takeoff flap settings (as permitted by takeoff performance) to reduce takeoff roll.

Align the aircraft with the runway centerline and ensure that the nosewheel is straight before applying power for takeoff. Under severe icing conditions, takeoff should be preceded by a static run-up to as high a thrust level as practical with observation of N_1 and EGT to assure normal engine operation. On slippery surfaces, ensure the parking brakes are released prior to setting takeoff power to preclude a takeoff with the parking brakes set.

Asymmetrical thrust can adversely affect directional control on slippery runways. Throttle alignment at partial power may not assure alignment at takeoff power as engine pairs may have different spool-up rates. Apply brakes and advance throttles to approximately 40% N_1 (35 - 45% N_1). After the engines are stabilized, manually advance the throttles toward the takeoff power setting, engaging TOGA when the Pilot Flying is satisfied acceleration is normal. If the aircraft starts to slide on ice or snow during engine power check, release brakes and begin takeoff roll. Continue engine check during early part of takeoff roll. During takeoff on icy runways, the lag in nose wheel steering and the possibility of nose wheel skidding must be realized and corrections must be anticipated.

On slippery runways, apply some nose down elevator to improve nosewheel traction and directional control until rudder control becomes effective for steering the aircraft. Excessive forward control column pressure should be avoided and, as speed increases, the forward pressure on the control column should be reduced to lessen the possibility of nosewheel spray being ingested into the engines when operating on wet, or slush and snow-covered runways.

To maintain the heading during takeoff roll, recognize initial heading deflections early and correct by small rudder pedal steering inputs. Do not use differential thrust.

If the decision is made to reject the takeoff and the runway is slick, position the throttles to idle, use maximum reverse thrust, verify the speedbrake has deployed, and use maximum braking. For directional control, use the rudder pedals down to taxi speed. The anti-skid system will provide the minimum stopping distance for the existing condition of the runway.

Caution: The nose wheel steering (tiller) should not be used above normal taxi speeds (20 knots).

If a skid develops, reduce reverse thrust to idle reverse. Return engines to forward thrust at low power, if necessary, to return to the runway centerline. Use rudder pedal steering if possible for directional control. The nose steering wheel, rudder and differential braking may also be used as necessary for directional control. Reduce brake pressure if directional control problems are encountered due to excessive anti-skid cycling.

Note: In a skid, the aircraft will go off the runway nose first with forward thrust and tail first with reverse thrust.

Wing Anti-Ice Operation In Flight

The wing anti-ice system may be used as a deicer or anti-icer in flight.

The preferred method is to use the system as a de-icer by allowing ice to accumulate before turning on wing anti-ice. Use of the wing anti-ice system as a de-icer provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty. Generally, anti-ice is not required during climb and cruise when temperature is below –40 degrees C SAT. At high altitudes when wing anti-ice is no longer needed, it should be turned OFF.

The secondary method, which is only used during extended operation in moderate to severe icing conditions, is to use the wing anti-ice system prior to ice accumulation. Operating the wing anti-ice system as an anti-icer may occur during holding or similar conditions.

Ice accumulation on the flight deck window frames, windshield center post, or on the windshield wiper arm may be used as an indication of structural icing conditions and the need to turn on wing anti-ice. However, such structural ice indications do not necessarily require wing de-ice system use. Under normal in-flight icing conditions, it is not necessary to shed ice unless extended flight through icing conditions is necessary. During takeoff, to meet second segment climb requirements at Continental Airlines, wing heat will not be used below 800 feet AGL.

Engine Anti-Ice Operation In Flight

Engine icing often forms when not expected and may occur when there is no evidence of icing on the windshield or other parts of the aircraft. Once ice commences to form, an appreciable accumulation can build with surprising rapidity. Although one bank of clouds may not cause icing, another bank, which to all appearances is similar, may induce icing. Therefore, it is required that the engine anti-icing system be turned on whenever icing conditions exist or are anticipated, except during climb and cruise when temperature is below –40° C SAT.

When engine anti-ice is required, the ignition switches must be placed in CONT prior to initially opening the anti-ice valves, and left in CONT during use of the engine anti-ice system.

Position engine anti-ice switches to ON. Observe that each **COWL VALVE OPEN** light illuminates bright, then dim.

When engine anti-ice is no longer required, position engine anti-ice switches to OFF and observe that each **COWL VALVE OPEN** light illuminates bright, then extinguishes. Ignition switches can then be turned off.

Descent - Approach

Engine anti-ice must be ON prior to, and during descent in all icing conditions, including temperatures below –40° C SAT.

Follow normal procedures for descent, including ice protection system operation if required. When descending through visible moisture, it will be necessary to anticipate wing and nacelle anti-icing requirements.

If moderate to severe icing conditions are encountered during descent or holding with thrust settings below 80% N_1, accomplish engine run up on one engine at a time to a minimum of 80% N_1 at approximately 15 minute intervals to clear ice from fan blades and spinner.

③ 3 5 Approach Target Speed In Icing Conditions

If ice formations are observed on the aircraft surfaces, (wings, windshield wipers, window frames, etc.) add 10 knots to the V_{REF} for establishing Target speed to ensure maneuvering capability. The airspeed additive will be either the ice correction of 10 knots or the additive for steady wind plus gust, whichever is higher, not to exceed the maximum additive of 20 knots. The ice additive applies to all flap settings.

Example: B737-300
Weight: 112,000 lbs
Sea Level
30° Flaps
Rwy 35
V_{REF} = 135

1. Wind: 330/12G20
   Ice additive = 10 knots
   Wind additive = ½ steady (6) + gust (8) = 14
   Max additive = 20
   Target = V_{REF} (135) + additive (14) = 149

2. Wind: Calm
   Ice additive = 10 knots
   Wind additive = 5 (wind additive minimum is 5)
   Max additive = 20
   Target = V_{REF} (135) + additive (10) = 145

7 8 9 Approach Target Speed In Icing Conditions

Use normal procedures and reference speeds without an additional ice additive, unless a flaps 15 landing is planned. If a flaps 15 landing is planned:

1. Set $V_{REF\ Ice}$, $V_{REF\ Ice}$ = Flaps 15 V_{REF} + 10 knots.
2. Then add the normal wind additive (between 5 and 20 knots) to $V_{REF\ Ice}$

   Note: 8 9 15-knot maximum wind additive applies to flaps 30 / 40 landings only.

This procedure applies under any of the following conditions:

- Engine anti-ice will be used during landing
- Wing anti-ice has been used any time during the flight
- Icing conditions were encountered during the flight and the landing temperature is below 10° C.

Example: B737-800
Weight: 140,000 lbs
Sea Level
Flaps 15
Rwy 35
Wind: 330/16

Flaps 15 V_{REF} = 154
$V_{REF\ Ice}$ = 154 + 10 = 164
Normal wind additive (between 5 and 20) = 8
Target = $V_{REF\ Ice}$ (164) + additive (8) = 172

Taxi-In

Caution: Structures are possibly colder than OAT due to cold soak at altitude. At low speed, minimize the intensity and duration of reverse thrust. After landing and/or if taxiing through water or slush, do not retract flaps beyond 15. A visual inspection should be accomplished to determine that the flaps and flap areas are clear of ice before further flap retraction. The jackscrews are especially vulnerable to water and slush.

A buildup of ice on the leading edge devices may occur during ground operations due to the use of reversers in light snow conditions. Snow is melted by the deflected engine gases and may refreeze as clear ice upon contact with cold leading edge devices. This buildup, which is difficult to see, occurs in temperature conditions at or moderately below freezing. Crosswind conditions can cause the ice buildup to be asymmetrical resulting in a tendency to roll at higher angles of attack during subsequent takeoffs.

After landing in icing conditions, position the stabilizer between 0 and 2 units, aircraft nose down (leading edge up). With flaps retracted, this requires approximately 8 hand wheel turns of the manual trim. This prevents melting snow and rain from running into balance bay areas and prevents the stabilizer limit switch from freezing.

Pitot heat and cowl anti-ice may be used during taxi-in if conditions warrant.

During operations on ice or snow covered surfaces, exercise extreme caution when approaching parking areas. Be on the alert for poor braking action and snow piles or drifts adjacent to taxi and runways.

If prolonged operation in icing conditions with the leading and trailing edge flaps extended was required:

Flaps 15

Retraction to less than flaps 15 is not recommended until ice has been removed or a ground inspection had been made.

Stabilizer Trim .... SET 0 TO 2 UNITS

Prevents melting snow and ice from running into balance bay areas and prevents the stabilizer limit switch from freezing. With flaps retracted, this requires approximately eight hand wheel turns of manual trim.

Engine Anti-ice .... ON

If icing conditions exist, engine anti-ice must be on.

Parking

The aircraft should be parked headed into the wind, if practical, particularly in driving rain and snow conditions. Protective plugs and covers, etc. should be installed. If brakes have been used immediately prior to parking, do not set brakes until sufficiently cooled.

Landing

Refer to LANDING ON WET OR SLIPPERY RUNWAYS this section.

Securing for Overnight or Extended Period (Aircraft Unattended)

If remaining overnight at off-line stations or at airports where normal support is not available, the flight crew should arrange for or ascertain that the following actions have been accomplished:

- Position the pressurization mode selector to MAN AC/MAN and hold the outflow valve switch to CLOSE until the outflow valve indicates closed.
- Wheel Chocks - check in place.
- Release parking brake to eliminate possibility of brakes freezing.
- Protective covers and plugs should be installed to protect the aircraft and engines from snow and ice if left unattended for an extended period of time.
- All water tanks and containers should be drained to protect from freezing if the aircraft is to be left unattended for an extended period of time.
- All toilets should be drained to protect from freezing if the aircraft is left unattended for an extended period of time.

INTENTIONALLY LEFT BLANK

HOT WEATHER OPERATION

High ground temperatures have adverse effects on passenger and crew comfort and generally decrease aircraft performance. Every effort should be made to keep the interior of the aircraft as cool as possible. All doors to the aircraft should be kept closed as much as possible. The flight deck windows must be kept closed and cargo doors should not be left open longer than necessary. The flight attendants should verify all gasper outlets are opened, reading lights extinguished, and window shades closed on the side of the aircraft exposed to the sun. All air conditioning packs should be used (when possible) for maximum cooling.

While the aircraft is electrically powered, a pack(s) should be run or cooling air supplied to the aircraft when OAT exceeds 40° C / 103° F to protect the reliability of electrical and electronic equipment in the aircraft.

If cooling air is available from an outside source, the supply should be plugged in immediately after engine shutdown and should not be removed until just prior to engine start.

Consideration should be given to reducing the heat being generated in the flight deck. Window heat, radar and other electronic components, which contribute to a high temperature level in the flight deck, should be turned off while the aircraft is on the ground. Windshield air, foot air vents, and all the air outlets on the flight deck should be open.

Caution: Window heat must be ON 10 minutes before takeoff.

③ 3 5 To attain maximum cooling on ground, follow these procedures:

IF External Air Is Available:

APU Bleed Air Switch .... OFF
Isolation Valve Switch .... OPEN
Recirculation Fan Switch .... AUTO
Air Conditioning Pack Switches .... HIGH
Duct Pressure .... 20 - 25 PSI

IF The External Air Supply Will Not Maintain 20 - 25 psi:

Isolation Valve Switch .... CLOSED
Recirculation Fan Switch .... AUTO
APU Bleed Air Switch .... ON

The APU will supply the left pack, and the external air will supply the right pack.

IF The APU Is The Only Source Of Pneumatic Air Pressure:

APU Bleed Air Switch .... ON

One Pack Switch.. HIGH

Recirculation Fan Switch .... AUTO

Temperature Selectors...AUTO NORMAL

7 8 9 The APU should supply adequate air pressure to operate both packs.

Taxi Out

When operating in high temperatures, brake temperatures levels may be reached which will cause the fuse plugs to melt and deflate the tires. Runways and taxiways maintain temperatures considerably above ambient. Excessive use and "riding" of brakes should be avoided. Intermittent brake usage provides a cooling period between applications. Allow the aircraft to accelerate, then brake to a very slow taxi speed and release the brakes completely. Gross weight permitting, single engine taxi may help to avoid excess brake usage. For optimum passenger comfort during single engine taxi, use the #2 engine to operate the right pack and use the APU as a source of bleed air to operate the left pack.

Takeoff

High temperatures degrade takeoff performance, especially combined with short runways or high elevation airports. Consideration should be given to using alternate takeoff procedures (no bleed takeoff, improved climb performance, etc.). Fuel temperature limitations listed in the limitations section must be observed.

Brake Cooling

Flight crews should be aware of brake temperature buildup when operating a series of short flight segments. They should attempt to maintain cool brakes by additional in-flight cooling prior to each landing to prevent ground delays resulting from overheated brakes and possible loss of main wheel fuse plugs at enroute stops. A series of short flight segments, without additional in-flight brake cooling, can cause excessive brake temperatures as the energy absorbed by the brakes from each landing is cumulative.

Leaving the gear extended for several minutes after takeoff will provide cooling for tires and brakes (important if on a short flight segment).

Extending the gear a few minutes early in the approach will provide sufficient cooling for a landing with cool tires and brakes.

LANDING ON WET OR SLIPPERY RUNWAYS

WARNING: Landing on a wet runway with Anti-Skid Inoperative is **not authorized**.

Touchdown and Landing Roll

Once on the ground, the importance of the early use of all means of stopping the aircraft cannot be overemphasized. Timely execution of the following actions will permit stopping the aircraft with the least landing roll.

Accomplish a firm touchdown as near centerline as possible.

Check that the auto speedbrake deploy immediately after the main gear contacts the runway. If the speedbrake lever fails to actuate automatically, immediately actuate it manually. Speedbrake will reduce lift, increase drag and increase main gear loading. Quick extension of the speedbrake is important because the effects of reduced lift and increased drag are cumulative in shortening the landing roll.

Immediately lower the nose wheel as the speedbrake and thrust reversers are being actuated. This is desirable because reducing the aircraft attitude decreases lift, increases main gear loading, and improves directional stability. Holding the nose off and delaying braking is undesirable as aerodynamic braking is relatively ineffective.

Use thrust reversers as soon as possible during landing roll. Thrust reversers are most effective at high speed.

Rapidly raise the reverse thrust levers and move them aft. Modulate reverse thrust as required and avoid exceeding engine limits.

At approximately 80 knots, begin a gradual reduction of reverse thrust to be at idle reverse when reaching taxi speed.

Under emergency conditions, maximum reverse thrust may be used to a complete stop.

Autobrake Stopping

Arm the autobrake system before landing by selecting position 2 or 3 deceleration level. At main gear touchdown, after wheel spin-up, the autobrake system smoothly begins to apply symmetrical braking and to control aircraft deceleration.

The autobrake system can be disarmed by application of pressure on any brake pedal; storage of speed brake handle to full forward detent, or turning autobrake selector to OFF and take over manual braking.

If the autobrake system is not available, complete the landing roll using manual braking.

Manual Brake Stopping

Without autobraking, apply brakes smoothly and symmetrically immediately after nose gear touchdown, with moderate to firm pedal pressure and hold until a safe stop is assured. Do not cycle the brake pedals. The brakes and thrust reversers should be applied together. Due to the 3 - 5 seconds delay before buildup of full effective reverse thrust, brakes will normally be operating before reverse thrust.

The anti-skid system will stop the aircraft for all runway conditions in a shorter distance than is possible with either anti-skid OFF or brake pedal modulation. The anti-skid system adapts pilot-applied brake pressure to runway conditions by sensing an impending skid condition and adjusting the brake pressure to each individual wheel for maximum braking effort. When brakes are applied on a slippery runway, several skid cycles may occur before the anti-skid system establishes the right amount of brake pressure for the most effective braking.

If the pilot modulates the brake pedals, the anti-skid system is forced to readjust the brake pressure to re-establish optimum braking. During this readjustment time, braking efficiency is lost.

Due to the low coefficient of friction on extremely slippery runways at high speeds, the pilot is confronted with a rather gradual increase in deceleration and may interpret the lack of an abrupt sensation of deceleration as a total anti-skid failure. His natural response might be to pump the brakes or turn the anti-skid OFF. Either action will degrade braking effectiveness.

Avoid large, abrupt steering and rudder pedal inputs that may lead to overcontrol and skidding. Rudder control is relatively effective down to 40 - 60 knots. Maintain directional control and wings level with appropriate control inputs. The optimum nosewheel steering angle varies with runway condition and aircraft speed and is about 1 to 2 degrees for a very slippery runway. Keep light forward pressure on the control column to improve nose wheel steering effectiveness.

Caution: The nose wheel steering (tiller) should not be used above normal taxi speeds (20 knots).

Reverse Thrust and Crosswind

The reverse thrust side force and a crosswind can cause the aircraft to drift to the downwind side of the runway if the aircraft is allowed to weathervane into the wind. As the aircraft starts to weathervane into the wind, the reverse thrust side force component adds to the crosswind component and drifts the aircraft to the downwind side of the runway. Main gear tire cornering forces available to counteract this drift will be reduced when the anti-skid system is operating at maximum braking effectiveness for existing conditions. To correct back to the centerline, reduce reverse thrust to idle reverse and release the brakes. This will minimize the side force component without the requirement to go through a full reverser actuating cycle, and provide the total tire cornering forces for realignment with the runway centerline. Use rudder steering and differential braking, as required to prevent overcorrecting past the runway centerline. When re-established on the runway centerline, reapply steady brakes and reverse thrust as required to stop the aircraft.

Turnoff

Do not attempt to turn off from a slippery runway until speed is reduced to a safe level to prevent skidding. Anticipate low friction when approaching the touchdown zone at the far end of the runway. The touchdown zone may be very slippery when wet due to heavy rubber and oil deposits.

The following chart summarizes the recommended procedure for landing the B737 on wet or slippery runways (see next page):

PHASE	RECOMMENDED PROCEDURE	REMARKS
Approach	Fly final approach with the aircraft positioned on the glidepath, on runway centerline and at the speed recommended for existing conditions. Arm autobrake system by selecting position 2, 3, or MAX. Arm speedbrake. Do not be misled by the relative bearing of the runway due to crab angle when breaking out of the overcast. Consider a go-around if zero drift conditions cannot be established prior to flare.	
Flare	Do not float or allow drift to build up during flare. Use crab technique on slippery runways.	
Touchdown	Crab may be held through touchdown. Accomplish a firm touchdown, as near centerline as possible. Get the wheels on the runway at approximately 1,000 feet from the approach end of the runway. The aircraft should be flown firmly onto the runway at the aiming point even if the speed is excessive. If a touchdown at the far end of TDZ is likely, consider a go-around.	A firm touchdown will improve wheel spin-up on slippery runways. Deceleration on the runway is about three times greater than in the air. Do not allow the aircraft to float in an attempt to reduce speed.
Transition to Braking Configuration (Expedite all items)	Check that the speedbrake deploys immediately after main gear touchdown. Immediately lower the nose gear to the runway, hold light forward control column pressure. Immediately select reverse thrust. Without autobraking, immediately after nose gear touchdown, smoothly apply moderate-to-firm, steady braking until a safe stop is assured. The autobrake system will begin symmetrical braking after wheel spin-up. Either pilot can disarm the system and take over manual braking at any time by applying normal pedal braking.	If the speedbrake lever fails to actuate automatically, immediately actuate it manually. Speedbrakes release approximately 70% of wing lift. Decrease lift, increases gear loading, improves wheel spin-up and directional stability. Aerodynamic braking is relatively ineffective. Reverse thrust is most efficient at high speeds. Do not cycle brake pedals.

PHASE	RECOMMENDED PROCEDURE	REMARKS
Rollout	Maintain light forward control column pressure. Keep the wings level. Use brakes as above. Maintain directional control primarily with rudder.	Improves directional control. Improves braking and traction.
Skid or Loss of Directional Control	Immediately release brake pressure. Reduce to reverse thrust idle. Keep the wings level. Immediately apply nose wheel steering*, rudder and differential braking to bring the aircraft to the centerline. When rolling parallel with the runway and near the centerline, apply reverse thrust and brake pressure to develop maximum braking.	Rudder control is effective down to 60 - 40 knots. Avoid large abrupt steering inputs. Optimum nose wheel steering angle varies with runway condition and speed and is about 1 to 2 degrees for a very slippery runway.
Turnoff	Reduce speed to a safe level prior to turnoff.	End of runway may be very slippery when wet due to heavy rubber and oil deposits.

Caution: * The nose wheel steering (tiller) should not be used above normal taxi speeds (20 knots).

FLIGHT MANEUVERS

Steep Turns

Steep turns in both directions will be accomplished during normal training, recurrent training, and proficiency checks as an exercise in instrument crosscheck and aircraft control.

Entry

Stabilize and trim at 250 knots on heading and altitude. In order to avoid gaining altitude during roll-out, pitch trim is not used during the turn. As the bank is increased past normal (25 - 30 degrees) loss of vertical lift requires a pitch adjustment. Maintain 45 degrees of bank.

Altimeter

The altimeter is the primary performance instrument during the turn. Be alert to the direction and rate of altimeter needle movement and use smooth elevator control pressure changes for corrections.

Rollout

Rollout at the same rate as used with normal turns.

Note: The ADI is reliable for accurate pitch and bank information throughout the turn. Precision error is not apparent on the ADI because the IRS is the source of attitude information.

Dutch Rolls

When a swept-wing aircraft is subjected to yaw, a dutch roll condition can result due to the forward-moving wing developing more lift than the other wing, which is losing some lift due to its relative direction of movement. Normally the yaw dampening system of the B737 prevents a dutch roll condition from developing.

Recovery from a dutch roll is accomplished by applying aileron into the rising wing followed by a return to the neutral aileron position. The combined effect of the aileron and spoiler deflection serves to destroy the developing lift on the forward-moving wing. The initial required aileron deflection will depend on the severity of the roll. In most cases, however, the control wheel should initially be displaced approximately 45 degrees. Subsequent corrections should be progressively less. Full speedbrakes aid in dutch roll damping. The use of rudder during recovery from a dutch roll is not recommended.

Stalls

General

Stall speed is defined as the minimum steady flight speed in any given configuration at which a constant altitude can be maintained (or the minimum steady flight speed at which the angle of attack for maximum lift is attained). During initial stages of stall, local airflow separation results in buffeting, giving natural warning of an approach to a stall.

Initial buffet is caused by airflow separation. Stall warning is considered to be any warning readily identifiable by the pilot, either artificial (stick shaker) or initial buffet (stabilizer shake, aileron shake, or wing shake). Recovery from an approach to stall will be initiated at the earliest recognizable stall warning, initial buffet, or stick shaker.

Lateral and Directional Control:

- Lateral control is maintained with ailerons and spoilers, which remain effective throughout the maneuver.
- Rudder control should not be used to help maintain wings level. A rudder input will cause yaw and the resultant roll due to yaw is undesirable.

Effects of Flaps

The B737 incorporates an auto-slat system. The auto-slat system provides improved handling qualities at high angles of attack during takeoff or approach to landing. When trailing edge flaps 1 through 5 are selected, the leading edge slats are in the EXTEND position. As the aircraft approaches the stall angle, the slats automatically drive to the FULL EXTEND position, prior to stick shaker activation. The slats return to the EXTEND position when the pitch angle is sufficiently reduced below the stall critical attitude.

With the trailing edge flaps up, the slats remain in the retracted position during the stall.

With flaps up, the aircraft exhibits normal stall characteristics. As airflow separation begins to occur, a light buffeting is felt which continues to increase as angle of attack is increased. As the stall is continued beyond initial buffet, any sideslip that develops will have a tendency to include roll-off. Heading and wings level attitude can effectively be controlled with lateral control inputs.

With flaps down, the stall characteristics are very docile. The auto-slat system fully extends the leading edge slats when approaching stall angle of attack if the flaps are in the takeoff range. Light buffeting is felt as airflow separation begins to occur, which continues to increase as angle of attack is increased. There is very little roll-off tendency, and the normal lateral controls remain effective, even at full stall.

Tailoring of the leading edge devices ensures the inboard wing will stall prior to the outboard wing resulting in a nose down pitch tendency at stall.

Approach to Stalls Maneuver

The pilot will accomplish the IN-RANGE checklist prior to demonstrating the stall recoveries. Trim as required throughout the maneuver.

Note: If stalls are accomplished in actual aircraft training, do not trim below maneuvering speed for flaps selected, set the start switches to CONT, and select G/A in N_1 limit.

Required Configurations

1. Clean
2. Turning, flaps 5, gear down, 20 degrees bank
3. Landing, flaps 30, gear down

Purpose and Desired Results

1. Understand and recognize an impending stall condition.
2. React with judgment and procedures to counteract the impending stall.
3. Accelerate to maneuvering speed for the configuration with minimum altitude loss or gain.

Approach to Stalls

1. Clean Stall - Reduce power to approximately 40% N_1.
2. Turning or Landing Stall - Reduce power to approximately 50% N_1.
3. Maintain altitude or a slight rate of climb (200 - 300 FPM).

Stall Recovery

Initiate recovery at first indication of a stall warning (buffet or stick shaker). The objective of the recovery action is to accelerate to the normal maneuvering airspeed with minimum altitude loss. This is accomplished by pushing the throttles to their furthest forward position, calling "MAX THROTTLE," and leveling the wings if in a turn. Smoothly adjust attitude as necessary to hold altitude (terrain avoidance), or manage altitude to minimum loss. If a pitch change is required, it should be smooth and gradual. At most configurations and gross weights, the aircraft will accelerate away from the stall warning without changing pitch attitude. Less altitude is lost and the recovery is simplified by not changing flap position.

The recovery procedures outlined above are for low altitude, minimum altitude loss situations with terrain a factor. If an indication of an impending stall is encountered at cruising altitude, it may be necessary to lower the pitch attitude below the horizon to trade altitude for airspeed.

At intermediate altitudes when terrain contact is not a factor, the pitch attitude should be lowered to approximately 5 degrees ANU while acceptable acceleration is achieved.

All recoveries from approaches to stalls are performed as if an actual stall has occurred. During stall recovery, smooth control inputs will help avoid or minimize altitude loss.

Gear and flaps should be retracted only after altitude loss is arrested, and the aircraft is accelerating toward the maneuvering speed.

If an approach to the stall is encountered with the autopilot engaged, apply limit thrust and allow the aircraft to return to the normal speed. At high altitude, it may be necessary to initiate a shallow descent to regain maneuvering speed. If autopilot response is not acceptable, it should be disengaged.

APPROACH TO STALL RECOVERY

APPSTALL

INITIAL CONDITIONS

Flaps	Gear	Trim Speed	Bank
0	UP	STICK SHAKER OR BUFFET	0°
5	DN		20°
30	DN		0°

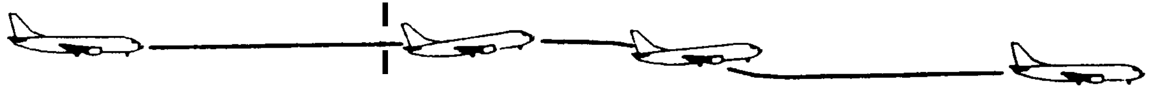
APPROACH

Approx N_1
40%
50%
50%

RECOVERY

At the first indication of stall warning (buffet or stick shaker):

" Call "MAX THROTTLE"
" Apply maximum throttle
" Adjust pitch to minimize altitude loss.
" Level wings.
" Accelerate to maneuvering speed.



• Establish initial conditions

• Note pitch attitude at trim speed.

• Maneuver complete

ADVANCED MANEUVERS

Introduction

Recent studies in the airline industry have concluded that attention needs to be focused on recovery from large bank angles and aircraft upsets. Flight tests performed by Boeing and additional research have yielded some new findings regarding lateral control and wake turbulence. Therefore, procedures have been developed by B737 operators and CAL to facilitate recovery from large bank angle upsets and unusual attitudes.

Crossover Point: May be defined as the point at which there is adequate aileron available to counter a full rudder input. When at flaps 0, or at flaps 15 or greater, the crossover point is at or near the stick shaker speed and therefore is not normally a concern. At flaps 1 through 10 however, the crossover point was found to be well above minimum maneuvering speed (1.3Vs) for the given flap position. For this reason, flying the fixed speeds when maneuvering for landing is strongly recommended.

Wake Turbulence: The wingtip vortices from an aircraft in level flight were found to drop only 300 feet, remain parallel, and maintain the same intensity for up to seven miles.

Upsets And Factors Affecting Recovery

Possible causes of upset may be wake turbulence, atmospheric conditions such as windshear or mountain wave, and aircraft system malfunctions including but not limited to uncommanded autopilot (yaw damper) or rudder inputs.

Human Factors

The NTSB is looking at human factors, such as a pilot's natural hesitancy to make abrupt movements of the flight controls. Additionally, due to aircraft reliability, crews do not expect abnormal events. This causes reaction time averages of four seconds in cruise and one second in the approach phase.

A significant factor involved with uncommanded changes in an aircraft's flight path is the "Startle Effect." In nearly all documented uncommanded yaw incidents, the crew perception of bank angle is two to three times the actual as derived from the flight data recorder. This misperception of actual events is attributed to the "startle effect."

Advanced Maneuvers (Upset) Training

The Advanced Maneuvers (Upset) Training is being conducted in Initial Training and Continuing Qualifications. The objective of this training is to improve the pilot's skill and knowledge, increase his confidence in himself and his aircraft, and heighten the pilot's level of awareness.

This training is intended to teach the pilot how to recognize and apply the correct recovery procedures, in a timely manner, if an unusual attitude should be encountered for any reason. Over time there have been numerous incidents where aircraft have encountered unstable flight conditions or uncommanded control inputs resulting in an upset attitude. In most cases involving air carrier aircraft there was significant but recoverable loss of control. While flying at the fixed maneuvering speeds gives the pilot more aileron authority to counter an uncommanded rudder deflection, *the most important factor is an immediate and aggressive action on the part of the crew.*

- Maneuvers Demonstrated in Upset Training
  - #1 Rudder hardover and recovery
  - #2 Roll to 135° bank, with gear up, and recover
  - #3 Excessive pitch recovery

Recovery

- Recognize and cross-check attitude
- Call out "ATTITUDE"
- Hold control wheel firmly
- Disconnect autopilot and autothrottles

  (CWS will further complicate the recovery if the autopilot is not disengaged.)
- Initiate recovery procedure
  - Nose High: Increase bank not to exceed 90°, allow nose to fall to level attitude, roll out.

    OR
  - Nose Low: Decrease bank before adjusting pitch. Do not apply back pressure until bank is less than 10°.
  - Roll and apply rudder towards the bank indicator (SKY POINTER).
  - Adjust thrust: Differential thrust may be required if speed is below the crossover point. (Add power to the low wing.)

Conclusion

Immediate and proper recovery is essential. Decrease bank prior to any attempt to recover altitude, accept altitude loss in order to prevent an accelerated stall. **DO NOT PULL UNTIL THE ANGLE OF BANK IS LESS THAN 10°.** Full control wheel deflection toward the "sky pointer" may be required and continued full control wheel deflection may be necessary to maintain level flight. Flying at the fixed maneuvering speeds will keep the aircraft at or above the crossover point, and allow the necessary lateral control.

Maneuvering Speeds

With the new data available regarding crossover speeds, greater emphasis is being placed on flying at the fixed maneuvering speeds, particularly at flaps 1 through 10. In addition to greater fuel efficiency and better over-the-nose visibility, flying at these speeds provides increased roll (lateral) control.

③ 3 5 Flap Maneuvering Speed Schedule (VM)

FLAP POSITION	AT & BELOW 117,000 LBS.	ABOVE 117,000 LBS.
Flaps 0	210	220
Flaps 1	190	200
Flaps 5	180	190
Flaps 10	170	180
Flaps 15	150	160
Flaps 25	140	150

7 8 9 Flap Maneuvering Speed Schedule (VM)

Flaps 0	V_M Flaps 0 Speed Bug
Flaps 1	V_M Flaps 1 Speed Bug
Flaps 5	V_M Flaps 5 Speed Bug
Flaps 10	V_M Flaps 10 Speed Bug
Flaps15	V_M Flaps 15 Speed Bug
Flaps 25	V_M Flaps 25 Speed Bug

The above table depicts the maneuvering speeds as published by Boeing Aircraft. As long as there is minimum delay in applying the correct control input, these speeds provide adequate control capability should a rudder hardover occur. As bank angle increases, crossover speed also increases, to a point where power or altitude will have to be adjusted to maintain a high enough speed for recovery.

TRAINING

GENERAL

The purpose of this section is to provide pilots with an overall view of what is expected of them during Continuing Qualification training. In order for the training periods to provide maximum value, it is critical that the systems and maneuvers for that period be reviewed in detail. It is also beneficial to thoroughly review your Jeppesen charts for the airport to be used during the event. Flight manual knowledge validation will be accomplished during the MV or LOE briefing.

All simulator / FTD training events are conducted with a full crew.

For specific information, concerning the briefing subjects, maneuvers, and airports to be used for each event refer to the AQP Continuing Qualification Training Bulletin for the specific year.

CONTINUING QUALIFICATION EVENTS

As a result of operational requirements and line pilot input, refinements and enhancements are continually being made to the Continuing Qualification (CQ) Training Program. The program consists of the following events, scheduled for maximum effectiveness and continuity:

1. Maneuvers Validation
2. Line Oriented Evaluation
3. 121-439 Landing Recency of Experience Simulator Training
4. Captain’s Annual Line Check
5. Annual Systems Review
6. Global Contrails
7. General Subjects Ground School

Maneuvers Validation (MV)

The MV is the first day of the 2 day MV/LOE annual simulator training / evaluation program. The MV is scheduled with a base month the same as the Initial Training Qualification LOE base month. Early / due / grace rules apply to scheduling for this event.

The MV is preceded by a **2-hour briefing** and is conducted as a 4-hour period in the full flight simulator. The period is designed to **train and validate** flight manual limitations, planning / performance issues, aircraft systems, normal / non-normal procedures, checklist usage, flow patterns, pilot tactile skills, and CRM.

The MV period contains 3 **"first look maneuvers"** which change every year. These items are intentionally not reviewed during the briefing in order to determine which specific skills deteriorate over time and require additional emphasis during future training. This method is mandated by the FAA for all AQP programs and is the most accurate method available in ascertaining the probable outcome should a crew encounter such an event / maneuver during line operations. **First look maneuvers are treated as "train to proficiency" items, thus affording multiple attempts to practice and demonstrate required proficiency.** Refer to the current CQ Training Bulletin for details concerning this event.

Inability to successfully accomplish all maneuvers during the MV period will require additional training prior to the LOE.

Line Oriented Evaluation (LOE)

The LOE is the second day of the 2 day MV/LOE annual simulator training / evaluation program. The LOE is preceded by a **2 hour briefing**; one hour devoted to a review of the LOE paperwork. The LOE is based on different flight scenarios, and is a line oriented, real time flight segment **evaluation**. It is based on typical line-encountered events and includes one major non-normal. Both individual and crew performances are evaluated with respect to normal and non-normal procedures, with emphasis on FMS skills, situational awareness, judgement, crew interaction, and CRM.

Inability to successfully accomplish all the events sets of the LOE program, will require additional retraining / checking prior to line flying.

121.439 Landing Recency Of Experience Simulator Training

The 121.439 Landing Recency of Experience training is designed to **retain or re-establish landing currency** as per the FARs.

It remains the pilot's responsibility to track their own landing currency and within 21 days of anticipated expiration of currency, to contact their base Assistant Chief Pilot and confirm that a simulator period is most likely required.

The Chief Pilot's office will then contact Training Scheduling to schedule the simulator period, transportation, and hotel room as required. If the period is subsequently not required due to accomplishment of required landings or for any other reason, **it is essential you contact training scheduling as soon as possible and advise of the circumstances.**

The Landing Recency of Experience period is preceded by a one-hour briefing. This period is considered as training to proficiency and allows pilots to review and practice skill sets affected by limited takeoffs and landings. In order to derive the most benefit, the pilot should review Section 3 of the Flight Manual with emphasis on normal procedures, flows, and checklists for all phases of flight, including flight deck safety inspection through the termination checklist. Refer to the current CQ Training Bulletin for details concerning this event.

Inability to successfully accomplish all maneuvers during the Landing Recency of Experience period will require additional training prior to line flying.

Captain Annual Line Check

The current Captain's Annual Line Check will continue to be required with no change to the base month. Although First Officers are not required a specific annual line check, they will be evaluated in the performance of their duties during the accomplishment of a Captains Line Check, as this evaluation is a review of the entire crew's performance.

Annual Systems Review (ASR)

The base month also serves as the base month for accomplishment of the 4 hour self study Computer Based Training (CBT) Annual Systems Review. This module is a review of selected aircraft systems as well as current subjects. Just like simulator training, this self-study CBT program **can only be completed during the pilot's base month (early / due / and no later than the 25th of the grace month) in order to retain qualification in the aircraft.**

All aircraft systems have been divided into 4 groups (A, B, C, D) based upon system interaction, complexity, and shear size of material to be reviewed. Refer to the **ASR SUBJECT MATTER** information in the training bulletin for the current year's subjects.

This course is available on the Continental CBT server available to the Bases or the Simulator building. It is identified by the respective aircraft and applicable years. It is not necessary to complete all ASR modules in a single visit. Individual modules need only be completed through the test to receive credit for the module during that session.

Global Contrails

There are self-study **summer** and **winter Global Contrails** publications, which provide a comprehensive review of the specific year's systems not covered by the ASR CBT. Due dates for completion will be included in the publications. By alternating the coverage between CBT and Global Contrails, all systems will be covered once in 2 years and twice (once by each method) in 4 years. A review of non-normals from the systems being covered that year will provide the foundation for many of the event sets embedded in the annual LOE. The Global Contrails are available on the internet.

General Subjects Ground School

General Subjects Ground School is the same as the current **Day 1** and is offered December through July.

ADMINISTRATIVE DETAILS

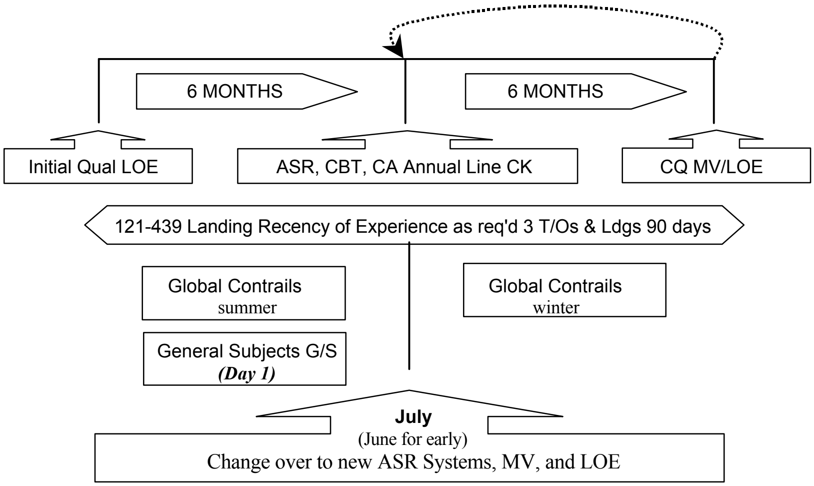
Pilots are required to bring their flight bag with seat specific publications to all simulator training events.

Every attempt is made to schedule a Captain and First Officer as a crew. This is frequently not possible. Continental pilots are rated in the aircraft, trained in the duties of both seats, and are able to fly the aircraft from either seat (with noted Ops Manual exceptions). Therefore, it is expected that all pilots be familiar with the duties of both seats.

SUMMARY OF CONTINUING QUALIFICATION PROGRAM

The following diagrams and profiles summarize the AQP Continuing Qualification Training Program.

A/C SPECIFIC CHART:



ACCEPTABLE PERFORMANCE

The aircraft should be flown with precision at all times. The following criteria are considered acceptable:

- Altitude - ± 100’
- Airspeed - ± 5 knots
- Heading - ± 5°

During non-normals, first consideration should be given to maintaining aircraft control. Be deliberate, i.e. fly the aircraft, then take care of the non-normal. Although non-normal procedures should be accomplished within a reasonable period of time, no time limit is placed on any particular item.

Satisfactory performance is required on each procedure and maneuver. Advanced preparation resulting in good procedural knowledge permits concentration on smooth and precise aircraft control. This enhances overall performance and makes the training a meaningful experience.

During the LOE, crews fly trip segments in real time using the same flight papers, navaids, and communications as they would during a line trip. Events such as operational emergencies, system non-normals and ATC / weather problems are a part of the LOFT scenarios. The intent is for the crew to work as a team, making the best use of available resources. There is often more than one “correct” solution to these problems.

Debriefings

Plan to devote adequate time for a complete debriefing following all training events. The debriefing is a critical portion of training / validation process. Crewmembers will be asked to evaluate personal and crew performance, openly discussing both successes and areas for improvement.

Preparation and Prerequisites

Proper preparation for all training should include a thorough review of all normal and non-normal procedures. You should always be prepared for an oral examination.

Problem Areas

- Non-Precision Approach
- Missed Approach
- Engine Out Procedures

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/15/02	* 19	11/15/02	* 49	11/15/02
* TOC-2	11/15/02	* 20	11/15/02	* 50	11/15/02
* TOC-3	11/15/02				
* TOC-4	11/15/02	* 21	11/15/02	* 51	11/15/02
* TOC-5	11/15/02	* 22	11/15/02	* 52	11/15/02
* TOC-6	11/15/02	* 23	11/15/02	* 53	11/15/02
* TOC-7	11/15/02	* 24	11/15/02	* 54	11/15/02
* TOC-8	11/15/02	* 25	11/15/02	* 55	11/15/02
* TOC-9	11/15/02	* 26	11/15/02	* 56	11/15/02
* TOC-10	11/15/02	* 27	11/15/02	* 57	11/15/02
		* 28	11/15/02	* 58	11/15/02
* TOC-11	11/15/02	* 29	11/15/02	* 59	11/15/02
* TOC-12	11/15/02	* 30	11/15/02	* 60	11/15/02
* 1	11/15/02	* 31	11/15/02	* 61	11/15/02
* 2	11/15/02	* 32	11/15/02	* 62	11/15/02
* 3	11/15/02	* 33	11/15/02	* 63	11/15/02
* 4	11/15/02	* 34	11/15/02	* 64	11/15/02
* 5	11/15/02	* 35	11/15/02	* 65	11/15/02
* 6	11/15/02	* 36	11/15/02	* 66	11/15/02
* 7	11/15/02	* 37	11/15/02	* 67	11/15/02
* 8	11/15/02	* 38	11/15/02	* 68	11/15/02
* 9	11/15/02	* 39	11/15/02	* 69	11/15/02
* 10	11/15/02	* 40	11/15/02	* 70	11/15/02
* 11	11/15/02	* 41	11/15/02		
* 12	11/15/02	* 42	11/15/02		
* 13	11/15/02	* 43	11/15/02		
* 14	11/15/02	* 44	11/15/02		
* 15	11/15/02	* 45	11/15/02		
* 16	11/15/02	* 46	11/15/02		
* 17	11/15/02	* 47	11/15/02		
* 18	11/15/02	* 48	11/15/02		

FAA APPROVED
12 NOV 2002
Don R. Klos
Principal Operations Inspector

FLIGHT PERFORMANCE

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INTRODUCTION

GENERAL

The purpose of the Flight Performance Section of the B737 Flight Manual is to provide a convenient source of aircraft performance data for flight crews. Since all weight, balance, and performance data required for dispatch resides within the FAA Approved computer based systems, the large majority of the Planning and Performance charts, graphs, and tables used to produce performance data for flight crews are not duplicated in this section. Instead, basic performance information is presented to accomplish the following:

- Provide insight and understanding to flight crews about the general concept of performance related questions.
- Present information on the nature and basis of the data provided.
- Provide a source of reference for non-normal operations.

ACCULOAD - NORMAL WEIGHT AND BALANCE

The Continental Airlines B737 fleet uses a computer based weight and balance system called ACCULOAD. Load planners enter departure and arrival runway and meteorological conditions, expected payload, planned fuel load, as well as any appropriate MEL/CDL penalties. ACCULOAD will compute a complete pilot weight manifest, including weight and balance, takeoff and landing data and takeoff flap and trim settings. Adjustments can be made for non-normal conditions with agreement of the Captain and Dispatch. Multiple adjustments are quickly and accurately calculated. All adjustments taken into consideration are described on line 9 RMKS as a plain language message.

Takeoff data provided by ACCULOAD is based upon the most recently observed meteorological and runway conditions. Takeoff weight limitations and V Speeds are based on normal (DRY) runway conditions unless the Captain or Ops / Ramp advise Load Planning / Dispatch that runway conditions are non-normal (i.e. wet or contaminated). Any non-normal conditions considered in computing ACCULOAD data are noted on line 9 RMKS.

Landing data and limitations found in the ACCULOAD are for dispatch purposes and are based upon forecast conditions for the estimated time of arrival.

ACCULOAD will always correct for tailwinds and can take credit for headwinds with agreement of the Captain and Load Planning / Dispatch. Headwinds used for ACCULOAD are based on steady state winds. Tailwind and crosswind adjustments are based upon peak gusts.

ACCULOAD will not generate a weight manifest if any limitation is not met. Should any discrepancy exist in actual conditions versus those listed on line 9, the crew must contact Load Planning to resolve the conflict.

ACCULOAD will be provided in hard copy via gate / aircraft printer or by radio. For radio close outs a Form 362A, Pilot Weight Manifest Worksheet, must be filled out and corrected if applicable.

Additional information regarding ACCULOAD can be found in subsequent paragraphs of this section of the Flight Manual as well as in the Continental Flight Operations Manual.

TAKEOFF

NORMAL

V Speeds

V Speeds are computed real-time by ACCULOAD based on takeoff gross weight, OAT, flap setting, applied wind, runway length, slope, obstacles, surface condition, any MEL/CDL penalties, and any allowable thrust reduction (assumed temperature). The Pilot Weight Manifest (PWM) speeds are to be considered the most accurate and should be used by the aircrew when available.

In the event of a runway change, the ACCULOAD PWM Assumed Temperature and V Speeds for the original runway may be considered valid for the new runway and may be used if:

1. The same flap setting is used.
2. The V Speeds are not based on improved climb.
3. The Runway Analysis (bleeds off data) for the new runway shows a performance limited weight greater than the GTOW on Line 7 without the use of a Headwind Credit.
4. Line 9 RMKS has no non-normal items noted (PMC Inoperative, Wet Runway, etc.).
5. The new runway does not have a tailwind component.
6. The Flex Temp GW (which is equal to or greater than the PWM Line 7 GTOW) has an assumed temperature equal to or hotter than Line 9 of the PWM.
7. Bleeds are turned OFF for takeoff.

   Note: Bleeds ON determination may be computed by adding the weight adjustment for the specific variant found in this section.

If all of the above conditions cannot be met following a runway change, new V-Speeds must be calculated prior to takeoff from the QRH, the Flight Manual, or by contacting Dispatch or Load Planning for a new PWM. New V-Speeds must be calculated at the Assumed Temperature. If after Assumed Temperature V-Speeds are calculated, the decision is made to use Full Takeoff Thrust, then the Assumed Temperature V-Speeds may be used without correction.

Stabilizer Trim Settings

Stabilizer trim settings provided on the ACCULOAD are a function of the aircraft center of gravity (C.G. in % MAC) and flap setting. In the event of a runway change, if the flap setting and C.G. remain unchanged, the trim setting for the original runway is valid for the new runway. If a different flap setting is used for the new runway, a new trim setting must be obtained from Load Planning, the Flight Manual or the QRH.

Weight Corrections

Any required corrections will be annotated directly to the ACCULOAD hard copy or Form 362A. Any change to the Zero Fuel Weight (ZFW) will also be made to the FMC.

ACCULOAD provided V Speeds, Stabilizer Trim settings and assumed temperature can be utilized as published as long as the passenger weight variation remains within the ACCULOAD provided passenger variance (the numbers under the GROUP heading). Weight differences (passenger counts) outside the variance require coordination with Load Planning.

ACCULOAD computations are based on the data given in line 2 of the pilot weight manifest. If the actual takeoff conditions differ from this data, the flight crew must obtain corrected data prior to takeoff, or make the appropriate corrections or adjustments using this section of the Flight Manual (or QRH) and the Runway Analysis in the flight papers.

Reduced Thrust Takeoff

Reduced takeoff thrust is to be used by Continental Airlines on all takeoffs as standard operating procedure, performance permitting. The method used is an FAA approved procedure called the "Assumed Temperature Method." This method computes a takeoff thrust that is tailored to the actual takeoff weight of the aircraft for a particular airport and runway. ACCULOAD will assure that thrust is not reduced more than 25% from full power settings in any instance and assure that V_{mcg} limits are met. Using this method takeoff performance is always guaranteed in case of an engine failure at the critical point during the takeoff roll. This guarantee applies to runway, obstacle, and second segment climb gradient requirements.

Note: Reduced thrust takeoffs are **not authorized** with:

- Improved climb data
- Wet or Slippery Runway
- Contaminated Runway
- Engine or wing anti-ice protection on
- After application of de-ice/anti-ice fluids
- Reported or suspected windshear

- Anti-skid inoperative
- PMC inoperative (③ 3 5)
- EEC Normal Mode Inoperative (7 8 9)
- FMC inoperative

If conditions permit use of an assumed temperature, it will be provided on line 9 RMKS of the ACCULOAD. This temperature is entered as the SEL TEMP on the N1 page of the FMC, which then generates a reduced takeoff N1.

For assumed temperature operations only, a 2000 pound "pad" is added to the planned takeoff weight to allow for last minute additions of passengers or cargo, before calculating the assumed temperature. Aircrews do not apply or consider this buffer when manually calculating an assumed temperature from the Runway Analysis.

Charters And Special Flights

Weight limitation charts for charters and special flights will be generated by Operations Engineering and will be forwarded to flight crews. If sufficient lead time is not available to issue such special charts, Operations Engineering will issue a telegram to all concerned to use “Equivalent Airport Data” from the CAL Planning and Performance Manuals. On such occasions the equivalent airport data will only be authorized for a single use.

MANUAL CALCULATION OF TAKEOFF DATA

If ACCULOAD is unavailable the crew may utilize the Runway Analysis section of the flight papers and V Speed charts found in this section of the Flight Manual or the QRH for manual calculation of takeoff weight limitations and V Speeds for a specific runway. Adjustments can be made for the following non-normal conditions with reference to appropriate charts found in this section of the Flight Manual:

- Engine Anti-Ice ON
- Anti Skid Inoperative
- PMC Inoperative (③$\boxed{3}\boxed{5}$)
- EEC Normal Mode Inoperative ($\boxed{7}\boxed{8}\boxed{9}$)

Note: Because of the precision of ACCULOAD (computerized) data, manual calculations using generic Flight Manual data (especially with non-normal conditions), may not exactly match those computed by ACCULOAD. ACCULOAD data is tailored for more specific conditions, and should be used when available.

Note: Manual calculation of takeoff data CANNOT be made for Improved Climb, Wet Runway conditions and Contaminated Runway conditions.

Runway Analysis (Takeoff Weight Charts)

The Runway Analysis is a computer generated takeoff performance section of the flight papers, derived from the FAA approved Airplane Flight Manual, for use in manual calculations of specific runway takeoff weight limitations. Weight and assumed temperature data is provided for up to seven (7) runways. Data is separated by flap setting. The runway and climb limit weights are provided for a range of temperatures either side of the planned takeoff temperature.

All data presented in the Runway Analysis is based on DRY (Normal Braking) Conditions, BLEEDS OFF, ANTI-ICE OFF, ANTI-SKID OPERATIVE, and PMC/EEC OPERATIVE/NORMAL. For any conditions that differ, corrections must be made using data found in this section of the Flight Manual.

Assumed (Flex) temperatures in the Runway Analysis section are limited to 54°C; however, ACCULOAD may select higher assumed temperatures up to a 70°C (or a maximum of 25% thrust reduction). ACCULOAD will adjust the takeoff V Speeds for the selected assumed temperature.

Example Of Runway Analysis Data:

```
   QP MIAOCEA
   .MIAXUEA 05/1956
   TGW
   CO 362/05    A/C 323
****       TAKEOFF GROSS WEIGHTS     B737-3-B1 -    BLEEDS OFF            ****
   DEN     ELEV 5333     TEMP 36F    WIND 2009     PLANNED GW 116921
                                                        PWR: -B1        FLAP: 05
   RUNWAYS:35L*       17R       17L       08R       08L       26L       35R
FLEX TEMP GW
    124000   N/A       N/A       N/A       N/A       N/A       N/A       N/A
    120000    80        80        80        80        80        80        80
    116000    85        85        85        85        85        85        85
    112000    95        95        95        95        95        95        95
TEMP-F                                                                       CLIMB
      25   1326      1259      1303      1265      1315      1240      1282     1214
      35   1323      1259      1301      1260      1303      1235      1279     1212
      45   1320      1257      1299      1256      1292      1231      1275     1211
      55   1314      1254      1297      1251      1282      1227      1272     1210
LB/KT
    HW        0      0050         0      0090      0210      0100      0080     +
    TW     0320      0380      0370      0540      0930      0530      0440     -
FLEX TEMP     GW                                           PWR: -B1       FLAP: 01
    124000   N/A       N/A       N/A       N/A       N/A       N/A      N/A
    120000    85        85        85        85        85        85       85
    116000    90        90        90        90        90        90       90
    112000   100       100       100       100       100       100      100
    TEMP-F                                                                 CLIMB
    25      1353      1279      1328      1262      1259      1238      1293     1242
    35      1350      1276      1326      1256      1249      1233      1289     1240
    45      1348      1273      1324      1250      1239      1228      1295     1239
    55      1342      1270      1322      1245      1229      1223      1283     1237
  LB/KT
    HW        0      0080         0      0120      0220      0120      0080
    TW     0500      0430      0390      0620      0670      0570      0460
LENGTH    11000     11500     12000     10004      8599     10004     12000
SLOPE     -0.43      0.43      0.30      0.21      0.09     -0.21     -0.30
   *35L    LAST 500 FT CLSD FOR CONSTRUCTION
PART 1 **  END - TGW  **
```

Legend and Description

Computer message information

Destination address

Computer message information origin address
Airline Code - Flight number / Flight departure origin date (local time)

Aircraft fleet number

Aircraft fleet type and series

Bleed Condition - Always provided BLEEDS OFF.

Note: Anti-ice corrected takeoff data will not be provided in the Runway Analysis. Apply the appropriate decrement from charts found in this section of the Flight Manual should engine anti-ice be required.

Three letter departure airport code

ELEV - Field elevation - MSL

TEMP - Departure airport ambient temperature in degrees Celsius

WIND - Departure airport surface wind direction and velocity in knots (True). (Presented for informational purpose only. Do not use for data computations.)

PLANNED GW - Planned takeoff gross weight in pounds

PWR - Engine rating

FLAP - Flap setting for which the performance data applies

RUNWAYS: Up to seven (7) primary takeoff runways are presented per page. An asterisk (*) following the runway number indicates one or more special conditions may exist for the indicated runway (i.e. intersection data or NOTAM, see note at bottom of page). Performance data for runways not presented maybe requested from dispatch or load planning.

FLEX TEMP GW (Assumed Temperature): Maximum assumed temperatures available for use with the specific weight and runway. If N/A is shown a reduced power takeoff is not authorized for that runway.

TEMP - A range of temperatures above and below the actual ambient degrees Celsius.

RUNWAY: Runway limit weight (in hundreds of pounds) for the associated temperature and runway. If N/A is shown the runway is not authorized for takeoff. Runway limit weights are based on CALM WINDS, DRY (normal braking) conditions, BLEEDS OFF, ANTI-ICE OFF, ANTI-SKID OPERATIVE, and PMC/EEC OPERATIVE/NORM. This is the lesser of field length limited and obstacle limited weights for takeoff from that runway.

CLIMB: The 2nd segment climb limited weight (in hundreds of pounds) for the associated temperature. This limit applies to ALL runways at the departure airport (2nd segment climb). Climb limited weights are based on ANTI-ICE OFF and PMC/EEC OPERATIVE/NORMAL. This weight ensures the 2.4% gross gradient required for second segment climb performance.

LB/KT: Weight corrections for actual takeoff wind components.

HW: Headwind correction. Add indicated pounds per knot of headwind to the zero wind runway weight. Headwind corrections may only be applied after agreement with the Captain.

TW: Tailwind correction. Subtract indicated pounds per knot of tailwind from the zero wind runway weight. Corrections <u>must</u> be made if tailwind is present.

LENGTH: Length of the runway (in feet). If a NOTAM was incorporated in the calculation, the NOTAMed runway length will be shown.

SLOPE: The slope of the takeoff runway in percent. Minus (-) sign for downhill slope.

Notes applicable to the asterisked (*) runway (i.e. intersection data or NOTAMs).

Manual Calculation Instructions

Utilize the following procedure for calculation of Takeoff Weight Limitations, Assumed Temperature and V Speeds, when coordination with load planning is not possible or feasible.

Given the conditions below and using the example Runway Analysis for Airport AAA, determine the maximum allowable takeoff weight, bleed configuration, assumed temperature and V Speeds to be used for this takeoff.

AIRPORT	AAA	RUNWAY	26 (dry)
ELEVATION	98 FT	FLAP SETTING	05
CEILING	CLR	ACTUAL TAKEOFF WEIGHT	108,000
VISIBILITY	10	AIRCRAFT	301
O.A.T.	26°C		
WIND	2407		
ALTIMETER	29.97		

CO 362/05 A/C 301
**** TAKEOFF GROSS WEIGHTS B737-3-B1 - BLEEDS OFF - ****
AAA ELEV 98 TEMP 79F WIND 2407 PLANNED GW 108000
PWR: -B1 FLAP: 05

RUNWAYS:	14L*	08	09*	26	27	32R	32L	
FLEX TEMP GW								
115000	110	110	110	110	110	110	95	
112000	115	115	115	115	115	115	115	
109000	120	120	120	120	120	120	110	
106000	120	120	120	120	120	120	110	
TEMP-F								CLIMB
65	1337	1315	1379	1359	1421	1421	1208	1292
75	1335	1313	1377	1356	1418	1418	1203	1290
85	1333	1312	1376	1353	1415	1415	1198	1290
95	1332	1310	1374	1351	1413	1413	1193	1289
LB/KT								
HW	0080	0050	0080	0	0060	0	0120	
TW	0320	0380	0370	0540	0930	0530	0440	

SOLUTION:

1. Maximum takeoff weight is the lesser of the runway limit, climb limit, or structural limit.

   A. Runway limit is found by entering the takeoff weight page for AAA flaps 5, moving across to the runway 26 column, and interpolating for 26°C (79°F) ----- 135,500 lbs.
   B. Climb limit is found in the same manner, with the climb column found at the far right ----- 129,000 lbs.
   C. The structural limits for this aircraft are 135,000 lbs. for takeoff, and 114,000 lbs. for landing.

   Assuming the burn is in excess of 15,000 lbs., the maximum takeoff weight is 129,000 lbs. (climb limit).

2. To determine if a BLEEDS ON takeoff can be made, refer to the Bleed Configuration paragraph in the following section. Add the appropriate weight correction to actual gross weight and compare to the appropriate runway limit and climb limit.

   Actual weight (108,000 lbs.) + the correction (4000 lbs.) = 112,000 lbs.

   112,000 lbs. is less than the runway limit of 135,500 lbs. and the climb limit of 129,000 lbs. so a BLEEDS ON takeoff is possible.

3. Assumed Temperature is determined by entering the FLEX TEMP GW portion, for the appropriate runway, with aircraft weight or actual weight + bleed correction if using a BLEEDS ON takeoff.

   In this case, utilizing BLEEDS ON, we enter the FLEX TEMP GW column for runway 26 with 112,000 lbs. --- 46°C. (SEL TEMP entry)

4. Determine V Speeds from the appropriate V Speed page (this section of the Flight Manual or the QRH). Enter the COLUMN REFERENCE chart with actual temperature (or assumed temperature if used). Reference the A, B, C, D, or E column to the appropriate flap setting chart and actual aircraft gross weight to find the V Speeds.

   In this case, using the gray ③ section in the QRH, enter the COLUMN REFERENCE with 46°C --- Column B.

   Proceeding down Column B for Flaps 5, interpolate to find V Speeds for the *actual* weight of 108,000 lbs. --- 130, 131, 137.

5. Adjustments to weight limitations and/or V_1 must be made if slope and/or wind are a factor. Head wind corrections are not applied unless deemed necessary by the Captain. Tail wind is always applied. Slope can be found at the bottom of the Runway Analysis.

Bleed Configuration

Data presented in the Runway Analysis section of the flight papers is BLEEDS OFF. Aircrews should attempt to use BLEEDS ON when possible.

ACCULOAD will calculate BLEEDS ON weight limits based on actual departure runway and conditions. In the absence of ACCULOAD, crews can determine legality for BLEEDS ON takeoff, by adding the following “worst case” corrections to actual gross weight:

③ $\boxed{3}$ $\boxed{5}$ + 4,000 lbs.

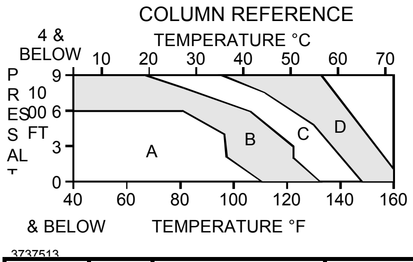
$\boxed{7}$ + 4,000 lbs.

$\boxed{8}$ + 5,100 lbs.

$\boxed{9}$ + 5,000 lbs.

This adjusted weight must be less than both the runway and climb limits for the takeoff runway. This adjusted weight is also used in determining BLEEDS ON Assumed Temperature. The above corrections are not runway specific and represent the most conservative conditions. ACCULOAD calculates BLEEDS ON corrections for a specific runway and conditions, which may provide a lesser weight reduction. Use ACCULOAD data if available.

③❸ Takeoff V Speeds



PMC ON

SLOPE/WIND V1 ADJUSTMENT*						
WEIGHT 1000 LB	SLOPE %			WIND KTS		
	-2	0	2	-15	0	40
140	-2	0	3	-2	0	1
120	-2	0	1	-3	0	1
100	-2	0	0	-3	0	0
80	-2	0	1	-3	0	0

*V_1 NOT TO EXCEED Vr

FLAPS	WT 1000 LB	A V1	A Vr	A V2	B V1	B Vr	B V2	C V1	C Vr	C V2	D V1	D Vr	D V2
FLAPS 1	140	158	160	165	159	162	165						
	130	151	153	158	152	154	158	154	156	158			
	120	143	145	152	144	147	151	146	148	151			
	110	136	137	145	137	139	144	139	140	144			
	100	128	128	138	129	130	137	131	132	137	133	134	137
	90	119	120	131	121	122	131	122	123	130	125	125	130
	80	111	111	124	112	113	124	114	114	123	116	116	122
	75	107	107	121	108	109	120	110	110	120	112	112	119
FLAPS 5	140	151	153	157	152	154	157						
	130	144	146	151	145	147	151	146	149	152			
	120	137	138	145	138	140	144	139	142	146			
	110	130	131	139	131	132	138	132	134	139	135	136	139
	100	122	123	133	123	125	132	125	126	132	127	128	132
	90	114	115	126	116	117	126	117	118	125	119	120	125
	80	106	106	120	108	108	120	109	110	118	111	111	118
	75	102	102	117	103	104	117	103	106	115	107	107	114
FLAPS 15	140	144	145	150	146	146	149						
	130	137	138	144	139	140	143						
	120	130	131	138	133	133	137	135	135	138			
	110	123	124	132	125	126	131	127	128	131			
	100	116	117	126	118	119	126	120	120	125	121	122	126
	90	108	110	120	110	111	120	112	112	119	113	114	119
	80	100	102	114	102	103	114	104	104	113	105	106	112
	75	96	98	111	98	99	111	100	100	110	101	102	109

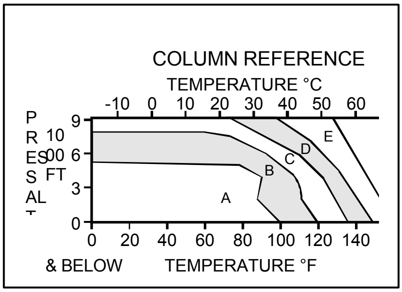
CHECK MINIMUM $V_{1(mcg)}$ AND/OR V_{rMIN} IN BOXED AREA.

MINIMUM $V_{1(mcg)}$ KIAS

PRESS ALT	ACTUAL OAT °C -50	50	15	20	25	30	35	40	45	50	55
0	112	111	111	111	111	110	109	107	104	102	100
2000	110	109	109	109	109	108	106	104	102	100	97
4000	110	109	109	108	108	108	106	103	101	98	
6000	107	106	106	106	105	103	101	99	96	93	
8000	103	102	102	101	100	97	95	94			
9000	101	100	100	99	95	93	90				

For Bleeds OFF Increase $V_{1(mcg)}$ By 2 Knots

5 Takeoff V Speeds



PMC ON

SLOPE/WIND V1 ADJUSTMENT*						
WEIGHT 1000 LB	SLOPE % DN		UP	WIND KTS TAIL		HEAD
	-2	0	2	-15	0	40
140	-2	0	2	-2	0	1
120	-2	0	1	-3	0	1
100	-2	0	1	-3	0	1
80	-2	0	2	-4	0	2

*V1 NOT TO EXCEED Vr

FLAP	WT 1000 LB	A			B			C			D			E		
		V1	Vr	V2	V1	Vr	V2	V1	Vr	V2	V1	Vr	V2	V1	Vr	V2
FLAPS 5	140	148	152	156	150	153	156	151	154	156	153	155	156	157	158	161
	130	143	145	151	144	147	151	146	148	151	148	149	151	151	151	153
	120	136	138	145	138	140	145	139	141	145	142	143	145	144	144	145
	110	129	131	139	131	132	139	132	133	139	135	135	139	137	137	139
	100	121	123	133	122	124	133	124	126	132	127	127	132	129	129	132
	90	113	115	126	114	116	126	116	117	126	118	119	125	121	121	125
	80	104	107	120	105	108	120	107	109	119	109	111	119	111	112	118
	70	93	98	113	96	100	113	97	100	112	99	102	112	102	104	111
FLAPS 15	130	136	136	142	138	138	142	139	140	143	141	141	143	143	143	145
	120	130	130	137	132	132	137	133	133	137	134	134	137	136	136	138
	110	123	124	132	125	125	131	126	126	131	127	127	131	129	129	132
	100	115	117	126	117	118	126	119	119	125	120	120	125	122	122	125
	90	107	109	120	109	111	120	111	112	119	112	113	119	114	114	119
	80	98	102	114	100	103	114	102	104	113	104	105	113	106	107	112
	70	89	93	108	91	95	108	92	96	107	94	97	106	96	98	105

CHECK MINIMUM V1 (mcg) AND/OR Vr MIN IN BOXED AREA.

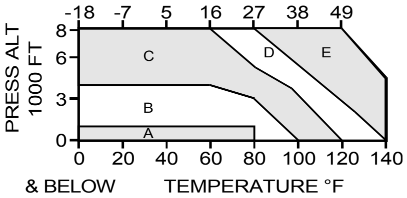
MINIMUM V1(mcg) KIAS

PRESS ALT	ACTUAL OAT °C									
	-50	50	15	20	25	30	35	40	45	50	55
0	110	109	109	109	109	109	105	105	103	100	98
2000	109	108	107	107	107	106	104	103	100	98	
4000	108	107	107	106	106	106	104	102	99	97	
6000	105	104	106	104	104	101	100	97	95	93	
8000	101	100	100	100	98	96	94	92	91	89	
9000	99	98	98	96	95	93	91				

For Bleeds OFF Increase V1(mcg) By 2 Knots

7 Takeoff V Speeds

TAKEOFF SPEEDS - DRY RUNWAY



SLOPE/WIND V1 ADJUSTMENT*						
WEIGHT 1000 LB	SLOPE % DN		UP	WIND KTS TAIL		HEAD
	-2	0	2	-15	0	40
170	-3	0	3	-1	0	1
150	-2	0	2	-2	0	1
130	-2	0	2	-2	0	1
110	-2	0	1	-2	0	1
90	-1	0	1	-2	0	1

*V1 NOT TO EXCEED Vr

FLAP	WT 1000 LB	A V1	A Vr	A V2	B V1	B Vr	B V2	C V1	C Vr	C V2	D V1	D Vr	D V2	E V1	E Vr	E V2
FLAPS 1	160	143	146	152	144	147	152	146	149	153						
	150	138	140	147	139	141	147	141	143	148						
	140	132	135	142	133	136	142	135	138	143	137	140	142			
	130	126	128	137	127	129	137	129	131	138	131	133	137	134	135	136
	120	120	122	132	121	123	132	123	125	133	125	127	132	128	129	131
	110	113	115	126	114	116	126	116	118	127	118	120	126	121	122	125
	100	106	108	120	107	109	120	109	111	121	111	113	120	114	115	119
	90	99	101	114	100	102	114	102	104	115	104	106	114	107	108	113
FLAPS 5	160	140	142	148	141	143	148	143	145	149						
	150	135	137	144	136	138	144	138	140	145						
	140	129	132	139	130	133	139	132	135	140	134	137	139			
	130	123	126	134	124	127	134	126	129	135	128	131	134	131	133	133
	120	117	119	129	118	120	129	120	122	130	122	124	129	125	126	128
	110	110	113	123	111	114	123	113	116	124	115	118	123	118	120	122
	100	103	106	117	104	107	117	106	109	118	108	111	117	111	113	116
	90	96	98	111	97	99	111	99	101	112	101	103	111	104	105	110
FLAPS 15	160	132	132	138	133	133	138									
	150	128	128	135	129	129	135	130	130	134						
	140	123	123	131	124	124	131	125	125	130						
	130	117	118	127	118	119	127	119	120	126	121	121	125			
	120	112	113	122	113	114	122	114	115	121	116	116	120	118	118	120
	110	106	107	117	107	108	117	108	109	116	110	110	115	112	112	115
	100	100	101	113	101	102	113	102	103	112	104	104	111	106	106	111
	90	93	95	107	94	96	107	95	97	106	97	98	105	99	100	105

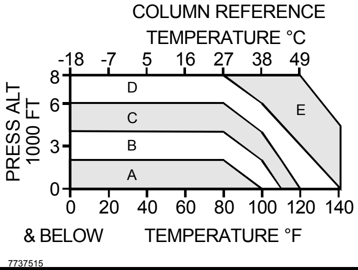
CHECK MINIMUM V1(mcg) AND/OR Vr MIN IN BOXED AREA.

MINIMUM V1(mcg) KIAS

PRESS ALT	ACTUAL OAT °C -5o	10	15	20	25	30	35	40	45	50
0	111	110	110	110	110	110	107	105	103	100
2000	109	108	108	108	107	106	103	101	99	96
4000	106	106	105	105	104	102	99	97	95	
6000	104	103	103	102	100	98	96	93		
8000	101	101	100	98	96	94	92			
10000	99	98	96	94	92	90				

8 Takeoff V Speeds

TAKEOFF SPEEDS - DRY RUNWAY



SLOPE/WIND V_1 ADJUSTMENT*						
WEIGHT 1000 LB	SLOPE % DN		UP	WIND KTS TAIL		HEAD
	-2	0	2	-15	0	40
180	-3	0	1	-2	0	1
170	-3	0	1	-2	0	1
150	-2	0	1	-2	0	1
130	-1	0	1	-2	0	1
110	-1	0	1	-2	0	1
90	-0	0	1	-2	0	1

*V_1 NOT TO EXCEED Vr

FLAPS	WT 1000 LB	A V_1	A Vr	A V_2	B V_1	B Vr	B V_2	C V_1	C Vr	C V_2	D V_1	D Vr	D V_2	E V_1	E Vr	E V_2
	180	160	162	167	161	163	166	162	164	165						
	170	155	157	164	156	158	163	157	159	162	158	160	162			
F	160	150	152	160	151	153	159	152	154	158	153	155	158	155	156	156
L	150	145	147	156	146	148	155	147	149	154	148	150	154	150	152	152
A	140	139	141	151	140	142	150	141	143	149	142	144	149	144	146	147
P	130	133	135	147	134	136	146	135	137	145	136	138	145	138	140	143
S	120	127	128	142	128	129	141	129	130	140	130	131	140	132	133	138
	110	121	122	137	122	123	136	123	124	135	124	125	135	126	127	133
1	100	114	115	131	115	116	130	116	117	129	117	118	129	119	120	127
	90	107	108	126	108	109	125	109	110	124	110	111	124	112	113	122
	180	153	156	161	154	157	160									
	170	149	151	158	150	152	157	151	153	156						
F	160	144	146	154	145	147	153	146	148	152	147	149	152			
L	150	139	141	150	140	142	149	141	143	148	142	144	148			
A	140	134	135	146	135	136	145	136	137	144	137	138	144	139	140	142
P	130	128	129	141	129	130	140	130	131	139	131	132	139	133	134	137
S	120	122	123	137	123	124	136	124	125	135	125	126	135	127	128	133
	110	116	117	132	117	118	131	118	119	130	119	120	130	121	122	128
5	100	109	110	127	110	111	126	111	112	125	112	113	125	114	115	123
	90	103	103	121	104	104	120	105	105	119	106	106	119	108	108	117
	180	150	150	156												
	170	145	146	153	146	147	152									
F	160	140	141	149	141	142	148	142	143	147						
L	150	135	136	145	136	137	144	137	138	143	138	139	143			
A	140	130	131	141	131	132	140	132	133	139	133	134	139			
P	130	124	125	137	125	126	136	126	127	135	127	128	135	129	130	133
S	120	118	119	133	119	120	132	120	121	131	121	122	131	123	124	129
	110	112	113	128	113	114	127	114	115	126	115	116	126	117	118	124
15	100	106	107	123	107	108	122	108	109	121	109	110	121	111	112	119
	90	99	100	118	100	101	117	101	102	116	102	103	116	104	105	114

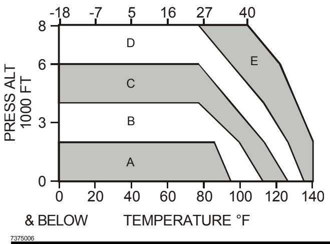
CHECK MINIMUM $V_{1(mcg)}$ AND/OR $V_{r\,MIN}$ IN BOXED AREA.

MINIMUM $V_{1(mcg)}$ KIAS

PRESS ALT	ACTUAL OAT °C -50	10	15	20	25	30	35	40	45	50
0	104	103	103	103	103	103	101	99	96	94
2000	102	101	100	100	100	99	97	95	93	91
4000	98	97	97	97	97	95	94	92	90	
6000	95	94	94	94	93	92	90	88		
8000	92	91	91	90	89	88	86			
10000	89	88	87	86	86	84				

9 Takeoff V Speeds

TAKEOFF SPEEDS - DRY RUNWAY



SLOPE/WIND V_1 ADJUSTMENT*						
WEIGHT 1000 LB	SLOPE % DN		UP	WIND KTS TAIL		HEAD
	-2	0	1	-15	0	40
180	-3	0	1	-2	0	1
170	-3	0	1	-2	0	1
150	-2	0	1	-2	0	1
130	-1	0	1	-2	0	1
110	-1	0	1	-2	0	1
100	0	0	0	-2	0	0

*V_1 NOT TO EXCEED V_r

FLAPS	WT 1000 LB	A V_1	A V_r	A V_2	B V_1	B V_r	B V_2	C V_1	C V_r	C V_2	D V_1	D V_r	D V_2	E V_1	E V_r	E V_2
	180	166	168	175	167	169	175	168	170	174						
F	170	161	163	171	162	164	171	163	165	170	164	166	170			
L	160	155	158	166	156	159	166	157	160	165	158	161	165	160	163	163
A	150	150	152	162	151	153	162	152	154	161	153	155	161	155	157	159
P	140	144	146	157	145	147	157	146	148	156	147	149	156	149	151	154
S	130	138	139	152	139	140	152	140	141	151	141	142	151	143	144	149
1	120	131	132	146	132	133	146	133	134	145	134	135	145	136	137	143
	110	124	125	141	125	126	141	126	127	140	127	128	140	129	130	138
	100	117	118	135	118	119	135	119	120	134	120	121	134	122	123	132
	180	158	161	168	159	162	168									
F	170	153	156	164	154	157	164	155	158	163						
L	160	148	150	160	149	151	160	150	152	159	151	153	159			
A	150	143	145	155	144	146	155	145	147	154	146	148	154			
P	140	137	139	151	138	140	151	139	141	150	140	142	150	142	144	148
S	130	131	133	146	132	134	146	133	135	145	134	136	145	136	138	143
5	120	125	126	141	126	127	141	127	128	140	128	129	140	130	131	138
	110	118	119	135	119	120	135	120	121	134	121	122	134	123	124	132
	100	112	112	129	113	113	129	114	114	128	115	115	128	117	117	126
	180	154	156	161												
F	170	149	151	157	150	152	157									
L	160	144	146	153	145	147	153	146	148	152						
A	150	139	140	149	140	141	149	141	142	148	142	143	148			
P	140	133	135	145	134	136	145	135	137	144	136	138	144			
S	130	127	128	140	128	129	140	129	130	139	130	131	139	132	133	137
15	120	121	122	135	122	123	135	123	124	134	124	125	134	126	127	132
	110	114	116	130	115	117	130	116	118	129	117	119	129	119	121	127
	100	108	109	125	109	110	125	110	111	124	111	112	124	113	114	122

CHECK MINIMUM $V_{1(mcg)}$ AND/OR $V_{r\,MIN}$ IN BOXED AREA.

MINIMUM $V_{1(mcg)}$ KIAS

PRESS ALT	ACTUAL OAT °C -50	10	15	20	25	30	35	40	45	50
0	103	102	102	102	101	101	99	97	95	93
2000	100	99	99	99	98	98	96	94	92	90
4000	96	95	95	95	94	94	92	90	88	88
6000	93	92	92	92	91	90	89	87	86	86
8000	90	98	88	88	87	86	85	83	83	83

INTENTIONALLY LEFT BLANK

③ 3 5 Max Takeoff % N1

PMC ON

VALID FOR 2 PACKS ON (AUTO) ENGINE A/I ON OR OFF										
OAT		AIRPORT PRESSURE ALTITUDE FEET								
°C	°F	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	90.5								
50	122	91.1	91.6	92.3	93.1					
45	113	91.6	92.1	92.6	93.9	94.9	94.7	94.2		
40	104	92.1	92.6	93.0	94.3	95.3	95.3	95.3	95.0	94.3
35	95	92.5	93.0	93.4	94.7	95.9	95.8	95.8	95.1	94.5
30	86	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	92.1	92.9	93.6	94.5	95.9	96.3	96.7	96.2	95.6
20	68	91.3	92.1	92.8	93.8	95.1	95.5	95.9	95.9	95.9
15	59	90.5	91.3	92.0	93.0	94.3	94.7	95.1	95.3	95.3
10	50	89.7	90.5	91.2	92.1	93.4	93.9	94.3	94.4	94.6
5	41	88.9	89.7	90.4	91.3	92.6	93.0	93.4	93.6	93.7
0	32	88.1	88.9	89.6	90.5	91.8	92.2	92.6	92.7	92.9
-10	14	86.5	87.2	87.9	88.8	90.1	90.5	90.9	91.0	91.2
-20	- 4	84.8	85.6	86.2	87.1	88.3	88.7	89.1	89.2	89.4
-30	-22	83.1	83.0	84.5	85.4	86.6	87.0	87.4	87.5	87.6
-40	-40	81.4	82.1	82.7	83.6	84.8	85.1	85.5	85.7	85.8
-50	-58	79.6	80.3	81.0	81.8	82.9	83.3	83.7	83.8	84.0

% N1 Bleed Adjustments
BLEEDS Off + 1.0

7 Max Takeoff % N1

VALID FOR 2 PACKS ON (AUTO) ENGINE AND WING A/I ON OR OFF											
OAT		AIRPORT PRESSURE ALTITUDE FEET									
°F	°C	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
140	60	91.2	91.2	91.1	91.0	91.1	91.2	91.2	91.0	91.2	91.3
130	54	92.1	92.1	92.0	92.0	92.0	92.0	92.0	91.9	91.9	91.5
120	49	93.0	93.0	93.0	92.9	92.9	92.9	92.9	92.8	92.7	92.4
110	43	93.9	93.9	93.8	93.8	93.8	93.7	93.7	93.7	93.6	93.4
100	38	94.8	94.7	94.7	94.7	94.6	94.6	94.5	94.5	94.4	94.3
90	32	95.7	95.7	95.7	95.6	95.6	95.5	95.4	95.4	95.3	95.2
80	27	95.6	96.1	96.4	96.4	96.4	96.4	96.3	96.2	96.2	96.1
70	21	94.8	95.3	95.8	96.4	97.0	97.4	97.3	97.2	97.1	97.1
60	16	93.9	94.4	95.0	95.6	96.2	96.9	97.6	98.3	98.4	98.4
50	10	93.0	93.6	94.1	94.7	95.3	96.0	96.7	97.4	98.2	99.1
40	4	92.2	92.7	93.2	93.8	94.4	95.1	95.8	96.6	97.4	98.3
30	-1	91.3	91.8	92.3	92.9	93.5	94.3	94.9	95.7	96.5	97.4
20	-7	90.4	90.9	91.4	92.0	92.6	93.4	94.0	94.8	95.6	96.6
10	-12	89.5	90.0	90.5	91.1	91.7	92.5	93.1	93.9	94.7	95.7
0	-18	88.5	89.1	89.6	90.2	90.8	91.5	92.2	93.0	93.8	94.8
-10	-23	87.6	88.1	88.6	89.3	89.9	90.6	91.3	92.1	92.9	94.0
-20	-29	86.7	87.2	87.7	88.3	89.0	89.7	90.4	91.2	92.0	93.1
-30	-34	85.7	86.2	86.7	87.4	88.0	88.7	89.4	90.2	91.1	92.2
-40	-40	84.8	85.3	85.8	86.4	87.0	87.8	88.5	89.3	90.1	91.2
-50	-46	83.8	84.3	84.8	85.4	86.1	86.8	87.5	88.3	89.2	90.3

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FEET)									
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
BLEEDS OFF	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9

8 9 Max Takeoff % N1

VALID FOR 2 PACKS ON (AUTO) ENGINE AND WING A/I ON OR OFF											
OAT		AIRPORT PRESSURE ALTITUDE FEET									
°F	°C	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
140	60	95.8	95.9	96.0	96.1	96.2	96.3	96.2	95.9	95.8	95.7
130	54	96.6	96.7	96.8	96.9	97.0	97.2	97.0	96.7	96.4	95.9
120	49	97.3	97.5	97.6	97.7	97.8	98.0	97.8	97.5	97.2	96.8
110	43	98.1	98.2	98.4	98.5	98.6	98.7	98.6	98.3	98.0	97.8
100	38	99.0	99.0	99.1	99.3	99.3	99.5	99.3	99.1	98.8	98.7
90	32	99.9	100.0	100.1	100.1	100.3	100.3	100.2	99.9	99.6	99.6
80	27	99.8	100.3	100.7	100.6	100.7	100.6	100.7	100.6	100.4	100.4
70	21	98.9	99.5	100.1	100.4	100.6	100.8	100.8	100.8	100.8	100.8
60	16	98.1	98.7	99.3	99.6	99.8	100.2	100.5	101.0	101.0	101.0
50	10	97.2	97.8	98.4	98.7	99.0	99.4	99.7	100.1	100.5	101.0
40	4	96.3	97.0	97.6	97.9	98.2	98.5	98.9	99.3	99.7	100.2
30	-1	95.5	96.1	96.7	97.0	97.3	97.7	98.1	98.5	98.9	99.3
20	-7	94.6	95.2	95.8	96.2	96.5	96.8	97.2	97.6	98.0	98.5
10	-12	93.7	94.3	94.9	95.3	95.6	96.0	96.4	96.8	97.2	97.6
0	-18	92.8	93.4	94.0	94.4	94.7	95.1	95.5	95.9	96.3	96.8
-10	-23	91.9	92.5	93.1	93.5	93.8	94.2	94.6	95.0	95.4	95.0
-20	-29	90.9	91.6	92.2	92.6	92.9	93.4	93.7	94.1	94.5	95.0
-30	-34	90.0	90.6	91.3	91.7	92.0	92.5	92.8	93.2	93.6	94.1
-40	-40	89.0	89.7	90.3	90.7	91.1	91.5	91.9	92.3	92.7	93.1
-50	-46	88.1	88.7	89.4	89.8	90.2	90.6	91.0	91.4	91.8	92.2

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FEET)									
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
BLEEDS OFF	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0

③ 3 5 Max Climb % N1

Max Climb % N1 250/280/.74M

VALID FOR 2 PACKS ON (AUTO) ENGINE A/I OFF									
TAT	PRESSURE ALTITUDE 1000 FEET								
°C	0	5	10	15	20	25	30	35	37
50	88.9	89.0	89.2						
40	89.8	90.0	90.2	90.7					
30	89.9	90.9	91.1	91.6	91.9	92.1			
20	88.4	90.5	91.8	92.5	92.8	93.0	93.2		
10	86.8	88.9	91.0	92.7	93.5	93.8	94.0	94.0	94.0
0	85.3	87.4	89.4	91.1	93.1	94.4	94.6	94.6	94.6
-10	83.7	85.7	87.7	89.4	91.3	93.1	94.6	95.2	95.2
-20	82.1	84.1	86.0	87.7	89.6	91.3	82.8	95.7	96.0
-30	80.5	82.4	84.3	85.9	87.8	89.5	90.9	93.8	94.5
-40	78.8	80.7	82.6	84.1	86.0	87.6	89.0	91.9	92.5
-50	77.1	79.0	80.8	82.3	84.1	85.7	87.1	89.9	90.5

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE 1000 FEET								
	0	5	10	15	20	25	30	35	37
BLEEDS OFF	+.5	+.5	+.6	+.7	+.8	+.9	+.9	+.8	+.7
PACKS HIGH	-.2	-.3	-.3	-.3	-.4	-.4	-.4	-.5	-.6
ENG A/I ON	-.7	-.8	-.9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
WING A/I ON	-1.2	-1.2	-1.3	-1.4	-1.6	-1.9	-1.8	-1.9	-1.9

7 Max Climb % N1

VALID FOR 2 PACKS ON OR OFF WING AND ENGINE A/I OFF										
TAT °C	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	37	41
	280	280	280	280	280	280	280	.78	.78	.78
60	89.4	89.7	89.7	89.8	89.6	91.4	93.0	94.4	94.5	92.8
55	90.5	90.5	90.7	90.0	90.8	92.4	93.7	93.8	92.1	90.2
50	90.0	91.2	91.3	91.5	91.0	90.8	91.7	93.0	93.1	91.4
45	91.6	91.9	92.1	92.3	91.9	91.7	91.7	92.3	92.4	90.7
40	92.4	92.6	92.9	93.1	92.7	92.5	92.5	91.6	91.7	90.0
35	93.3	93.6	93.8	93.6	93.3	93.3	92.4	91.7	90.1	92.9
30	92.2	94.1	94.3	94.6	94.4	94.1	94.0	93.2	92.6	91.1
25	91.5	94.1	95.0	95.2	95.2	94.8	94.7	94.0	93.4	92.1
20	90.7	93.3	95.8	96.0	95.9	95.6	95.4	94.7	94.2	93.0
15	90.0	92.5	95.2	96.8	96.7	96.3	96.1	95.5	95.0	94.0
10	89.2	91.8	94.4	97.1	97.6	97.0	96.7	96.2	95.8	94.9
5	88.4	91.0	93.6	96.3	98.5	97.9	97.4	97.0	96.6	95.8
0	87.7	90.2	92.8	95.5	97.9	99.0	98.4	97.8	97.5	96.7
-5	86.9	89.4	92.0	94.7	97.2	98.9	99.4	98.6	98.3	97.7
-10	86.1	88.6	91.2	93.9	96.4	98.1	99.7	99.5	99.2	98.7
-15	85.3	87.8	90.3	93.1	95.6	97.4	98.9	100.5	100.1	99.7
-20	84.5	87.0	89.5	92.3	94.8	96.6	98.1	100.2	100.7	100.3
-25	83.7	86.1	88.7	91.4	94.1	95.8	97.3	99.3	99.9	99.5
-30	92.9	85.3	87.8	90.6	93.3	95.0	96.5	98.5	99.0	98.7
-35	82.0	84.5	87.0	89.8	92.4	94.1	95.6	97.6	98.2	97.8
-40	81.2	83.6	86.1	88.9	91.6	93.3	94.8	96.8	97.3	96.9

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	0	10	20	30	35	41
ENGINE ANTI-ICE	-0.6	-0.7	-0.9	-0.9	-0.8	-0.8
ENG AND WING ANTI-ICE*	-1.6	-1.9	-2.4	-2.6	-2.9	-3.0
ENG AND WING ANTI-ICE**	-2.4	-2.9	-3.7	-4.1	-4.8	-5.0

*Dual Bleed Sources **Single Bleed Source

8 9 Max Climb % N1

VALID FOR 2 PACKS ON OR OFF					WING AND ENGINE A/I OFF					
TAT °C	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	37	41
	280	280	280	280	280	280	280	.78	.78	.78
60	90.2	90.5	90.4	90.6	90.4	92.1	93.8	95.1	95.2	93.5
55	91.2	91.3	91.4	90.8	91.5	93.1	94.4	94.5	92.8	91.0
50	91.7	92.0	92.1	92.2	91.7	91.5	92.4	93.7	93.8	92.1
45	92.4	92.6	92.8	93.0	92.6	92.4	92.4	93.0	93.1	91.4
40	93.1	93.3	93.6	93.8	93.4	93.2	93.2	92.3	92.4	90.7
35	94.0	94.3	94.5	94.3	94.0	94.0	93.0	92.4	90.8	93.6
30	92.9	94.8	95.0	95.2	95.1	94.8	94.7	93.9	93.3	91.8
25	92.2	94.8	95.7	95.9	95.9	95.5	95.4	94.7	94.1	92.8
20	91.4	94.0	96.5	96.7	96.6	96.2	96.1	95.4	94.9	93.7
15	90.6	93.2	95.9	97.5	97.4	96.9	96.7	96.2	95.7	94.6
10	89.9	92.5	95.1	97.8	98.3	97.7	97.4	96.9	96.5	95.6
5	89.1	91.7	94.3	97.0	99.2	98.6	98.1	97.7	97.3	96.5
0	88.3	90.9	93.5	96.2	98.6	99.6	99.1	98.5	98.2	97.5
-5	87.6	90.1	92.7	95.4	97.8	99.6	100.0	99.2	99.0	98.4
-10	86.8	89.3	91.9	94.6	97.1	98.8	100.3	100.2	99.8	99.4
-15	86.0	88.5	91.0	93.8	96.3	98.0	99.6	101.1	100.8	100.4
-20	85.2	87.6	90.2	93.0	95.5	97.2	98.7	100.8	101.3	101.0
-25	84.3	86.8	89.4	92.2	94.7	96.4	97.9	100.0	100.5	100.1
-30	83.5	86.0	88.5	91.3	93.9	95.6	97.1	99.1	99.6	99.3
-35	82.7	85.1	87.7	90.5	93.1	94.8	96.3	98.3	98.8	98.4
-40	81.8	84.3	86.8	89.6	92.3	93.9	95.4	97.4	97.9	97.6

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	0	10	20	30	35	41
ENGINE ANTI-ICE	-0.6	-0.7	-0.9	-0.9	-0.8	-0.8
ENG AND WING ANTI-ICE*	-1.6	-1.9	-2.4	-2.6	-2.9	-3.0
ENG AND WING ANTI-ICE**	-2.4	-2.9	-3.7	-4.1	-4.8	-5.0

*Dual Bleed Sources **Single Bleed Source

Stabilizer Trim Settings Tables

Stabilizer Trim Settings

③ 3

FLAP	C.G. % MAC						
POS	6	10	14	18	22	26	30
	STAB TRIM UNITS (NOSE UP)						
1 & 5 15	6 ¼ 5 ¾	5 ¾ 5	5 ¼ 4 ½	4 ¾ 3 ¾	4 ¼ 3	3 ¾ 2 ½	3 1 ¾
For weights at or below 100,000 lbs. subtract ½ unit from above value.							

Stabilizer Trim Settings

5

FLAP	C.G. % MAC						
POS	6	10	14	18	22	26	30
	STAB TRIM UNITS (NOSE UP)						
5 & 15	6 ¼	5 ½	5	4 ¼	3 ¾	3	2 ½
For weights at or below 100,000 lbs. subtract ½ unit from above value.							
For weights at or above 120,000 lbs. add ½ unit from above value.							

Stabilizer Trim Settings

7

FLAPS 1 & 5	C.G. % MAC									
	9	10	12	13	16	20	24	28	30	33
	STAB TRIM UNITS (NOSE UP)									
160	8 ½	8 ½	8 ½	8 ½	7 ¾	6 ¾	6	5 ¼	4 ¾	4 ¼
140	8 ½	8 ½	8 ¼	8	7 ¼	6 ½	5 ½	4 ¾	4 ½	3 ¾
120	8 ½	8 ¼	7 ¾	7 ½	6 ½	5 ¾	5	4 ¼	4	3 ¼
100	6 ¾	6 ½	6 ¼	6	5 ½	5	4 ¼	3 ½	3 ¼	2 ¾
Weight (1000 lbs)										

Stabilizer Trim Settings

7

FLAPS 15	C.G. % MAC									
	9	10	12	13	16	20	24	28	30	33
	STAB TRIM UNITS (NOSE UP)									
160	8 ½	8 ½	8 ½	8 ½	7 ¼	6 ½	5 ½	4 ½	4 ¼	3 ½
140	8 ½	8 ½	8 ¼	7 ¾	6 ¾	6	5	4 ¼	3 ¾	3 ¼
120	8 ½	8 ¼	7 ½	7 ¼	6 ¼	5 ¼	4 ½	3 ¾	3 ¼	2 ¾
100	6 ¼	6 ¼	5 ¾	5 ½	5	4 ½	3 ¾	3	2 ¾	2 ¾
Weight (1000 lbs)										

Stabilizer Trim Settings

8

FLAPS 1 & 5	C.G. % MAC							
	6	8	11	16	30	32	34	36
	STAB TRIM UNITS (NOSE UP)							
180	8 ½	8 ½	7 ¾	6 ¾	4 ¾	4 ½	4	3 ¾
160	8 ¼	8	7 ¼	6 ¼	4 ¼	4	3 ½	3 ¼
140	7 ½	7 ¼	6 ¾	6	4	3 ¾	3 ¼	3
120	6 ¾	6 ½	6 ¼	5 ½	3 ½	3 ¼	2 ¾	2 ½
100	6	5 ¾	5 ½	4 ¾	3	2 ¾	2 ½	2 ¼
90	6	5 ¾	5 ½	4 ¾	3	2 ¾	2 ½	2 ¼
Weight (1000 lbs)								

Stabilizer Trim Settings

8

FLAPS 15	C.G. % MAC							
	6	8	11	16	30	32	34	36
	STAB TRIM UNITS (NOSE UP)							
180	8 ½	8 ½	8 ½	6 ¼	3 ¼	2 ¾	2 ½	2 ¼
160	8 ½	8 ½	7 ¾	5 ½	3	2 ½	2 ¼	2 ¼
140	8	7 ½	6 ½	5	2 ½	2 ¼	2 ¼	2 ¼
120	7	6 ½	5 ¾	4 ½	2 ¼	2 ¼	2 ¼	2 ¼
100	5	4 ¾	4 ¼	3 ½	2 ¼	2 ¼	2 ¼	2 ¼
90	5	4 ¾	4 ¼	3 ½	2 ¼	2 ¼	2 ¼	2 ¼
Weight (1000 lbs)								

Stabilizer Trim Settings

9

FLAPS 1 & 5	C.G. % MAC							
	6	8	11	16	30	32	34	36
	STAB TRIM UNITS (NOSE UP)							
180	7 ¾	7 ½	7	6 ¼	4	3 ¾	3 ½	3 ¼
160	7 ½	7	6 ¾	6	3 ¾	3 ½	3 ¼	3
140	6 ¾	6 ½	6	5 ½	3 ½	3 ¼	3	2 ¾
120	6 ¼	6	5 ½	5	3	2 ¾	2 ¾	2 ¾
100	5 ¾	5 ½	5	4 ½	2 ¾	2 ¾	2 ¾	2 ¾
90	5 ¾	5 ½	5	4 ½	2 ¾	2 ¾	2 ¾	2 ¾
Weight (1000 lbs)								

Stabilizer Trim Settings

9

FLAPS 15	C.G. % MAC							
	6	8	11	16	30	32	34	36
	STAB TRIM UNITS (NOSE UP)							
180	7 ½	7 ¼	6 ¾	5 ¾	3 ½	3 ¼	2 ¾	2 ¾
160	7	6 ¾	6 ¼	5 ½	3 ¼	3	2 ¾	2 ¾
140	6 ½	6 ¼	5 ¾	5	3	2 ¾	2 ¾	2 ¾
120	5 ¾	5 ½	5	4 ½	2 ¾	2 ¾	2 ¾	2 ¾
100	5 ½	5 ¼	4 ¾	4	2 ¾	2 ¾	2 ¾	2 ¾
90	5 ½	5 ¼	4 ¾	4	2 ¾	2 ¾	2 ¾	2 ¾
Weight (1000 lbs)								

INTENTIONALLY LEFT BLANK

NON-NORMAL

The following charts provide adjustments to takeoff weight limitations, V Speeds and thrust settings for several non-normal takeoff situations. Using this information, manual calculation of takeoff data can be made. For other conditions, ACCULOAD data must be obtained.

Improved Climb Takeoff

For instances where standard takeoff data does not provide sufficient takeoff weight, Improved Climb takeoff performance is provided. This procedure uses increased speeds on the runway to improve obstacle clearance and second segment climb performance for higher takeoff weights. This procedure has no effect on enroute climb performance. Use of this data is not authorized with:

- Anti-skid inoperative
- Operations from contaminated runways
- Reduced thrust

By adjusting the V Speeds to the optimum value, the highest possible takeoff weight is calculated when considering runway limits, obstacle limits, and second segment climb limits. ACCULOAD presents the actual gross takeoff weight, along with the MGTOW for the existing temperature. ACCULOAD will compute Improved Climb data for dry as well as wet runway conditions.

Improved Climb data will normally be presented for flaps 5 configuration; however, data for flaps 1 and flaps 15, is available if needed.

V Speeds for Improved Climb takeoffs will be included on line 9 of the Pilot Weight Manifest. If non-normal conditions require V speed corrections, those corrections must be computed by ACCULOAD.

Note: If the departure runway changes, or if the runway is determined to be wet or slippery by the flight crew, Load Planning must be contacted for adjusted improved-climb V Speeds for the new conditions.

Runway Condition

The condition of the runway, with respect to its effect on aircraft takeoff and landing performance, can vary with its construction and the weather. Effects of these conditions fall into two categories - those that slow acceleration and those that increase stopping distance. It is important to note that takeoff performance is not an exact science. Because the potential conditions and combinations are infinitely variable and ever changing, a precise calculation of takeoff / landing performance is impossible. The ACCULOAD program can compute data for the following runway conditions: Dry, Wet, and several types and depths of contamination (depending upon aircraft type). It is the responsibility of the Captain and Dispatcher to use good judgment in selection of the estimated runway condition and performance correction factors. Calculations available for B737, on dry and wet runways, are based upon demonstrated performance in Boeing tests, not on any specific Coefficient of Braking or Mu.

Takeoff data is based on reported conditions at the time of departure. Load Planning will provide an ACCULOAD for wet or contaminated takeoff runway conditions when requested or when a wet or contaminated runway is reported for a specific flight. Landing data used on the ACCULOAD is for dispatch purposes and is based upon forecast conditions at the estimated time of arrival. Refer to the Flight Operations Manual for additional information on this issue.

Dry Runway

ACCULOAD assumes normal braking action on a runway that is smooth without an enhanced braking friction surface. Stopping data is based upon "application of the first retarding device" (brake application) at V1 and includes a pad equivalent to travel for 2 seconds at the V1 speed. Obstacle clearance height of 35 feet is provided based on the critical engine inoperative. No credit is available for use of Thrust Reversers. A runway that is only damp (dark appearance) may have dry braking characteristics.

Wet Or Slippery Runway

A runway is considered wet when it has a shiny appearance with no measurable depth of water. Under these conditions, the runway is not considered to be contaminated, but braking is less than under dry conditions. Runways that are grooved or have a porous surface are rarely considered wet except during, but not after a moderate rain shower.

In addition, a runway may be considered slippery but not contaminated as a result of being covered by packed snow, ice or a combination of water, ice and/or rubber deposits. Stopping distances under these conditions may exceed those demonstrated under "wet" conditions.

Wet Runway Adjustments

The wet runway ACCULOAD data provided will be full power, utilizing the highest compatible numerical flap setting. A wet limit weight is calculated for the runway length available. V Speeds for the selected flaps are adjusted for the wet braking conditions and a reduced runway-end crossing height at V_2 (15 ft. instead of 35 ft.). Credit may be taken for use of one Thrust Reverser with agreement between the Captain and Dispatch. Braking data used by ACCULOAD for Wet Runways takes no credit for the effect of grooving or other porous surface characteristics, nor does it incorporate the 2 second pad found in dry data.

If weather forecasts indicate that wet conditions are a possibility at the time of departure, the flight will be dispatched for dry runway conditions. The following line 9 statement will be included in the ACCULOAD weight manifest (differs for aircraft series):

Wet Rwy possible - Contact Ops If Wet Runway Data Is Required.

Note: When the Captain or Dispatcher concludes that the runway will be wet or slippery at the time of departure, weights and V Speeds based a wet runway must be obtained via ACCULOAD / Load Planning and used for that departure. Manual corrections for wet runways cannot be made.

Contaminated Runway

A runway is considered contaminated if more than 25% of its usable length is covered by a measurable amount of water, slush and/or snow. These contaminants slow the acceleration of the aircraft during takeoff and degrade directional control during landing. ACCULOAD calculations are based on the same conditions as for wet runways, with the addition of performance penalties created by the contaminant. There are several levels of takeoff runway contamination calculated by ACCULOAD for the B737:

- 1mm to 3mm (up to1/8") water/slush depth.
- 1/8" (3mm) to 1/4" (6mm) water/slush depth.
- 1/4" (6mm) to 1/2" (13mm) water/slush depth.
- Four levels (1" 2" 3" 4") of Dry Snow.

Manual corrections for contaminated runways cannot be made. Only ACCULOAD can calculate Runway Weight Limits and V Speeds for contaminated runways.

Takeoff in Icing Conditions

Normal operating procedures limit the use of wing anti-ice to altitudes above 800 feet AGL and do not require takeoff penalties when so limited. Engine anti-ice is often required on takeoff and requires a reduction of the Runway Limit Weight and the Climb Limit Weight. If engine anti-ice is required for takeoff, these reductions are taken by ACCULOAD and noted in LINE 9 RMKS. If ACCULOAD is not available, reduce the Runway Limit Weight and the Climb Limit Weight as shown in the following correction charts.

③ 3

FLAP POSITION	ENGINE ANTI-ICE DECREMENT LB		
	RUNWAY LIMIT	CLIMB LIMIT PA ≤ = 8000 FT	CLIMB LIMIT PA > 8000 FT
1, 5,OR 15	400	450	900

5

FLAP POSITION	ENGINE ANTI-ICE DECREMENT LB		
	RUNWAY LIMIT	CLIMB LIMIT PA ≤ = 8000 FT	CLIMB LIMIT PA > 8000 FT
5	700	375	825
15	700	325	725

7 8 9

FLAP POSITION	ENGINE ANTI-ICE DECREMENT LB		
	RUNWAY LIMIT	CLIMB LIMIT PA ≤ = 8000 FT	CLIMB LIMIT PA > 8000 FT
1, 5, OR 15	300	300	300

Note: The above corrections are not runway specific and represent the most conservative conditions. ACCULOAD can calculate Anti-Ice corrections for a specific runway and conditions, which may provide a lower weight reduction. Use ACCULOAD data if available.

Anti-Skid Inoperative

For takeoff with the anti-skid sytem inoperative the Runway Limit Weight and V_1 for that limiting weight must be reduced to allow for the resulting adverse effect on accelerate-stop performance. ACCULOAD will adjust the Runway Limit weight and V speeds for the anti-skid inoperative condition. If this weight is limiting for takeoff, it will be found on line 8 (MAX GTOW-) of the pilot weight manifest followed by the code "R" for runway limited. ACCULOAD will calculate proper V Speeds for the Anti-Skid inoperative condition. In the absence of ACCULOAD, use the following procedure.

Procedure For Departures With Anti-Skid Inoperative Without ACCULOAD:

1. Reduce the <u>Runway Limit Weight</u> found in the Runway Analysis by the following amounts for the indicated series aircraft:

   3 3: 15,500 lbs.

   5: 16,500 lbs.

   7: 17,200 lbs.

   8: 18,700 lbs.

   9: 18,000 lbs.

2. Determine the V_1 for the adjusted runway limit weight and reduce this V_1 by the amount shown in the ANTI-SKID INOPERATIVE V1 DECREMENT table for the appropriate series aircraft.

3. Compare this adjusted runway limit V_1 to V_{mcg}.

   - If this V_1 is equal to or greater than V_{mcg} then skip to step 4 below.
   - If this V_1 is less than V_{mcg} and the runway is 7900 feet or longer, then set V_1 equal to V_{mcg} and obtain Vr and V_2 from the published V speed charts.
   - If this V_1 is <u>less</u> than the published V_{mcg} and the runway is <u>less</u> than <u>7900 feet</u>, <u>**takeoff is not authorized**</u>.

4. Compare the adjusted V_1 to the <u>actual</u> gross weight V_1 and use the lesser of the two. Obtain Vr and V_2 from the published V speed charts.

<u>Note</u>: If the actual gross weight V_1 is used, and it is less than V_{mcg}, set V_1 equal to V_{mcg}.

③ 3

ANTI-SKID INOPERATIVE V_1 DECREMENTS	
FIELD LENGTH	V_1 REDUCTION - KTS
6,000	27
8,000	22
10,000	17
12,000	14
14,000	11

5

ANTI-SKID INOPERATIVE V_1 DECREMENTS	
FIELD LENGTH	V_1 REDUCTION - KTS
6,000	31
8,000	24
10,000	19
12,000	15
14,000	12

7

ANTI-SKID INOPERATIVE V_1 DECREMENTS	
FIELD LENGTH	V_1 REDUCTION - KTS
6,000	18
8,000	14
10,000	12
12,000	10
14,000	8

8

ANTI-SKID INOPERATIVE V_1 DECREMENTS	
FIELD LENGTH	V_1 REDUCTION - KTS
6,000	20
8,000	16
10,000	14
12,000	12
14,000	11

9

ANTI-SKID INOPERATIVE V_1 DECREMENTS	
FIELD LENGTH	V_1 REDUCTION - KTS
6,000	19
8,000	15
10,000	13
12,000	11
14,000	10

Anti-Skid Inoperative Example

Determine the proper V Speeds for the (③③) anti-skid inoperative takeoff below:

From Runway Analysis data:

Runway Length 32R	12,001 ft.
Actual Takeoff Weight	113,850 lbs.
Runway Limit Weight	143,800 lbs.

1. Runway Limit Weight is ------------ 143,800 lbs.

   Weight adjustment (③③) ----------- 15,500 lbs.

   Adjusted Runway Limit Weight ---- 128,300 lbs.

2. V_1 for 128,300 is 143 kts.

   Reduction from table -14 kts.

   Reduced V_1 129 kts.

3. The adjusted limit weight V_1 (129 kts.), is compared to V_{mcg} (111 kts.). Since it is greater skip to step 4.

   Note: If the limit weight V_1 was less than V_{mcg}, having more than 7900 feet of runway, V_1 would be set to V_{mcg}.

4. The adjusted limit V_1 (129 kts.) is compared to actual gross weight V_1 (133 kts.) and the smaller (129 kts.) is used. Vr (134 kts.) and V_2 (141 kts.) are obtained in the normal manner from the V Speed charts.

Answer: V_1 --- 129 kts.
Vr --- 134 kts.
V_2 --- 141 kts.

WARNING: Takeoff on a wet or slippery runway with anti-skid inoperative is not authorized. Landing on a wet or slippery runway with anti-skid inoperative is not authorized.

③ 3 5 Power Management Control (PMC) Inoperative

The B737-300/500 can be operated without the Performance Management Control system provided both systems are OFF or deactivated and operating weight limits are decreased. Additionally, V_{mcg} must be increased to compensate for increased differential thrust during takeoff roll. The ACCULOAD will apply appropriate weight decrements for PMC inoperative and calculate an adjusted maximum takeoff weight limit. ACCULOAD will calculate proper V Speeds for the PMC inoperative condition. In the absence of ACCULOAD, use the procedure below.

Procedure For Departures With PMC Inoperative Without ACCULOAD:

The performance adjustments for PMC inoperative are charted below and apply to both standard and improved climb takeoffs. Use the following procedure for PMC off or inoperative:

1. Determine the normal runway limit and climb limit weights using the Runway Analysis data.
2. Determine the appropriate weight corrections from the PMC OFF or INOPERATIVE ADJUSTMENTS chart.
3. Subtract these weight corrections from the normal takeoff runway and climb limit weights.
4. Compare the adjusted runway limit and climb limit weights. The lesser of the two is the maximum allowable takeoff weight (PMC inoperative). Actual weight must be equal to or less than this limit weight.
5. Determine V_{mcg} from the QRH or Flight Manual. Add the speed adjustment from the chart to the V_{mcg}. This becomes the adjusted V_{mcg}.
6. Compare this adjusted V_{mcg} to V_1, for the actual weight and set V_1 equal to the greater of the two.
7. Determine V_r and V_2 in the normal manner.
8. If the FMC is inoperative, determine the takeoff power setting from the Max Takeoff % N_1 - PMC OFF chart.

PMC OFF or Inoperative Example (No ACCULOAD)

Aircraft ---------------------- 303
Airport Elevation----------- 200 ft.
Wind------------------------- Calm
Temperature ---------------- 4°C
Flap Setting ----------------- 5 Flaps
PMC------------------------- Inoperative
FMC ------------------------- Inoperative
Actual Weight -------------- 110,000 lbs.

1. From the Runway Analysis data, the Runway Limit Weight is found to be 137,800 lbs. and the Climb Limit is 129,500.

2. Runway Limit Weight correction is -1,100 lbs. and the Climb Limit correction is -1,425 lbs.

3. Subtract the corrections.

Runway Limit	Climb Limit
137,800 lbs.	129,500 lbs.
-1,100 lbs.	-1,425 lbs.
136,700 lbs.	128,075 lbs.

4. The Climb Limit of 128,075 lbs. is the limiting weight. The actual aircraft weight (110,000 lbs.) is below this limit, so takeoff is allowed.

5. V_{mcg} for the actual weight of 110,000 lbs. 111 kts.
   Correction + 6 kts.
   Adjusted V_{mcg} 117 kts.

6. V_1 for the actual weight is 130 kts. It is greater than the adjusted V_{mcg} of 117 kts. so V_1 will be set at 130 kts.

7. Vr and V_2 are unaffected at 131 kts. and 139 kts.

8. The Maximum Takeoff % N_1 is read from the MAX TAKEOFF % N1 chart:

   BLEEDS ON--------------- 90.5% N_1
   BLEEDS OFF-------------- 91.4% N_1

③ 3 PMC OFF or INOPERATIVE PERFORMANCE ADJUSTMENTS

Altitude FT.	Temp °C	Weight Decrement, LB		V_1(mcg) Adjustment, KT.
		Runway Limit	Climb Limit	
BELOW 5000	ABOVE 21	3,200	5,625	+6
	21 & BELOW	1,100	1,425	
5000 & ABOVE	ABOVE 21	3,325	5,650	+4
	21 & BELOW	1,725	2,050	

5 PMC OFF or INOPERATIVE PERFORMANCE ADJUSTMENTS

Altitude FT.	Temp °C	Weight Decrement, LB		V_1(mcg) Adjustment, KT.
		Runway Limit	Climb Limit	
3000 & BELOW	ABOVE 27	300	300	+6
	27 & BELOW	1,000	1,000	
ABOVE 3000	ABOVE 27	2,200	2,000	+4
	27 & BELOW	2,400	2,400	+3

③ 3 5

MAX TAKEOFF % N1 - PMC OFF BLEEDS ON

VALID FOR ENGINE ANTI-ICE ON OR OFF										
OAT		AIRPORT PRESSURE ALTITUDE - FEET								
°C	°F	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	92.3	92.2	91.7						
50	122	92.8	93.4	93.7	93.0	93.0				
45	113	93.1	93.6	93.9	93.9	94.5	94.3	93.7		
40	104	93.6	94.0	94.2	94.3	95.1	95.0	94.9	94.8	94.5
35	95	94.1	94.6	94.8	94.8	95.5	95.7	95.6	95.8	95.7
30	86	94.5	94.3	94.5	95.0	95.4	95.6	95.8	95.8	95.8
25	77	93.7	93.7	93.7	94.4	95.5	95.3	95.1	95.4	95.8
20	68	92.9	92.9	92.9	93.6	95.5	95.7	95.8	95.8	95.7
15	59	92.1	92.1	92.1	92.8	94.9	95.1	95.1	95.1	95.1
10	50	91.3	91.3	91.3	92.0	94.1	94.3	94.3	94.3	94.3
5	41	90.5	90.5	90.5	91.2	93.2	93.4	93.4	93.4	93.4
0	32	89.7	89.7	89.7	90.4	92.4	92.6	92.6	92.6	92.6
-10	13	88.0	88.0	88.0	88.7	90.7	90.9	90.9	90.9	90.9
-20	- 4	86.3	86.3	86.4	87.0	89.0	89.1	89.1	89.1	89.1
-30	-22	84.6	84.6	84.6	85.3	87.2	87.4	87.4	87.4	87.4
-40	-40	82.9	82.9	82.9	83.5	85.4	85.5	85.5	85.6	85.6
-50	-58	81.1	81.1	81.1	81.7	83.5	83.7	83.7	83.7	83.7

③ 3 5

MAX TAKEOFF % N1 - PMC OFF BLEEDS OFF

VALID FOR ENGINE ANTI-ICE ON OR OFF										
OAT		AIRPORT PRESSURE ALTITUDE - FEET								
°C	°F	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	93.3	93.2	92.7						
50	122	93.8	94.4	94.6	94.0	94.0				
45	113	94.0	94.6	94.9	94.8	95.5	95.3	94.7		
40	104	94.5	94.9	95.1	95.2	96.1	95.9	95.8	95.8	95.4
35	95	95.0	95.6	95.7	95.7	96.5	96.6	96.6	96.7	96.6
30	86	95.4	95.2	95.4	96.0	96.3	96.5	96.7	96.7	96.8
25	77	94.6	94.6	94.6	95.3	96.4	96.2	96.0	96.3	96.7
20	68	93.8	93.8	93.8	94.6	95.9	95.9	95.9	95.9	95.9
15	59	93.0	93.0	93.0	93.7	95.1	95.1	95.1	95.1	95.1
10	50	92.2	92.2	92.2	92.9	94.3	94.3	94.3	94.3	94.3
5	41	91.4	91.4	91.4	92.1	93.4	93.4	93.4	93.4	93.4
0	32	90.6	90.6	90.6	91.3	92.6	92.6	92.6	92.6	92.6
-10	13	88.9	88.9	88.9	89.6	90.9	90.9	90.9	90.9	90.9
-20	- 4	87.2	87.2	87.2	87.9	89.1	89.1	89.1	89.1	89.1
-30	-22	85.5	85.5	85.5	86.1	87.4	87.4	87.4	87.4	87.4
-40	-40	83.7	83.7	83.7	84.3	85.5	85.5	85.5	85.6	85.6
-50	-58	81.9	81.9	81.9	82.5	83.7	83.7	83.7	83.7	83.7

7 8 9 EEC Normal Mode Inoperative

The B737-700/-800/-900 can be dispatched with the EEC Normal (NORM) Mode Inoperative provided both engines are operated in the Alternate (ALTN) Mode.

For the 7:

1. Assumed Temperature Thrust Reduction not permitted. Use full Takeoff Thrust.
2. No other adjustments are required.

For the 8 9:

- With ACCULOAD:
    1. ACCULOAD will calculate appropriate weight decrements, and adjustments to Takeoff V Speeds.
    2. Determine the Takeoff Power Setting from the Max Takeoff % N_1 – EEC Normal Mode Inoperative tables. Be sure to use the correct table for Engine Bleeds ON or OFF.
       Do not use FMC computed Takeoff % N_1 values.
    3. Assumed Temperature Thrust Reduction not permitted. Use full Takeoff Thrust.
- Without ACCULOAD:
    1. Determine the normal runway limit and climb limit weights from the Runway Analysis data.
    2. Determine the appropriate weight corrections for each from the Performance Adjustment table.
    3. Subtract these weight corrections from the normal runway limit and climb limit weights.
    4. Select the lesser of these two limit weights. This is the maximum allowable takeoff weight (EEC NORM Mode Inoperative). Actual weight must be equal to or less than this limit weight. Manual adjustments for Bleeds ON can be made as discussed in the **Bleed Configuration** paragraph earlier in this section.
    5. Determine V_1, Vr and V_2 in the normal manner then apply the adjustments from the Takeoff V Speed Adjustment table.
    6. Determine the Takeoff Power Setting from the Max Takeoff % N_1 – EEC Normal Mode Inoperative tables. Be sure to use the correct table for Engine Bleeds ON or OFF.
       Do not use FMC computed Takeoff % N_1 values.
    7. Assumed Temperature Thrust Reduction not permitted. Use full Takeoff Thrust.

7 8 9 EEC Normal Mode Inoperative Example (Without ACCULOAD)

Runway Limit Weight (Normal): ....181,000 lbs.
Climb Limit Weight (Normal): ....183,300 lbs.
Actual Weight:...166,000 lbs.
Engine Bleed: ....Bleeds OFF
Airport Elevation:....................................Sea Level
Temperature: ....30°C
Takeoff Flap Setting: ....Flaps 5

1. From the Performance Adjustments table (EEC Normal Mode Inoperative):

   Runway Limit adjustment:.......................11,600 lbs.
   Climb Limit adjustment:..........................12,300 lbs.

2. Subtract the corrections:

   Runway Limit ....Climb Limit
   181,000 lbs. ....183,300 lbs.
   -11,600 lbs. .... -12,300 lbs.
   169,400 lbs. ....171,000 lbs.

3. The limit weight for this takeoff under these conditions is the Runway Limit of 169,400 lbs. Since the actual takeoff weight is 166,000 lbs. (below the limit weight), takeoff is allowed Bleeds OFF.

4. Normal V_1, Vr and V_2 are 147, 149 and 156 knots respectively.

5. From the Takeoff V Speeds Adjustment table (EEC Normal Mode Inoperative):

   V_1 adjustment:..+1 knot
   Vr adjustment: ....+1 knot
   V_2 adjustment:.. 0 knot

6. The corrected V Speeds are 148, 150 and 156 knots respectively.

7. From the Max Takeoff % N_1 table (EEC Normal Mode Inoperative):
   Takeoff Power Setting (Bleeds OFF): 98.8% N_1

8 EEC Normal Mode Inoperative Performance Adjustments

Normal Limit Weight (LB)	Weight Decrement (LB)	
	Runway Limit	Climb Limit
< 130000	8000	8400
130000-140000	8600	8800
140000-150000	9500	9800
150000-160000	10300	10500
160000-170000	11100	11300
170000-190000	11600	12300

8 MAX TAKEOFF % N1 - EEC Normal Mode Inoperative

Engine Bleeds ON

						VALID FOR ENGINE ANTI-ICE ON OR OFF							
OAT						AIRPORT PRESSURE ALTITUDE - FEET							
°C	°F	-2000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	129	93.3	94.4										
50	122	93.8	94.9	95.1	95.2								
45	113	94.6	95.6	95.8	95.9	96.1	96.2						
40	104	95.2	96.4	96.5	96.6	96.7	96.8	97.0	96.9	96.6			
35	95	95.8	97.2	97.3	97.4	97.5	97.6	97.7	97.6	97.3	97.0	96.9	
30	86	95.4	98.1	98.1	98.2	98.2	98.3	98.3	98.2	98.1	97.8	97.7	97.7
25	77	94.6	97.3	97.9	98.5	98.6	98.5	98.5	98.5	98.5	98.4	98.4	98.5
20	68	93.8	96.6	97.1	97.7	98.0	98.3	98.6	98.6	98.7	98.6	98.6	98.6
15	59	93.0	95.8	96.4	97.0	97.3	97.6	97.9	98.3	98.7	98.9	98.9	98.9
10	50	92.3	95.0	95.6	96.2	96.5	96.8	97.2	97.5	97.9	98.3	98.8	99.3
5	41	91.5	94.2	94.8	95.4	95.8	96.1	96.4	96.8	97.2	97.6	98.1	98.5
0	32	90.7	93.4	94.1	94.7	95.0	95.3	95.7	96.0	96.4	96.8	97.3	97.8
-10	14	89.0	91.8	92.5	93.1	93.4	93.8	94.1	94.5	94.9	95.3	95.8	96.2
-20	-4	87.4	90.2	90.8	91.5	91.8	92.2	92.6	93.0	93.4	93.7	94.2	94.6
-30	-22	85.7	88.5	89.2	89.8	90.2	90.6	91.0	91.4	91.8	92.1	92.6	93.0
-40	-40	83.9	86.8	87.5	88.1	88.5	88.9	89.3	89.7	90.1	90.5	90.9	91.4
-50	-58	82.2	85.1	85.7	86.4	86.8	87.2	87.7	88.1	88.4	88.8	89.3	89.7

8 MAX TAKEOFF % N1 - EEC Normal Mode Inoperative

Engine Bleeds OFF

						VALID FOR ENGINE ANTI-ICE ON OR OFF							
OAT						AIRPORT PRESSURE ALTITUDE - FEET							
°C	°F	-2000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	129	94.0	95.3										
50	122	94.5	95.8	96.0	96.1								
45	113	95.3	96.5	96.6	96.8	97.0	97.1						
40	104	95.9	97.2	97.3	97.5	97.6	97.7	97.9	97.8	97.5			
35	95	96.5	98.0	98.1	98.2	98.3	98.5	98.6	98.5	98.2	97.9	97.9	
30	86	96.0	98.8	98.9	99.0	99.0	99.2	99.2	99.1	99.0	98.8	98.7	98.7
25	77	95.3	98.1	98.7	99.3	99.4	99.4	99.4	99.4	99.4	99.3	99.3	99.4
20	68	94.5	97.3	97.9	98.5	98.9	99.2	99.5	99.6	99.6	99.6	99.6	99.6
15	59	93.7	96.6	97.2	97.8	98.1	98.5	98.8	99.2	99.6	99.9	99.9	99.8
10	50	92.9	95.8	96.4	97.1	97.4	97.7	98.1	98.5	98.9	99.3	99.8	100.3
5	41	92.1	95.0	95.7	96.3	96.7	97.0	97.3	97.7	98.1	98.5	99.0	99.5
0	32	91.3	94.3	94.9	95.6	95.9	96.2	96.6	97.0	97.4	97.8	98.3	98.7
-10	14	89.7	92.7	93.3	94.0	94.4	94.7	95.1	95.4	95.8	96.2	96.7	97.2
-20	-4	88.1	91.1	91.7	92.5	92.8	93.2	93.5	93.9	94.3	94.7	95.1	95.6
-30	-22	86.4	89.4	90.1	90.9	91.2	91.6	91.9	92.3	92.7	93.0	93.5	93.9
-40	-40	84.6	87.7	88.4	89.2	89.6	89.9	90.3	90.6	91.0	91.4	91.8	92.3
-50	-58	82.9	86.0	86.7	87.6	87.9	88.3	88.6	89.0	89.3	89.7	90.1	90.6

8 Takeoff V Speeds Adjustments

EEC Normal Mode Inoperative

Takeoff Speeds	Takeoff Speed Adjustments (Kts.)
V_1	+1
Vr	+1
V_2	0

9 EEC Normal Mode Inoperative Performance Adjustments

Normal Limit Weight (LB)	Weight Decrement (LB)	
	Runway Limit	Climb Limit
< 130000	8800	8900
130000-140000	9200	9300
140000-150000	9700	9900
150000-160000	10400	10800
160000-170000	10800	11300
170000-190000	12100	12700

9 MAX TAKEOFF % N1 - EEC Normal Mode Inoperative

Engine Bleeds ON

						VALID FOR ENGINE ANTI-ICE ON OR OFF							
OAT						AIRPORT PRESSURE ALTITUDE - FEET							
°C	°F	-2000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	129	93.3	94.4										
50	122	93.8	94.9	95.1	95.2								
45	113	94.6	95.6	95.8	95.9	96.1	96.2						
40	104	95.2	96.4	96.5	96.6	96.7	96.8	97.0	96.9	96.6			
35	95	95.8	97.2	97.3	97.4	97.5	97.6	97.7	97.6	97.3	97.0	96.9	
30	86	95.4	98.1	98.1	98.2	98.2	98.3	98.3	98.2	98.1	97.8	97.7	97.7
25	77	94.6	97.3	97.9	98.5	98.6	98.5	98.5	98.5	98.5	98.4	98.4	98.5
20	68	93.8	96.6	97.1	97.7	98.0	98.3	98.6	98.6	98.7	98.6	98.6	98.6
15	59	93.0	95.8	96.4	97.0	97.3	97.6	97.9	98.3	98.7	98.9	98.9	98.9
10	50	92.3	95.0	95.6	96.2	96.5	96.8	97.2	97.5	97.9	98.3	98.8	99.3
5	41	91.5	94.2	94.8	95.4	95.8	96.1	96.4	96.8	97.2	97.6	98.1	98.5
0	32	90.7	93.4	94.1	94.7	95.0	95.3	95.7	96.0	96.4	96.8	97.3	97.8
-10	14	89.0	91.8	92.5	93.1	93.4	93.8	94.1	94.5	94.9	95.3	95.8	96.2
-20	-4	87.4	90.2	90.8	91.5	91.8	92.2	92.6	93.0	93.4	93.7	94.2	94.6
-30	-22	85.7	88.5	89.2	89.8	90.2	90.6	91.0	91.4	91.8	92.1	92.6	93.0
-40	-40	83.9	86.8	87.5	88.1	88.5	88.9	89.3	89.7	90.1	90.5	90.9	91.4
-50	-58	82.2	85.1	85.7	86.4	86.8	87.2	87.7	88.1	88.4	88.8	89.3	89.7

9 MAX TAKEOFF % N_1 - EEC Normal Mode Inoperative

Engine Bleeds OFF

						VALID FOR ENGINE ANTI-ICE ON OR OFF							
OAT						AIRPORT PRESSURE ALTITUDE - FEET							
°C	°F	-2000	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
54	129	94.0	95.3										
50	122	94.5	95.8	96.0	96.1								
45	113	95.3	96.5	96.6	96.8	97.0	97.1						
40	104	95.9	97.2	97.3	97.5	97.6	97.7	97.9	97.8	97.5			
35	95	96.5	98.0	98.1	98.2	98.3	98.5	98.6	98.5	98.2	97.9	97.9	
30	86	96.0	98.8	98.9	99.0	99.0	99.2	99.2	99.1	99.0	98.8	98.7	98.7
25	77	95.3	98.1	98.7	99.3	99.4	99.4	99.4	99.4	99.4	99.3	99.3	99.4
20	68	94.5	97.3	97.9	98.5	98.9	99.2	99.5	99.6	99.6	99.6	99.6	99.6
15	59	93.7	96.6	97.2	97.8	98.1	98.5	98.8	99.2	99.6	99.9	99.9	99.8
10	50	92.9	95.8	96.4	97.1	97.4	97.7	98.1	98.5	98.9	99.3	99.8	100.3
5	41	92.1	95.0	95.7	96.3	96.7	97.0	97.3	97.7	98.1	98.5	99.0	99.5
0	32	91.3	94.3	94.9	95.6	95.9	96.2	96.6	97.0	97.4	97.8	98.3	98.7
-10	14	89.7	92.7	93.3	94.0	94.4	94.7	95.1	95.4	95.8	96.2	96.7	97.2
-20	-4	88.1	91.1	91.7	92.5	92.8	93.2	93.5	93.9	94.3	94.7	95.1	95.6
-30	-22	86.4	89.4	90.1	90.9	91.2	91.6	91.9	92.3	92.7	93.0	93.5	93.9
-40	-40	84.6	87.7	88.4	89.2	89.6	89.9	90.3	90.6	91.0	91.4	91.8	92.3
-50	-58	82.9	86.0	86.7	87.6	87.9	88.3	88.6	89.0	89.3	89.7	90.1	90.6

9 Takeoff V Speeds Adjustments

EEC Normal Mode Inoperative

Takeoff Speeds	Takeoff Speed Adjustments (Kts.)
V_1	+1
Vr	+1
V_2	0

RTO Brake Cooling Charts

The following RTO Brake Cooling Charts are derived from the complete Boeing Brake Cooling Charts for each aircraft type. These charts are designed for quick reference by crews following a Rejected Takeoff. Cooling times are based on RTO or maximum manual braking to a stop with an ambient temperature of 32°C. These charts reflect the Boeing cooling charts.

③ 3 5 RTO Brake Cooling Chart - Time (minutes)

Gross Wt Pounds X 1000	Pressure Alt Feet X 1000	Brakes Applied Speed Kts									
		60	70	80	90	100	110	120	130	140	150
	0	08	18	34	48	60	C	W	W	W	W
135	4	19	28	45	59	C	W	W	W	W	W
	8	29	40	55	C	C	W	W	W	W	W
	0	05	15	32	46	58	C	C	W	W	W
130	4	17	26	43	57	C	C	W	W	W	W
	8	28	38	53	C	C	W	W	W	W	W
	0	02	13	29	44	56	C	C	W	W	W
125	4	15	24	41	54	C	C	W	W	W	W
	8	26	35	51	C	C	W	W	W	W	W
	0	0	11	27	42	53	C	C	W	W	W
120	4	14	22	33	52	C	C	W	W	W	W
	8	25	33	49	C	C	W	W	W	W	W
	0	0	10	26	39	51	C	C	W	W	W
115	4	12	20	36	50	C	C	W	W	W	W
	8	24	30	47	60	C	W	W	W	W	W
	0	0	10	28	36	49	C	C	C	W	W
110	4	09	17	33	47	59	C	W	W	W	W
	8	23	28	44	57	C	W	W	W	W	W
	0	0	10	20	33	46	C	C	C	W	W
105	4	06	15	31	44	57	C	C	W	W	W
	8	20	26	42	55	C	C	W	W	W	W
	0	0	10	17	31	43	C	C	C	W	W
100	4	03	12	28	42	54	C	C	W	W	W
	8	19	23	40	52	C	C	W	W	W	W

- Add 3 minutes for each approximate taxi mile.
- For low speed RTOs (<60Kts.) at airport elevations below 1000' and OAT below 15°C no cooling time is required. Otherwise, use cooling limits for 60 knots.

0-60 mins	Cool as scheduled prior to takeoff.	
C	Caution Wheel Fuse Plugs may melt. Delay takeoff and inspect after 60 minutes.	
W	• Alert fire equipment	• Clear runway immediately
	• Unless required, do not set parking brake.	• Do not approach gear or attempt taxi for 90 min.
	• Tire, wheel, and brake replacement may be required.	

7 RTO Brake Cooling Chart - Time (minutes)

Gross Wt Pounds X 1000	Pressure Alt Feet X 1000	Brake Applied Speed (Kts)									
		80	90	100	110	120	130	140	150	160	170
155	0	0	17	27	42	57	C	C	C	W	W
	4	10	23	35	52	C	C	C	W	W	W
	8	17	33	45	C	C	C	W	W	W	W
150	0	0	15	25	40	53	C	C	C	W	W
	4	0	22	33	50	C	C	C	W	W	W
	8	13	30	43	60	C	C	W	W	W	W
145	0	0	13	23	37	50	C	C	C	C	W
	4	0	20	32	47	C	C	C	W	W	W
	8	13	28	42	57	C	C	C	W	W	W
140	0	0	12	22	35	45	C	C	C	C	W
	4	0	18	28	45	57	C	C	C	W	W
	8	12	27	38	55	C	C	C	W	W	W
135	0	0	0	20	32	43	58	C	C	C	W
	4	0	15	27	40	53	C	C	C	W	W
	8	12	22	37	50	C	C	C	W	W	W
130	0	0	0	18	30	42	55	C	C	C	W
	4	0	13	25	38	52	C	C	C	W	W
	8	10	20	35	48	C	C	C	W	W	W
125	0	0	0	17	27	40	52	C	C	C	C
	4	0	10	23	35	50	C	C	C	W	W
	8	0	17	33	42	60	C	C	C	W	W
120	0	0	0	13	25	37	50	C	C	C	C
	4	0	0	20	33	47	C	C	C	C	W
	8	0	15	28	40	57	C	C	C	W	W
115	0	0	0	12	20	32	45	58	C	C	C
	4	0	0	18	27	40	55	C	C	C	C
	8	0	15	25	37	50	C	C	C	W	W
110	0	0	0	10	15	32	42	53	C	C	C
	4	0	0	17	22	40	52	C	C	C	C
	8	0	13	23	30	50	C	C	C	C	W

- Add 3 minutes for each approximate taxi mile.
- For low speed RTOs (<80Kts.) at airport elevations below 1000' and OAT below 15°C no cooling time is required. Otherwise, use cooling limits for 80 knots.
- Interpolation may be used for airport elevations above 8000'.

0-60 mins	Cool as scheduled prior to takeoff.	
C	Caution Wheel Fuse Plugs may melt. Delay takeoff and inspect after 60 minutes.	
W	• Alert fire equipment.	• Clear runway immediately.
	• Unless required, do not set parking brake.	• Do not approach gear or attempt taxi for 90 min.
	• Tire, wheel, and brake replacement may be required.	

8 9 RTO Brake Cooling Chart - Time (minutes)

Gross Wt Pounds X 1000	Pressure Alt Feet X 1000	Brake Applied Speed (Kts)									
		80	90	100	110	120	130	140	150	160	170
175	0	0	7	20	33	50	C	C	C	W	W
	4	0	13	30	47	C	C	C	W	W	W
	8	0	22	35	57	C	C	W	W	W	W
170	0	0	0	17	32	48	C	C	C	W	W
	4	0	12	25	45	C	C	C	W	W	W
	8	0	20	32	53	C	C	W	W	W	W
165	0	0	0	15	30	47	C	C	C	W	W
	4	0	10	23	38	60	C	C	W	W	W
	8	0	18	30	52	C	C	W	W	W	W
160	0	0	0	13	28	43	C	C	C	C	W
	4	0	8	22	37	53	C	C	C	W	W
	8	0	18	30	47	C	C	C	W	W	W
155	0	0	0	10	25	40	57	C	C	C	W
	4	0	0	20	35	50	C	C	C	W	W
	8	0	12	30	45	C	C	C	W	W	W
150	0	0	0	10	23	37	53	C	C	C	W
	4	0	0	18	32	48	C	C	C	W	W
	8	0	8	28	43	C	C	C	W	W	W
145	0	0	0	8	20	35	50	C	C	C	C
	4	0	0	17	30	47	C	C	C	W	W
	8	0	0	27	40	57	C	C	C	W	W
140	0	0	0	7	18	33	47	C	C	C	C
	4	0	0	15	28	45	60	C	C	W	W
	8	0	0	23	35	53	C	C	C	W	W
135	0	0	0	0	15	32	43	C	C	C	C
	4	0	0	15	25	38	53	C	C	W	W
	8	0	0	22	33	50	C	C	C	W	W
130	0	0	0	0	13	28	40	C	C	C	C
	4	0	0	12	22	37	50	C	C	C	C
	8	0	0	20	32	47	C	C	C	W	W
120	0	0	0	0	10	22	33	47	60	C	C
	4	0	0	0	17	27	47	C	C	C	C
	8	0	0	13	27	42	58	C	C	W	W

- Add 3 minutes for each approximate taxi mile.
- For low speed RTOs (<80Kts.) at airport elevations below 1000’ and OAT below 15°C no cooling time is required. Otherwise, use cooling limits for 80 knots.
- Interpolation may be used for airport elevations above 8000’.

0-60 mins	Cool as scheduled prior to takeoff.	
C	Caution Wheel Fuse Plugs may melt. Delay takeoff and inspect after 60 minutes.	
W	• Alert fire equipment.	• Clear runway immediately.
	• Unless required, do not set parking brake.	• Do not approach gear or attempt taxi for 90 min.
	• Tire, wheel, and brake replacement may be required.	

INTENTIONALLY LEFT BLANK

ENROUTE

NORMAL

③ 3 Altitude Capability

LRC AND .74 MACH

WEIGHT 1000 LB.	OPTIMUM ALTITUDE FEET	CRUISE THRUST LIMIT PRESS ALT (FT)		
		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
140	31000	34500	33600	32600
135	31800	35400	34600	33700
130	32600	36300	35600	34700
125	33500	37000	36500	35800
120	34400	37000	37000	36700
115	35300	37000	37000	37000
110	36200	37000	37000	37000
105	37000	37000	37000	37000

③ 3 Maneuver Capability

LRC AND .74 MACH

WEIGHT 1000 LB	MAXIMUM PRESSURE ALTITUDE (FT)					
	MANEUVER CAPABILITY 'G' (BANK ANGLE)					
	1.2 (33°)	1.3 (39°)	1.4 (44°)	1.5 (48°)	1.6 (51°)	1.7 (54°)
140	34200	32600	31000	29500	28000	26700
135	35000	33300	31800	30300	28800	27500
130	35800	34200	32600	31100	29700	28300
125	36600	35000	33400	31900	30500	29200
120		35800	34300	32800	31400	30100
115		36600	35200	33700	32300	31000
110			36000	34600	33300	32000
105			37000	35600	34300	33000
100				36600	35300	34000
95					36300	35100
90						36200

5 Altitude Capability

LRC AND .74 MACH

WEIGHT 1000 LB.	OPTIMUM ALTITUDE FEET	CRUISE THRUST LIMIT PRESS ALT (FT) ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
140	31000	34300	33400	32400
135	31800	35200	34400	33500
130	32600	36100	35400	34500
125	33500	36900	36300	35600
120	34400	37000	37000	36500
115	35300	37000	37000	37000
110	36200	37000	37000	37000
105	37000	37000	37000	37000
100	37000	37000	37000	37000

5 Maneuver Capability

LRC AND .74 MACH

WEIGHT	MAXIMUM PRESSURE ALTITUDE (FT) MANEUVER CAPABILITY 'G' (BANK ANGLE)					
1000 LB	1.2 (33°)	1.3 (39°)	1.4 (44°)	1.5 (48°)	1.6 (51°)	1.7 (54°)
140	34200	32600	31000	29500	28000	26700
135	35100	33400	31800	30300	28900	27500
130	35900	34100	32600	31200	29700	28400
125	36700	35000	33500	32000	30500	29200
120		35900	34300	32800	31400	30100
115		36800	35200	33700	32400	31000
110			36100	34700	33400	32000
105				35700	34300	33000
100				36700	35300	34000
95					36400	35200
90						36300

7 Altitude Capability

LRC AND .78 MACH

WEIGHT 1000 LB.	OPTIMUM ALTITUDE FEET	CRUISE THRUST LIMIT PRESS ALT (FT)		
		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
155	33800	37200	36300	35000
150	34500	37800	37000	35800
145	35200	38500	37600	36500
140	35900	39100	38300	37200
135	36700	39800	38900	37800
130	37500	40500	39600	38500
125	38300	41000	40400	39200
120	39100	41000	41000	40000
115	40000	41000	41000	40700

7 Maneuver Capability

LRC AND .78 MACH

WEIGHT 1000 LB	MAXIMUM PRESSURE ALTITUDE (FT) MANEUVER CAPABILITY 'G' (BANK ANGLE)					
	1.2 (33°)	1.3 (39°)	1.4 (44°)	1.5 (48°)	1.6 (51°)	1.7 (54°)
155	39500	37800	36200	34800	33500	32200
150	40200	38500	36800	35500	34200	32900
145	40900	39200	37500	36200	34900	33600
140	41000	39900	38300	36900	35600	34300
135		40700	39000	37700	36400	35100
130		41000	39800	38500	37200	35900
125			40600	39300	38000	36700
120			41000	40100	38800	37600
115				41000	39700	38500

8 Altitude Capability

LRC AND .78 MACH

WEIGHT 1000 LB.	OPTIMUM ALTITUDE FEET	CRUISE THRUST LIMIT PRESS ALT (FT)		
		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
180	31100	33800	32100	29100
175	31700	34600	33100	30300
170	32400	35300	34000	31500
165	33000	36000	34900	32800
160	33700	36600	35600	33800
155	34300	37200	36200	34700
150	35000	37800	36900	35500
145	35700	38500	37500	36200
140	36500	39100	38200	37000
135	37200	39800	38800	37600
130	38000	40500	39500	38300
125	38800	41000	40200	39000
120	39700	41000	40900	39700

8 Maneuver Capability

LRC AND .78 MACH

WEIGHT 1000 LB	MAXIMUM PRESSURE ALTITUDE (FT) MANEUVER CAPABILITY 'G' (BANK ANGLE)					
	1.2 (33°)	1.3 (39°)	1.4 (44°)	1.5 (48°)	1.6 (51°)	1.7 (54°)
180	36400	34600	32900	31600	30300	29000
175	37000	35200	33500	32200	30900	29600
170	37600	35800	34200	32800	31500	30200
165	38300	36400	34800	33400	32200	30900
160	38900	37100	35400	34100	32800	31600
155	39600	37700	36100	34700	33500	32200
150	40200	38400	36800	35400	34200	32900
145	40900	39100	37500	36100	34900	33700
140	41000	39800	38200	36900	35600	34400
135		40600	39000	37600	36400	35200
130		41000	39800	38400	37200	36000
125			40600	39200	38000	36800
120			41000	40100	38900	37600

9 Altitude Capability

LRC AND .79 MACH

WEIGHT 1000 LB.	OPTIMUM ALTITUDE FEET	CRUISE THRUST LIMIT PRESS ALT (FT)		
		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
180	31100	31200	27900	24400
175	31800	32200	29100	25600
170	32400	33200	30500	26900
165	33000	34100	31800	28100
160	33700	35000	33000	29300
155	34400	35700	34000	30600
150	35000	36300	35000	32200
145	35800	37000	35800	33600
140	36500	37600	36300	34600
135	37200	38300	37100	35600
130	38000	39000	37800	36200
125	38800	39700	38500	37000
120	39700	40400	39200	37700

9 Maneuver Capability

LRC AND .79 MACH

WEIGHT 1000 LB	MAXIMUM PRESSURE ALTITUDE (FT) MANEUVER CAPABILITY 'G' (BANK ANGLE)					
	1.2 (33°)	1.3 (39°)	1.4 (44°)	1.5 (48°)	1.6 (51°)	1.7 (54°)
180	36000	34200	32600	31200	29900	28700
175	36600	34800	33200	31800	30600	29300
170	37200	35400	33800	32500	31200	29900
165	37800	36000	34500	33100	31800	30600
160	38500	36700	35100	33800	32500	31200
155	39100	37300	35800	34400	33200	31900
150	39800	38000	36500	35100	33900	32600
145	40500	38700	37200	35800	34600	33400
140	41000	39400	37900	36600	35300	34100
135		40200	38600	37300	36100	34900
130		41000	39400	38100	36900	35700
125			40300	38900	37700	36500
120			41000	39800	38500	37300

③ 3 Two Engine Long Range Cruise

LONG RANGE CRUISE	ISA Average % N1 Required
ALL ENGINES • A/C AUTO	Max TAT for Thrust Rating
MAX CRUISE THRUST LIMITS	IAS Knots
	Mach Number
	ISA Fuel Flow LB/HR/ENG
	ISA TAS Kts.

PRESSURE ALTITUDE **37000 FT TO 25000 FT**

Press Alt 1000 Feet (Std TAT)	GROSS WEIGHT (1,000 POUNDS) 140	135	130	125	120	115	110	105	100	95	90	85	80	75
37 (-32)				91.1	89.3	87.8	86.4	85.2	84.2	83.2	82.3	81.4	80.3	79.2
				-21	-14	-7	0							
				239	240	240	240	240	240	240	240	239	237	233
				.743	.745	.745	.745	.745	.745	.745	.745	.743	.736	.725
				2751	2602	2473	2360	2260	2174	2097	2026	1956	1871	1783
				426	427	427	427	427	427	427	427	426	422	416
35 (-30)		90.5	89.0	87.7	86.5	85.4	84.5	83.6	82.8	81.9	81.0	80.0	78.9	77.7
		-16	-9	-3	2									
		251	251	252	251	251	251	251	251	251	249	246	242	237
		.744	.745	.745	.745	.745	.745	.745	.745	.744	.739	.731	.719	.705
		2938	2798	2674	2563	2465	2379	2301	2229	2160	2078	1991	1901	1804
		429	429	430	429	429	429	429	429	429	426	421	414	406
33 (-26)	89.0	87.8	86.8	85.8	85.0	84.2	83.4	82.6	81.8	80.9	80.0	78.9	77.7	76.5
	-6	0	4											
	263	263	263	263	263	263	263	263	261	259	255	250	245	239
	.745	.745	.745	.745	.745	.745	.745	.744	.741	.734	.724	.712	.698	.682
	3009	2891	2783	2688	2603	2525	2452	2381	2302	2214	2124	2029	1929	1827
	433	433	433	433	433	433	433	433	431	427	421	414	406	397
31 (-21)	86.9	86.1	85.4	84.6	83.9	83.2	82.5	81.6	80.8	79.8	78.8	77.7	76.4	75.1
	7	11												
	275	275	275	275	275	275	273	271	268	264	259	253	247	241
	.745	.745	.745	.745	.745	.744	.741	.735	.726	.716	.704	.690	.675	.660
	3009	2918	2834	2757	2683	2612	2531	2443	2351	2257	2158	2054	1954	1852
	437	437	437	437	437	437	435	431	426	420	413	405	396	387
29 (-17)	85.7	85.0	84.4	83.7	83.0	82.2	81.4	80.6	79.6	78.6	77.6	76.3	75.1	73.8
	287	287	287	287	285	283	280	276	272	266	261	255	249	243
	.745	.745	.744	.744	.741	.735	.727	.718	.707	.695	.682	.668	.653	.637
	3075	2999	2924	2853	2768	2678	2586	2491	2391	2288	2185	2083	1981	1879
	441	441	441	440	438	435	430	425	418	411	403	395	386	377
27 (-12)	84.7	84.1	83.4	82.7	82.0	81.2	80.3	79.4	78.4	77.3	76.2	75.0	73.8	72.5
	300	299	297	295	292	288	284	279	274	269	26.3	257	251	244
	.744	.743	.739	.734	.727	.718	.709	697	.685	.673	.660	.646	.631	.615
	3175	3100	3011	2920	2826	2730	2630	2526	2421	2318	2216	2114	2011	1909
	444	444	441	438	434	429	423	416	409	402	394	386	377	367
25 (-9)	83.7	83.1	82.4	81.6	80.8	80.0	79.1	78.1	77.1	76.0	74.9	73.8	72.5	71.2
	309	307	304	300	296	292	287	282	277	271	265	259	252	246
	.738	.732	.725	.717	.708	.698	.687	.676	.664	.652	.638	.624	.609	.594
	3261	3169	3073	2976	2874	2769	2662	2559	2456	2354	2252	2150	2049	1948
	444	441	436	432	426	420	414	407	400	392	384	376	367	357

Max TAT not shown where N1 can be set in ISA + 30°C conditions.
Increase/decrease avg. N1 required by 1% per 5°C above/below STD TAT.
Increase/decrease fuel flow 1% per 5°C above/below STD TAT.
Increase/decrease TAS by 1 Kt. per 1°C above/below STD TAT.

(Continued)

③③ Turbulent Air Penetration

TARGET SPEED IAS/MACH	PRESS ALT 1000 FT	GROSS WEIGHT 1000 LB						
		70	80	90	100	110	120	130
		APPROXIMATE POWER SETTING IN %N1 RPM						
280/.73	37	78	79	81	83	86	89	
	35	77	78	80	82	83	86	88
	30	77	78	79	80	81	82	84
	25	75	76	77	77	78	80	81
	20	72	72	73	74	75	76	77
	15	68	69	69	70	71	72	73
	10	64	65	66	66	67	68	69

N1 BLEED ADJUSTMENTS

BLEED CONFIGURATION	N_1 ADJUSTMENT %
A/C OFF	+.8
A/C HIGH	-0.5
ENG TAI	-1.0
WING TAI NORMAL	-2.0
HIGH	-2.3

③③ Max Cruise Percent N1

MAX CRUISE PERCENT N1

PRESS ALT 1000 FEET	TAT DEG C											
	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
37	87.1	88.1	89.1	90.0	91.0	91.9	92.8	93.3	93.0	92.7	92.5	92.2
35	86.6	87.6	88.6	89.5	90.5	91.4	92.3	93.2	93.2	92.9	92.6	92.3
33	85.7	86.7	87.6	88.6	89.5	90.4	91.3	92.2	93.1	92.9	92.6	92.3

MAX CRUISE PERCENT N1

PRESS ALT 1000 FEET	TAT DEG C												
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
31	85.8	86.7	87.7	88.6	89.5	90.4	91.3	92.2	92.8	92.6	92.3	91.9	91.6
29	84.9	85.8	86.8	87.7	88.6	89.5	90.4	91.2	92.1	92.5	92.2	91.9	91.5
27	84.0	84.9	85.8	86.8	87.7	88.6	89.4	90.3	91.1	92.0	92.2	91.8	91.4

MAX CRUISE PERCENT N1

PRESS ALT 1000 FEET	TAT DEG C												
	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
25	85.0	86.0	86.9	87.7	88.6	89.5	90.3	91.1	91.9	91.7	91.3	90.9	90.4

5 Two Engine Long Range Cruise

LONG RANGE CRUISE ALL ENGINES • A/C AUTO MAX CRUISE THRUST LIMITS	ISA Average %N1 Required Max TAT for Thrust Rating IAS Knots Mach Number ISA Fuel Flow LB/HR/ENG ISA TAS Kts.

PRESSURE ALTITUDE **37000 FT TO 25000 FT**

Press Alt 1000 Feet (Std TAT)	GROSS WEIGHT (1,000 POUNDS)														
	140	135	130	125	120	115	110	105	100	95	90	85	80	75	70
					89.4	87.8	86.3	85.1	84.0	83.1	82.3	81.5	80.4	79.4	78.2
					-15	-8	-1								
37					240	240	240	240	240	240	240	239	237	233	228
(-33)					.745	.745	.745	.745	.745	.745	.745	.743	.736	.725	.711
					2603	2473	2353	2249	2158	2085	2019	1953	1868	1780	1690
					427	427	427	427	427	427	427	426	422	416	408
		90.6	89.0	87.6	86.4	85.2	84.3	83.5	82.7	82.0	81.1	80.1	79.1	77.9	76.6
		-18	-11	-4	2										
35		251	251	252	251	251	251	251	251	251	249	246	242	237	231
(-31)		.744	.745	.745	.745	.745	.745	.745	.745	.744	.739	.731	.719	.705	.688
		2941	2800	2673	2556	2452	2362	2287	2221	2156	2074	1987	1897	1802	1703
		429	429	430	430	429	429	429	429	429	426	421	415	406	397
	89.0	87.7	86.6	85.6	84.8	84.0	83.4	82.7	81.9	81.0	80.1	79.1	77.9	76.7	75.4
	-7	-1	4												
33	263	263	263	263	263	263	263	263	261	259	255	250	245	239	233
(-27)	.745	.745	.745	.745	.745	.745	.745	.744	.741	.734	.724	.712	.698	682	.665
	3010	2886	2773	2671	2583	2509	2442	2376	2297	2208	2117	2023	1923	1825	1727
	433	434	433	433	433	433	433	433	431	427	421	414	406	397	387
	86.8	85.9	85.9	84.5	83.9	83.3	82.5	81.7	80.9	80.0	79.0	77.9	76.7	75.4	74.1
	7														
31	275	275	275	275	275	275	273	271	268	264	259	253	247	241	235
(-23)	.745	.745	.745	.745	.745	.744	.741	.735	.726	.716	.704	.690	.675	.660	.643
	2994	2897	2813	2741	2673	2606	2526	2436	2344	2250	2151	2049	1950	1850	1751
	437	437	437	437	437	437	435	431	426	420	413	405	396	387	377
	85.5	84.9	84.3	83.8	83.1	82.3	81.6	80.7	79.8	78.8	77.8	76.6	75.4	74.1	72.7
29	287	287	287	287	285	283	280	276	272	266	261	255	249	243	236
(-20)	.745	.745	.744	.744	.741	.735	.727	.718	.707	.695	.682	.668	.653	.637	.620
	3053	2983	2914	2846	2762	2671	2578	2484	2385	2281	2178	2077	1977	1876	1776
	441	441	441	440	438	435	430	425	419	411	403	395	387	377	367
	84.7	84.2	83.5	82.8	82.1	81.3	80.5	79.6	78.6	77.6	76.5	75.4	74.1	72.8	71.3
27	300	299	297	295	292	288	284	279	274	269	263	257	251	244	237
(-16)	.744	.743	.739	.734	.727	.718	.709	.697	.685	.673	.660	.646	.631	.615	.598
	3165	3094	3004	2912	2817	2722	2622	2517	2413	2311	2210	2109	2007	1906	1804
	444	444	441	438	434	429	423	416	409	402	394	386	377	367	357
	83.8	83.2	82.5	81.8	81.1	80.2	79.3	78.4	77.4	76.4	75.2	74.0	72.7	71.4	69.9
25	309	307	304	300	296	292	287	282	277	271	265	259	252	246	238
(-13)	.738	.732	.725	.717	.708	.698	.687	.676	.664	.652	.638	.624	.609	.594	.577
	3252	3158	3062	2965	2864	2759	2655	2553	2451	2350	2248	2146	2045	1944	1842
	444	441	437	432	426	420	414	407	400	392	384	376	367	357	347

Max TAT not shown where N1 can be set in ISA + 30°C conditions.
Increase/decrease avg. N1 required by 1% per 5°C above/below STD TAT.
Increase/decrease fuel flow 1% per 5°C above/below STD TAT.
Increase/decrease TAS by 1 Kt. per 1°C above/below STD TAT.

(Continued)

5 Turbulent Air Penetration

TARGET SPEED IAS/MACH	PRESS ALT 1000 FT	GROSS WEIGHT 1000 LB						
		70	80	90	100	110	120	130
		APPROXIMATE POWER SETTING IN %N1 RPM						
280/.73	37	78	79	81	83	85	88	
	35	77	78	80	81	83	85	88
	30	77	78	79	80	81	82	83
	25	75	76	77	78	79	80	81
	20	72	72	73	74	75	76	77
	15	68	69	69	70	71	72	73
	10	64	65	66	67	67	68	69

N1 BLEED ADJUSTMENTS

BLEED CONFIGURATION	N1 ADJUSTMENT %
A/C OFF	+0.8
A/C HIGH	-0.6
ENG TAI	-1.0
WING TAI	
NORMAL	-2.0
HIGH	-2.0

5 Max Cruise Percent N1

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
37	85.9	87.0	87.9	88.9	89.9	90.8	91.7	92.6	93.0	92.7	92.4	92.2	91.9	91.8
36	85.9	86.5	87.5	88.4	89.4	90.3	91.2	92.2	93.1	92.8	92.6	92.2	91.9	91.6
35	84.5	85.5	86.5	87.4	88.4	89.3	90.2	91.1	92.0	92.8	92.6	92.2	92.0	91.7

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	-0	5	10	15
31	85.6	86.5	87.5	88.4	89.3	90.2	91.1	91.9	92.5	92.2	91.8	91.5	91.3	91.0
29	84.6	85.6	86.5	87.4	88.4	89.3	90.1	91.0	91.8	92.0	91.7	91.4	91.1	90.8
27	83.8	84.7	85.6	86.5	87.4	88.3	89.2	90.1	90.9	91.7	91.6	91.3	91.0	90.7

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
25	84.9	85.8	86.7	87.5	88.4	89.3	90.1	90.9	91.5	91.2	90.9	90.6	90.2	89.8

7 Two Engine Long Range Cruise

LONG RANGE CRUISE ALL ENGINES A/C AUTO MAX CRUISE THRUST LIMITS	ISA Average %N1 Required Max TAT for Thrust Rating IAS Knots Mach Number ISA Fuel Flow LB/HR/ENG ISA TAS Kts.

PRESSURE ALTITUDE **41000 FT TO 25000 FT**

Press Alt 1000 Feet (Std TAT)	GROSS WEIGHT (1,000 POUNDS)													
	160	155	150	145	140	135	130	125	120	115	110	105	100	95
41 (-30)							93.7 -18 233 0.789 2593 452	91.6 -13 234 0.79 2439 453	90 -9 233 0.79 2312 453	88.6 -5 232 0.786 2195 451	87.4 -2 230 0.78 2090 448	86.3 1 228 0.774 1995 444	85.3 226 0.767 1928 440	84.3 223 0.759 1844 435
39 (-31)				94.3 -19 244 0.787 2878 452	92.2 -14 244 0.79 2715 453	90.5 -10 245 0.79 2580 453	89.1 -6 244 0.788 2461 452	87.9 -2 243 0.785 2349 450	86.9 1 241 0.779 2248 447	86 239 0.773 2156 443	85.1 236 0.767 2070 440	84.2 234 0.76 1988 436	83.3 231 0.752 1911 431	82.3 228 0.743 1851 426
37 (-31)	94.1 -18 255 0.787 3139 451	92.2 -13 256 0.79 2975 453	90.6 -9 256 0.791 2838 453	89.3 -6 256 0.789 2717 453	88.2 -2 255 0.786 2603 451	87.3 1 253 0.782 2499 449	86.4 251 0.777 2403 446	85.5 249 0.771 2315 442	84.7 247 0.765 2230 439	83.9 245 0.759 2149 435	83 242 0.752 2073 431	82.2 240 0.744 1996 427	81.2 235 0.732 1910 420	80.1 230 0.718 1841 412
35 (-30)	89.6 -4 268 0.789 2978 455	88.6 -1 267 0.787 2861 454	87.7 2 266 0.783 2753 452	86.9 4 264 0.779 2655 449	86.1 262 0.774 2565 446	85.4 260 0.768 2481 443	84.6 258 0.763 2401 440	83.9 256 0.757 2324 436	83.1 253 0.751 2250 433	82.3 251 0.743 2172 428	81.4 247 0.732 2086 422	80.4 242 0.719 1999 414	79.4 236 0.704 1908 406	78.2 230 0.687 1812 396
33 (-26)	87.6 6 276 0.779 2932 453	86.9 8 275 0.775 2841 451	86.2 273 0.77 2755 448	85.5 271 0.765 2673 445	84.8 269 0.76 2593 442	84.1 267 0.754 2518 439	83.4 264 0.748 2443 435	82.6 261 0.74 2362 430	81.8 257 0.73 2275 425	80.9 253 0.718 2187 418	79.9 248 0.705 2095 410	78.8 242 0.689 1998 401	77.8 236 0.675 1907 393	76.7 231 0.662 1820 385
29 (-20)	84.9 290 0.752 2987 445	84.3 288 0.747 2911 442	83.7 285 0.74 2828 438	83 282 0.731 2741 433	82.3 278 0.722 2653 427	81.5 273 0.711 2562 421	80.6 268 0.699 2467 414	79.7 263 0.686 2368 406	78.8 258 0.675 2277 399	77.9 254 0.664 2187 393	77 249 0.652 2099 386	76.1 244 0.641 2013 379	75.1 240 0.629 1930 372	74.1 235 0.617 1852 365
25 (-15)	82.4 296 0.709 3021 427	81.6 292 0.699 2925 421	80.8 287 0.688 2826 414	80.1 283 0.678 2732 408	79.3 278 0.669 2643 402	78.6 274 0.659 2554 397	77.8 270 0.65 2466 391	77 266 0.64 2380 385	76.2 262 0.63 2297 379	75.3 257 0.62 2217 373	74.4 253 0.61 2137 367	73.4 247 0.597 2052 359	72.3 241 0.583 1966 351	71.1 235 0.569 1878 343

Max TAT not shown where N_1 can be set in ISA + 30°C conditions.
Increase/decrease avg. N_1 required by 1% per 5°C above/below STD TAT.
Increase/decrease fuel flow 1% per 5°C above/below STD TAT.
Increase/decrease TAS by 1 Kt. per 1°C above/below STD TAT.
Interpolate if necessary.

(Continued)

7 Turbulent Air Penetration

TARGET SPEED IASMACH	PRESS ALT 1000 FT	GROSS WEIGHT 1000 LB							
		160	150	140	130	120	110	100	90
		APPROXIMATE POWER SETTING IN %N1 RPM							
280/.76	41				93.1	89.2	86.7	85.1	83.7
	40				90.3	87.6	85.7	84.3	83.0
	35	89.0	87.1	85.7	84.5	83.5	82.5	81.6	81.0
	30	84.9	84.1	83.2	82.5	81.8	81.2	80.7	80.3
	25	81.2	80.3	79.5	78.8	78.1	77.6	77.1	76.7
	20	77.2	76.4	75.7	75.0	74.4	73.9	73.5	73.1
	15	73.4	72.6	72.0	71.3	70.7	70.2	69.7	69.2
	10	69.5	68.8	68.2	67.6	67.1	66.7	66.3	65.9

7 Max Cruise Percent N1

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
41	87.4	88.3	89.3	90.2	91.1	92.0	92.9	93.7	94.6	94.3	93.4	92.7	91.9	91.1
39	87.6	88.5	89.5	90.4	91.3	92.2	93.1	94.0	94.7	94.1	93.4	92.7	92.0	91.3
37	87.8	88.7	89.7	90.6	91.5	92.4	93.3	94.2	94.4	93.8	93.1	92.4	91.6	90.8
35	87.2	88.2	89.1	90.1	91.0	91.9	92.8	93.6	94.5	94.2	93.4	92.7	91.8	91.0
33	86.0	87.0	88.0	88.9	89.9	90.8	91.7	92.6	93.6	94.5	94.2	93.4	92.5	91.6
31	85.4	86.3	87.3	88.2	89.2	90.1	91.0	91.9	92.8	93.7	94.6	94.0	93.1	92.2

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
29	86.2	87.2	88.1	89.0	90.0	90.9	91.8	92.6	93.5	94.3	93.6	92.8	92.0	91.1
27	85.5	86.5	87.4	88.3	89.2	90.1	91.0	91.9	92.8	93.6	93.8	93.0	92.2	91.3
25	85.0	85.9	86.8	87.7	88.6	89.5	90.4	91.3	92.2	93.0	93.9	93.2	92.5	91.6

(8) Two Engine Long Range Cruise

LONG RANGE CRUISE	
ALL ENGINES A/C AUTO MAX CRUISE THRUST LIMITS	ISA Average %N1 Required Max TAT for Thrust Rating IAS Knots Mach Number ISA Fuel Flow LB/HR/ENG ISA TAS Kts.

PRESSURE ALTITUDE **41000 FT TO 25000 FT**

Press Alt 1000 Feet (Std TAT)	GROSS WEIGHT (1,000 POUNDS)													
	175	170	165	160	155	150	145	140	135	130	125	120	115	110
41 (-29)											91.6 -13 235 0.795 2458 456	90.2 -9 235 0.794 2344 455	88.9 -6 234 0.791 2239 454	87.8 -3 232 0.786 2142 451
39 (-30)								92.1 -13 246 0.795 2725 456	90.6 -10 246 0.795 2606 456	89.4 -6 246 0.793 2498 455	88.3 -3 244 0.789 2397 453	87.4 0 243 0.785 2304 450	86.5 2 241 0.78 2216 447	85.7 239 0.774 2139 444
37 (-30)					92 -13 258 0.794 2982 456	90.6 -9 258 0.795 2858 456	89.5 -6 258 0.794 2750 455	88.5 -3 256 0.791 2648 454	87.6 0 255 0.787 2553 452	86.8 2 254 0.783 2463 449	86 252 0.778 2380 446	85.3 250 0.773 2304 443	84.6 248 0.766 2225 439	83.7 244 0.756 2137 434
35 (-28)		91.9 -10 270 0.795 3241 458	90.7 -7 270 0.795 3122 458	89.7 -4 270 0.794 3013 458	88.8 -2 269 0.792 2909 456	88.1 1 268 0.788 2810 454	87.3 3 266 0.784 2717 452	86.6 264 0.78 2630 450	85.9 263 0.776 2553 447	85.3 261 0.771 2480 444	84.5 258 0.764 2400 440	83.7 255 0.754 2314 435	82.8 250 0.742 2221 428	81.7 244 0.726 2116 419
33 (-25)	90.1 -2 282 0.794 3293 462	89.4 0 281 0.791 3190 460	88.7 3 280 0.788 3091 459	88 5 279 0.785 2998 457	87.3 7 277 0.781 2910 454	86.7 9 276 0.777 2831 452	86.1 274 0.773 2756 450	85.5 272 0.768 2679 446	84.7 269 0.76 2595 442	83.9 265 0.751 2507 437	83 261 0.738 2409 429	82.1 255 0.723 2303 421	81 248 0.706 2196 411	80 242 0.69 2095 401
29 (-19)	87.3 13 299 0.773 3322 458	86.8 15 298 0.769 3245 455	86.2 17 295 0.764 3160 452	85.5 292 0.757 3072 448	84.9 289 0.749 2982 443	84.1 284 0.738 2882 437	83.3 279 0.725 2777 429	82.4 273 0.711 2667 421	81.5 268 0.698 2565 413	80.6 262 0.684 2461 405	79.6 256 0.67 2357 396	78.7 251 0.658 2263 389	77.8 247 0.647 2175 383	77 243 0.638 2093 377
25 (-13)	84.7 306 0.729 3335 439	83.9 301 0.718 3228 432	83.2 295 0.706 3120 425	82.4 290 0.695 3018 418	81.6 285 0.683 2915 411	80.8 280 0.671 2810 404	80 275 0.661 2712 398	79.2 271 0.652 2622 392	78.5 267 0.643 2536 387	77.8 264 0.636 2456 383	77 260 0.627 2374 377	76.2 256 0.619 2295 372	75.4 253 0.61 2221 367	74.5 249 0.601 2148 362

Max TAT not shown where N_1 can be set in ISA + 30°C conditions.
Increase/decrease avg. N_1 required by 1% per 5°C above/below STD TAT.
Increase/decrease fuel flow 1% per 5°C above/below STD TAT.
Increase/decrease TAS by 1 Kt. per 1°C above/below STD TAT.
Interpolate if necessary.

(Continued)

8 Turbulent Air Penetration

TARGET SPEED IASMACH	PRESS ALT 1000 FT	GROSS WEIGHT 1000 LB							
		180	170	160	150	140	130	120	110
		APPROXIMATE POWER SETTING IN %N1 RPM							
280/.76	41							89.4	87.1
	40						90.3	87.9	86.1
	35		91.2	89.1	87.4	86.0	84.9	83.9	83.0
	30	87.5	86.4	85.4	84.5	83.7	83.0	82.3	81.7
	25	83.4	82.5	81.6	80.8	80.0	79.3	78.6	78.0
	20	79.4	78.5	77.7	77.0	76.2	75.6	74.9	74.4
	15	75.4	74.6	73.9	73.2	72.5	71.8	71.2	70.7
	10	71.5	70.7	70.0	69.3	68.7	68.1	67.6	67.2

8 Max Cruise Percent N1

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
41	87.2	88.2	89.1	90	90.9	91.8	92.7	93.6	94.4	94.3	93.5	92.7	91.9	91.2
39	87.5	88.4	89.3	90.3	91.2	92.1	93	93.8	94.7	94.4	93.6	93	92.2	91.6
37	87.7	88.6	89.5	90.4	91.3	92.3	93.2	94	94.7	94	93.4	92.7	92	91.3
35	87	88	88.9	89.9	90.8	91.7	92.6	93.4	94.3	94.3	93.7	92.9	92.1	91.3
33	85.7	86.7	87.7	88.6	89.6	90.5	91.5	92.4	93.3	94.2	94.3	93.5	92.7	91.8
29	83.8	84.7	85.7	86.6	87.6	88.5	89.4	90.3	91.2	92.1	92.9	93.8	93.6	92.8

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
25	84.3	85.2	86.1	87	87.9	88.8	89.7	90.5	91.4	92.3	93.1	93.3	92.5	91.6

9 Two Engine Long Range Cruise

LONG RANGE CRUISE ALL ENGINES A/C AUTO MAX CRUISE THRUST LIMITS	ISA Average %N1 Required Max TAT for Thrust Rating IAS Knots Mach Number ISA Fuel Flow LB/HR/ENG ISA TAS Kts.

PRESSURE ALTITUDE 41000 FT TO 25000 FT

Press Alt 1000 Feet (Std TAT)	GROSS WEIGHT (1,000 POUNDS)														
	180	175	170	165	160	155	150	145	140	135	130	125	120	115	110
41 (-29)												92.3 -15 235 .796 2506 456	90.6 -11 235 .795 2384 456	89.4 -7 234 .792 2283 454	88.3 -4 233 .788 2185 452
39 (-30)									92.9 -15 246 .796 2786 456	91.1 -11 246 .796 2650 456	89.9 -8 246 .794 2543 456	88.8 -5 245 .791 2444 454	87.8 -2 243 .787 2350 451	87.0 1 242 .781 2261 448	86.1 239 .774 2176 444
37 (-30)						92.9 -15 258 .796 3049 456	91.1 -11 258 .796 2909 456	90.0 -8 258 .795 2797 456	89.0 -5 257 .793 2699 455	88.1 -2 256 .789 2603 453	87.3 1 254 .785 2513 450	86.5 252 .779 2427 447	85.7 250 .773 2342 443	85.0 247 .765 2258 439	84.1 244 .756 2174 434
35 (-28)		94.3 -27 270 .795 3476 458	92.7 -12 270 .796 3312 459	91.2 -9 270 .796 3177 459	90.2 -6 270 .795 3064 458	89.3 -3 269 .793 2966 457	88.5 -1 268 .790 2866 456	87.8 2 267 .787 2773 454	87.0 4 265 .782 2684 451	86.4 263 .776 2600 448	85.7 261 .770 2517 444	84.9 258 .762 2437 439	84.1 255 .754 2355 435	83.3 252 .745 2270 430	82.4 248 .735 2181 424
33 (-24)	91.5 -6 283 .796 3458 463	90.6 -3 282 .795 3350 462	89.8 -1 282 .793 3252 461	89.1 1 281 .791 3153 460	88.4 4 280 .787 3059 458	87.8 6 278 .783 2969 456	87.1 8 276 .778 2884 453	86.5 274 .772 2801 449	85.9 271 .766 2719 446	85.2 269 .759 2638 441	84.4 266 .752 2554 437	83.6 262 .743 2467 432	82.8 259 .733 2378 427	81.9 254 .723 2288 420	80.9 249 .709 2191 412
29 (-18)	88.3 10 301 .778 3465 460	87.7 12 299 .773 3380 458	87.2 14 297 .768 3294 455	86.6 15 295 .762 3210 451	86.0 292 .756 3126 448	85.3 289 .750 3040 444	84.7 286 .743 2952 440	84.0 283 .735 2863 435	83.3 280 .726 2775 430	82.5 275 .715 2679 423	81.6 270 .703 2579 416	80.7 264 .689 2474 408	79.8 259 .676 2375 400	78.8 254 .664 2278 393	77.9 249 .651 2182 386
25 (-12)	85.9 23 312 .744 3520 448	85.3 309 .737 3431 444	84.7 306 .730 3343 440	84.1 303 .723 3251 435	83.4 298 .713 3154 429	82.7 294 .702 3054 423	81.9 288 .691 2949 416	81.1 283 .680 2848 409	80.3 279 .669 2751 403	79.5 274 .659 2654 397	78.7 270 .649 2558 390	77.8 265 .638 2464 384	77.0 261 .628 2373 378	76.1 256 .618 2286 372	75.2 251 .607 2202 365

Max TAT not shown where N1 can be set in ISA + 30°C conditions.
Increase/decrease avg. N1 required by 1% per 5°C above/below STD TAT.
Increase/decrease fuel flow 1% per 5°C above/below STD TAT.
Increase/decrease TAS by 1 Kt. per 1°C above/below STD TAT.
Interpolate if necessary.

(Continued)

9 Turbulent Air Penetration

TARGET SPEED IASMACH	PRESS ALT 1000 FT	GROSS WEIGHT 1000 LB							
		180	170	160	150	140	130	120	110
		APPROXIMATE POWER SETTING IN %N1 RPM							
280/.76	41						93.9	89.9	87.6
	40						90.9	88.4	86.5
	35		92.0	89.5	87.8	86.4	85.3	84.4	83.4
	30	88.0	86.9	85.8	84.9	84.1	83.3	82.7	82.1
	25	83.9	83.0	82.0	81.2	80.4	79.7	79.1	78.4
	20	79.9	79.0	78.1	77.3	76.6	75.9	75.3	74.8
	15	75.8	75.0	74.3	73.6	72.9	72.2	71.6	71.1
	10	72.0	71.2	70.4	69.7	69.1	68.5	67.9	67.5

9 Max Cruise Percent N1

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
41	87.2	88.2	89.1	90.0	90.9	91.8	92.7	93.6	94.4	94.4	93.5	92.8	92.0	91.3
39	87.4	88.4	89.3	90.2	91.1	92.1	92.9	93.8	94.7	94.5	93.6	93.0	92.3	91.7
37	87.6	88.6	89.5	90.4	91.3	92.2	93.1	94.0	94.9	94.3	93.5	92.9	92.2	91.5
35	87.0	88.0	88.9	89.8	90.8	91.7	92.5	93.4	94.2	94.5	93.7	93.1	92.4	91.7
33	85.7	86.7	87.7	88.6	89.6	90.5	91.5	92.4	93.3	94.2	94.6	93.9	93.1	92.3
29	83.8	84.7	85.7	86.6	87.5	88.5	89.4	90.3	91.2	92.0	92.9	93.8	93.6	92.9

MAX CRUISE PERCENT N1

PRESS ALT 1000 FT	TAT DEG C													
	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
25	85.1	86.0	86.9	87.8	88.7	89.6	90.5	91.3	92.2	93.0	93.2	92.5	91.7	90.8

③ 3 5 Buffet Boundary

1.3 G Buffet Boundaries
Low / High IAS

FLT LVL	WEIGHT - 1,000 LBS.								
	90	95	100	105	110	115	120	125	130
370	188/258	197/254	204/251	211/249	220/247	233/233			
350	185/273	192/270	199/268	206/265	213/263	220/259	228/257	239/251	
330	181/292	188/289	195/286	202/282	208/279	215/276	222/275	228/273	235/270
310	177/305	184/305	191/304	198/301	204/298	211/295	217/293	223/291	230/289
290	174/319	181/319	187/319	193/319	200/319	207/315	213/311	218/309	225/306
270	171/333	177/333	184/333	190/333	196/333	203/333	209/333	215/330	220/327
250	169/340	175/340	181/340	187/340	193/340	199/340	205/340	211/340	216/340

7 Buffet Boundary

1.3 G Buffet Boundaries
Low / High IAS

FLT LVL	WEIGHT - 1,000 LBS.								
	110	115	120	125	130	135	140	145	150
410	199/243	204/243	211/243	218/238					
390	195/255	200/255	207/255	211/255	217/255	224/251	232/244		
370	192/267	197/267	203/267	208/267	213/267	219/267	224/267	231/266	235/263
350	187/279	192/279	198/279	203/279	209/279	215/279	221/279	227/279	230/279
330	184/292	189/292	194/292	199/292	205/292	211/292	217/292	223/292	227/292
310	180/306	185/306	190/306	194/306	200/306	206/306	211/306	218/306	223/306
290	180/319	182/319	187/319	191/319	196/319	201/319	207/319	213/319	218/319
270	189/333	189/333	189/333	189/333	193/333	198/333	203/333	209/333	213/333
250	197/340	197/340	197/340	197/340	197/340	197/340	200/340	205/340	209/340

8 Buffet Boundary

1.3 G Buffet Boundaries
Low / High IAS

FLT LVL	WEIGHT - 1,000 LBS.									
	120	130	135	140	145	150	155	160	165	170
410	211/242									
390	206/255	218/255	224/251	233/245						
370	202/267	213/267	218/267	224/267	230/267	237/262	245/255			
350	198/279	209/279	215/279	221/279	225/279	231/279	236/279	241/279	248/274	256/269
330	193/292	204/292	210/292	216/292	221/292	227/292	232/292	237/292	242/292	247/292
310	189/306	200/306	206/306	211/306	217/306	223/306	228/306	233/306	238/306	242/306
290	186/319	197/319	202/319	207/319	212/319	218/319	223/319	228/319	234/319	238/319
270	189/333	193/333	198/333	203/333	208/333	213/333	219/333	223/333	228/333	237/333
250	197/340	197/340	197/340	200/340	204/340	209/340	215/340	219/340	223/340	228/340

9 Buffet Boundary

1.3 G Buffet Boundaries
Low / High IAS

FLT LVL	WEIGHT - 1,000 LBS.									
	120	130	135	140	145	150	155	160	165	170
410	211/241									
390	206/254	218/254	224/251	233/245						
370	203/267	213/267	218/267	224/267	230/266	237/262	244/256			
350	198/279	210/279	215/279	221/279	225/279	230/279	235/279	240/278	247/274	254/270
330	194/292	205/292	211/292	217/292	222/292	227/292	231/292	236/292	241/292	246/292
310	190/305	201/305	206/305	212/305	218/305	223/305	227/305	232/305	236/305	242/305
290	187/318	197/318	202/318	208/318	213/318	218/318	222/318	227/318	233/318	238/318
270	188/332	193/332	199/332	204/332	209/332	213/332	218/332	222/332	228/332	233/332
250	197/340	197/340	198/340	201/340	205/340	210/340	215/340	218/340	223/340	228/340

3 3 5 Holding

Based On:
Flaps Up
V_{MIN} Drag
(210 knots lower limit)

$\%N_1$
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1,000 LBS											
	135	130	125	120	115	110	105	100	95	90	85	80
37000			90.7 238 2850	88.5 235 2640	87.0 232 2490	85.6 228 2360	84.3 224 2240	83.0 220 2120	81.7 215 2010	80.4 210 1910	79.2 210 1830	78.1 210 1760
35000	89.9 248 3010	88.2 245 2830	86.9 242 2680	85.6 238 2560	84.5 235 2440	83.3 230 2320	82.1 225 2210	80.9 221 2110	79.6 216 2000	78.4 210 1900	77.2 210 1820	76.1 210 1750
30000	84.2 254 2850	83.2 250 2740	82.2 246 2630	81.2 241 2530	80.2 237 2420	79.1 231 2310	77.9 226 2210	76.8 220 2110	75.5 214 2000	74.2 210 1910	73.1 210 1840	72.1 210 1770
25000	80.1 255 2860	79.1 250 2760	78.2 245 2650	77.2 240 2540	76.1 235 2440	74.9 230 2340	73.8 224 2230	72.7 218 2130	71.4 212 2030	70.2 210 1940	69.2 210 1880	68.2 210 1810
20000	76.0 253 2860	75.1 248 2760	74.2 243 2660	73.2 238 2550	72.1 233 2450	70.9 227 2350	69.8 222 2260	68.4 216 2160	67.1 210 2060	66.1 210 2000	65.0 210 1930	64.0 210 1870
15000	72.1 251 2900	71.1 246 2800	70.0 241 2700	69.0 236 2600	67.9 230 2500	66.7 225 2410	65.5 219 2310	64.3 214 2220	63.1 210 2130	62.1 210 2070	61.1 210 2000	60.1 210 1950
10000	68.0 248 2960	67.0 244 2860	66.0 239 2770	64.9 233 2670	63.9 228 2580	62.8 223 2480	61.6 218 2390	60.4 212 2300	59.3 210 2220	58.4 210 2150	57.4 210 2090	56.5 210 2030
5000	64.1 246 3050	63.1 242 2960	62.1 237 2860	61.1 232 2770	60.1 227 2670	59.1 223 2580	58.0 218 2490	56.9 213 2400	55.8 210 2310	54.9 210 2180	54.0 210 2180	53.2 210 2120
1500	61.5 246 3130	60.6 241 3040	59.7 237 2950	58.7 232 2850	57.7 228 2760	56.7 223 2660	55.6 214 2480	54.6 214 2480	53.6 210 2390	52.7 210 2320	51.7 210 2250	50.9 210 2190

Note: Fuel flow is based on a racetrack pattern.

For holding in straight and level flight, reduce fuel flow values by 5%.

7 Holding

Based On:
Flaps Up
V_{MIN} Drag
(V_{ref}40 + 70 Knots Lower Limit)

$\%N_1$
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1,000 LBS														
	160	155	150	145	140	135	130	125	120	115	110	105	100	95	90
41000							93.1 224 2610	90.9 219 2420	89.3 214 2280	87.9 209 2150	86.6 204 2050	85.3 199 1940	84.0 194 1840	82.7 189 1740	81.4 183 1640
35000	89.0 246 2950	88.0 242 2820	87.0 238 2700	86.1 234 2590	85.2 229 2480	84.2 225 2380	83.3 220 2290	82.3 216 2190	81.3 211 2100	80.3 206 2000	79.2 201 1930	78.1 196 1840	76.9 191 1750	75.6 186 1660	74.3 181 1580
30000	84.1 243 2810	83.3 239 2720	82.5 235 2620	81.7 231 2530	80.8 226 2440	79.9 222 2340	79.0 218 2250	78.0 213 2160	77.0 209 2070	76.0 204 1980	74.8 200 1890	73.6 195 1830	72.3 190 1750	71.1 185 1670	69.8 180 1590
25000	80.0 241 2750	79.2 237 2660	78.4 233 2570	77.5 229 2480	76.6 225 2380	75.6 220 2300	74.6 216 2210	73.6 212 2130	72.6 207 2050	71.6 203 1970	70.5 198 1890	69.4 193 1850	68.1 188 1770	66.7 183 1690	65.3 179 1610
20000	75.6 239 2760	74.8 235 2680	74.0 231 2600	73.1 227 2520	72.3 223 2440	71.4 219 2360	70.4 215 2270	69.4 210 2190	68.3 206 2100	67.2 201 2020	66.0 197 1940	64.9 192 1860	63.8 188 1800	62.7 183 1720	61.4 179 1640
15000	71.5 237 2820	70.7 234 2730	69.8 230 2640	68.8 226 2560	67.9 222 2470	67.0 217 2390	66.1 213 2300	65.2 209 2220	64.3 205 2140	63.3 201 2060	62.2 196 1980	61.0 192 1890	59.6 187 1840	58.3 182 1760	56.9 179 1680
10000	67.4 236 2840	66.6 232 2750	65.8 229 2670	65.1 225 2590	64.2 221 2500	63.3 217 2420	62.3 213 2340	61.2 209 2260	60.1 204 2170	58.9 200 2090	57.8 196 2010	56.7 191 1930	55.6 187 1850	54.4 182 1800	53.2 179 1720
5000	63.6 236 2870	62.7 232 2780	61.8 228 2700	60.9 224 2620	59.9 220 2540	59.0 216 2460	58.1 212 2370	57.2 208 2290	56.2 204 2210	55.2 199 2130	54.2 195 2050	53.1 190 1970	51.9 186 1890	50.8 182 1850	49.6 179 1770
1500	60.6 235 2910	59.8 231 2830	58.9 228 2750	58.1 224 2670	57.3 220 2590	56.4 216 2510	55.5 212 2420	54.6 208 2340	53.7 203 2260	52.7 199 2190	51.6 194 2110	50.6 190 2030	49.5 185 1950	48.3 182 1910	47.2 179 1840

Note: Fuel flow is based on a racetrack pattern.

For holding in straight and level flight, reduce fuel flow values by 5%.

(8) Holding

Based On:
Flaps Up
V_{MIN} Drag
(Vref40 + 70 Knots Lower Limit)

%N_1
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1,000 LBS																
	180	175	170	165	160	155	150	145	140	135	130	125	120	115	110	105	100
41000											93.4 217 2600	90.9 217 2430	89.4 212 2290	88.1 208 2170	86.8 203 2070	85.5 198 1960	84.2 192 1860
35000		93.5 250 3400	91.5 250 3220	90.1 248 3080	89.1 244 2950	88.2 240 2830	87.2 236 2720	86.3 232 2610	85.3 227 2500	84.4 223 2400	83.4 218 2300	82.5 214 2210	81.5 209 2110	80.4 204 2020	79.3 199 1950	78.2 195 1860	77.0 190 1770
30000	87.3 257 3230	86.6 253 3130	85.8 249 3030	85.1 245 2930	84.3 241 2830	83.5 237 2730	82.7 233 2640	81.8 229 2540	81.0 224 2450	80.1 220 2360	79.1 216 2270	78.1 212 2170	77.1 207 2080	76.0 203 1990	74.9 198 1930	73.7 193 1840	72.4 188 1760
25000	83.1 254 3150	82.4 250 3050	81.7 246 2960	80.9 243 2860	80.1 239 2770	79.3 235 2680	78.5 231 2580	77.6 227 2490	76.7 223 2400	75.7 219 2310	74.7 214 2220	73.7 210 2140	72.7 205 2060	71.7 201 1990	70.6 196 1910	69.5 192 1870	68.2 187 1790
20000	78.8 252 3130	78.1 248 3040	77.3 245 2950	76.5 241 2860	75.7 237 2780	74.9 233 2690	74.0 229 2610	73.2 225 2530	72.3 221 2450	71.5 217 2370	70.5 213 2290	69.5 208 2200	68.4 204 2120	67.3 200 2040	66.2 195 1950	65.1 191 1900	64.0 186 1820
15000	74.6 250 3180	73.9 246 3090	73.1 243 3010	72.4 239 2920	71.6 235 2830	70.8 231 2750	69.9 228 2660	69.0 224 2570	68.0 220 2490	67.1 216 2400	66.2 212 2320	65.3 207 2240	64.4 203 2160	63.4 199 2080	62.4 195 1990	61.2 190 1910	59.8 186 1860
10000	70.5 249 3200	69.7 245 3110	69.0 242 3020	68.2 238 2940	67.5 234 2860	66.7 230 2770	66.0 227 2690	65.2 223 2610	64.4 219 2520	63.5 215 2440	62.5 211 2360	61.4 207 2280	60.3 202 2200	59.2 198 2120	58.1 194 2030	57.0 189 1950	55.9 186 1870
5000	66.7 248 3220	66.1 244 3140	65.4 241 3050	64.6 237 2970	63.8 234 2890	62.9 230 2810	62.0 226 2730	61.1 222 2650	60.1 218 2560	59.2 214 2480	58.3 210 2400	57.4 206 2320	56.5 202 2240	55.5 197 2160	54.5 193 2080	53.4 189 2000	52.3 186 1920
1500	64.0 247 3270	63.2 243 3190	62.4 240 3110	61.6 236 3020	60.8 233 2940	60.0 229 2860	59.2 225 2780	58.3 222 2700	57.5 218 2620	56.7 214 2540	55.8 209 2460	54.9 205 2380	54.0 201 2300	53.0 196 2220	52.0 192 2140	50.9 189 2060	49.8 186 1990

Note: Fuel flow is based on a racetrack pattern.

For holding in straight and level flight, reduce fuel flow values by 5%.

9 Holding

Based On:
Flaps Up
V_{MIN} Drag
($V_{ref}40$ + 70 knots lower limit)

$\%N_1$
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1,000 LBS																
	180	175	170	165	160	155	150	145	140	135	130	125	120	115	110	105	100
41000											94.2	92.0	90.1	88.8	87.3	85.9	84.6
											222	217	212	208	203	197	192
											2680	2500	2350	2210	2110	1990	1890
35000		94.2	92.5	90.9	89.8	88.8	87.8	86.7	85.8	84.8	83.8	82.8	81.8	80.7	79.6	78.4	77.2
		255	252	248	244	240	236	232	227	223	218	214	209	204	200	195	190
		3510	3320	3160	3020	2890	2770	2650	2540	2440	2330	2230	2140	2040	1970	1880	1780
30000	87.7	87.0	86.2	85.4	84.6	83.8	83.0	82.1	81.2	80.3	79.3	78.3	77.3	76.2	75.1	73.8	72.5
	257	253	249	245	241	237	233	229	225	220	216	211	207	202	198	193	188
	3290	3180	3070	2970	2870	2770	2670	2570	2470	2380	2280	2190	2100	2000	1940	1850	1770
25000	83.4	82.7	81.9	81.1	80.3	79.5	78.6	77.8	76.9	75.9	74.9	73.8	72.8	71.8	70.7	69.6	68.3
	254	250	246	243	239	235	231	227	223	218	214	210	205	201	196	192	187
	3180	3080	2980	2890	2790	2700	2600	2510	2410	2320	2240	2150	2070	1990	1910	1870	1790
20000	79.0	78.3	77.5	76.6	75.8	75.0	74.1	73.3	72.4	71.5	70.6	69.6	68.5	67.3	66.2	65.1	64.0
	252	248	244	241	237	233	229	225	221	217	213	208	204	200	195	191	187
	3150	3060	2960	2880	2790	2700	2620	2540	2460	2370	2290	2210	2120	2040	1960	1880	1830
15000	74.6	73.9	73.2	72.5	71.7	70.8	69.9	69.0	68.1	67.2	66.3	65.4	64.5	63.5	62.5	61.3	60.0
	250	246	243	239	235	231	228	224	220	216	212	207	203	199	194	190	187
	3190	3100	3010	2930	2840	2750	2670	2580	2490	2410	2330	2250	2160	2080	2000	1920	1880
10000	70.5	69.7	69.0	68.3	67.5	66.8	66.0	65.3	64.4	63.6	62.6	61.5	60.4	59.3	58.2	57.1	56.1
	249	245	242	238	234	230	227	223	219	215	211	206	202	198	194	190	187
	3200	3120	3030	2950	2860	2780	2700	2620	2530	2450	2370	2290	2210	2130	2050	1960	1890
5000	66.8	66.1	65.5	64.7	63.9	63.0	62.1	61.2	60.3	59.4	58.5	57.5	56.6	55.7	54.6	53.6	52.5
	247	244	241	237	233	229	226	222	218	214	210	206	202	197	193	190	187
	3230	3150	3060	2980	2900	2820	2740	2660	2580	2500	2420	2330	2250	2170	2090	2020	1940
1500	64.1	63.3	62.5	61.7	60.9	60.1	59.3	58.5	57.7	56.9	56.0	55.1	54.2	53.2	52.2	51.2	50.1
	247	243	240	236	232	229	225	222	218	214	209	205	201	197	193	190	187
	3280	3200	3120	3040	2960	2880	2790	2710	2630	2550	2470	2390	2310	2230	2160	2080	2010

Note: Fuel flow is based on a racetrack pattern.

For holding in straight and level flight, reduce fuel flow values by 5%.

③ 3 5 Alternate Planning

All Engine

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		80,000 to 90,000	90,000 to 100,000	100,000 to 114,000	
		Fuel – Lbs.			
50 & Less	:13	1350	1400	1490	10,000
100	:21	2050	2150	2280	21,000
150	:29	2640	2780	2980	27,000
200	:35	3180	3350	3610	31,000
300	:49	4160	4410	4790	35,000
400	1:03	5170	5490	5980	35,000
500	1:17	6190	6570	7170	35,000
600	1:31	7210	7660	8380	35,000

Conditions: Climb at 280/.74
Cruise at Long Range Cruise
Descent at .74/280

7 Alternate Planning

All Engine

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		100,000 to 110,000	110,000 to 120,000	120,000 to 128,000	
		Fuel – Lbs.			
50 & Less	:13	1340	1410	1470	10,000
100	:22	2070	2180	2260	19,000
150	:29	2700	2830	2930	23,000
200	:36	3260	3420	3550	27,000
300	:49	4270	4500	4690	35,000
400	1:03	5300	5570	5800	35,000
500	1:16	6240	6600	6900	37,000
600	1:29	7190	7650	8070	39,000

Conditions: Climb at 280/.78
Cruise at Long Range Cruise
Descent at .78/280

8 Alternate Planning

All Engine

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		120,000 to 130,000	130,000 to 140,000	140,000 to 144,000	
		Fuel – Lbs.			
50 & Less	:13	1500	1570	1600	10,000
100	:22	2320	2430	2470	19,000
150	:30	3020	3170	3220	23,000
200	:37	3680	3850	3920	27,000
300	:50	4870	5110	5220	35,000
400	1:03	6020	6320	6450	35,000
500	1:16	7180	7540	7700	35,000
600	1:30	8340	8770	8950	35,000

Conditions: Climb at 280/.78
Cruise at Long Range Cruise
Descent at .78/280

9 Alternate Planning

All Engine

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		120,000 to 130,000	130,000 to 140,000	140,000 to 146,300	
		Fuel – Lbs.			
50 & Less	:13	1510	1580	1630	10,000
100	:22	2340	2450	2520	19,000
150	:30	3060	3200	3290	23,000
200	:37	3720	3900	4010	27,000
300	:50	4930	5180	5340	35,000
400	1:03	6100	6410	6610	35,000
500	1:16	7280	7650	7900	35,000
600	1:30	8460	8900	9260	35,000

Conditions: Climb at 280/.78
Cruise at Long Range Cruise
Descent at .78/280

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NON-NORMAL

Inflight Diversion

In the event a flight must be diverted while enroute (both engines remain operating) and performance information is not readily available from Dispatch and/or Load Planning, it is recommended that the flight crew refer to the TWO ENGINE LONG RANGE CRUISE CHART (located in this section) for planning purposes.

WARNING: FMC Calculated fuel predictions are based on gear and flaps up during climb, cruise and descent. Any prolonged flight with gear and/or flaps extended will increase fuel required and will not be displayed correctly on the FMC fuel prediction pages.

Dirftdown / Terrain Clearance Weight Restrictions

When a flight is planned over high terrain, the Dispatch Release considers single engine operation at the most critical segments of the flight. The MAX GTOW could be restricted by Terrain Clearance (TC) or Driftdown (DD) performance criteria. This restriction is pre-faced with **"Subject to the following conditions…PLAN 3… (TC or DD)…"**. The dispatch Driftdown and Terrain Clearance weights are based on net aircraft performance using the APU as the bleed source for pressurization below 17,000 ft. Therefore, if APU bleed air is placarded inoperative, an additional dispatch weight penalty may be incurred due to the engine bleed required for pressurization. All of the following One Engine Inoperative performance charts are based upon gross aircraft performance using bleed air from the operating engine for pressurization and may differ slightly from dispatch calculations.

In the event of an engine failure during cruise, it will generally be necessary to reduce speed and descend to a lower altitude. Immediately following engine failure, set Max Continuous Thrust Limit %N1 and allow the aircraft to descend at the optimum driftdown speed shown in the single engine cruise page of the FMC or the driftdown table. The aircraft should level off at the altitude and weight shown. If terrain clearance is critical, maintain the level off altitude and allow the aircraft to accelerate to the Long Range Cruise speed shown. If terrain clearance is not critical, the aircraft may be accelerated immediately to Long Range Cruise speed with a resulting loss in altitude of up to 3,000 feet. When the Long Range Cruise speed is achieved, follow a level flight cruise procedure at the airspeed appropriate to the aircraft weight.

Terrain Clearance

A Terrain Clearance limited MAX GTOW considers loss of an engine at cruise, descent at an optimum speed or rate to a lower level-off altitude, that if maintained, would guarantee a minimum 1,000 ft. terrain clearance above the highest feature over the entire length of the planned flight route.

Driftdown

A Driftdown limited MAX GTOW allows a greater takeoff weight than the Terrain Clearance weight, but in the event of engine loss, the flight must land at an alternate airport. (The 1000' terrain clearance guarantee is lost with the higher takeoff weights.) These airports are designated as Driftdown Alternates on the flight plan, and as such must meet all alternate airport criteria. The standard mountain clearance of 2000 ft. is maintained with the Driftdown profiles.

③ 3 5 Initial Max Continuous %N1- One Engine Inop

PRESS ALT FEET	TAT °C - .74M A/C AUTO (HIGH)												
	-50	-40	-30	-25	-20	-15	-10	-5	0	5	10	15	20
37000	90.0	92.0	94.0	94.9	95.4	94.9	94.6	94.4	94.1	93.8	93.5	93.1	92.7
35000	89.5	91.5	93.4	94.4	95.3	95.0	94.7	94.5	94.2	93.9	93.6	93.2	92.8
33000	88.3	90.3	92.2	93.2	94.1	95.0	94.7	94.5	94.2	93.9	93.6	93.2	92.8
31000	87.3	89.2	91.1	92.0	93.0	93.9	94.7	94.5	94.2	93.9	93.6	93.2	92.8
29000	86.4	88.3	90.2	91.1	92.0	93.0	93.9	94.6	94.3	94.0	93.7	93.3	92.9
27000	85.5	87.4	89.2	90.1	91.0	91.9	92.8	93.7	94.3	94.0	93.7	93.3	92.9

③ 3 5 Driftdown Speed / Level Off - One Engine Inop

WEIGHT 1000 LBS		OPTIMUM DRIFT DOWN SPEED	LEVEL OFF ALTITUDE - FT		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
140	135	235	17000	16000	14600
130	124	227	18600	17900	17000
120	115	218	20600	19600	18300
110	106	209	23300	22200	21000
100	96	199	26200	25200	24100
90	87	190	29200	28300	27300

7 Initial Max Continuous %N1 - One Engine Inop

.78M, ENGINE BLEEDS FOR PACKS HIGH AND A/I OFF									
TAT	PRESSURE ALTITUDE 1000 FEET								
°C	25	27	29	31	33	35	37	39	41
20	96.1	95.9	95.7	95.5	95.3	94.7	94.3	94.0	93.0
15	96.7	96.5	96.3	96.2	96.0	95.5	95.1	94.8	94.0
10	97.4	97.2	96.9	96.8	96.7	96.2	95.8	95.6	94.9
5	97.8	97.9	97.7	97.5	97.5	97.0	96.6	96.4	95.8
0	97.1	98.3	98.6	98.4	98.3	97.8	97.5	97.3	96.7
-5	96.3	97.6	98.8	99.2	99.1	98.6	98.3	98.1	97.7
-10	95.5	96.8	98.0	99.3	99.9	99.5	99.2	99.0	98.7
-15	94.7	96.1	97.2	98.5	99.8	100.5	100.2	99.9	99.7
-20	93.9	95.3	96.4	97.7	99.0	100.2	100.7	100.5	100.3
-25	93.1	94.5	95.7	96.9	98.1	99.3	99.9	99.7	99.5
-30	92.3	93.7	94.8	96.0	97.3	98.5	99.0	98.8	98.7
-35	91.5	92.9	94.0	95.2	96.5	97.6	98.2	98.0	97.8
-40	90.6	92.0	93.2	94.4	95.6	96.8	97.3	97.1	96.9

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE 1000 FEET								
	25	27	29	31	33	35	37	39	41
ENG A/I ON	-1.0	-1.0	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8
ENG & WING A/I ON	-3.7	-3.9	-4.0	-4.7	-4.5	-4.8	-4.8	-4.8	-5.0

7 Driftdown Speed / Level Off - One Engine Inop

WEIGHT 1000 LBS		OPTIMUM DRIFT DOWN SPEED	LEVEL OFF ALTITUDE - FT		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
160	153	250	19200	18000	16600
150	144	242	21200	20000	18700
140	134	235	23300	22200	21000
130	125	226	25400	24500	23500
120	115	218	27500	26700	25800
110	106	209	29700	28900	28000

100 ft/min residual rate of climb

8 9 Initial Max Continuous % N1 - One Engine Inop

.79M, ENGINE BLEEDS FOR PACKS HIGH AND A/I OFF									
TAT	PRESSURE ALTITUDE 1000 FEET								
°C	25	27	29	31	33	35	37	39	41
20	96.9	96.7	96.4	96.2	96.0	95.5	95.0	94.8	94.0
15	97.5	97.2	97.0	96.8	96.7	96.3	95.8	95.6	94.9
10	98.1	97.9	97.6	97.5	97.4	97.0	96.6	96.4	95.8
5	98.3	98.7	98.4	98.2	98.2	97.8	97.4	97.2	96.7
0	97.6	98.8	99.2	99.1	99.0	98.6	98.3	98.0	97.6
-5	96.8	98.1	99.2	99.9	99.8	99.3	99.0	98.8	98.5
-10	96.1	97.3	98.4	99.7	100.6	100.2	99.9	99.7	99.5
-15	95.3	96.5	97.7	98.9	100.2	101.1	100.8	100.6	100.4
-20	94.5	95.7	96.9	98.1	99.4	100.6	101.1	100.9	100.7
-25	93.7	94.9	96.1	97.3	98.6	99.7	100.3	100.1	99.9
-30	92.9	94.1	95.3	96.5	97.7	98.9	99.4	99.2	99.1
-35	92.1	93.3	94.4	95.6	96.9	98.0	98.6	98.4	98.2
-40	91.3	92.5	93.6	94.8	96.0	97.2	97.7	97.5	97.3

% N1 Adjustments For Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE 1000 FEET								
	25	27	29	31	33	35	37	39	41
ENG A/I ON	-1.0	-1.0	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8
ENG & WING A/I ON	-3.7	-3.9	-4.0	-4.7	-4.5	-4.8	-4.8	-4.8	-5.0

8 Driftdown Speed / Level Off - One Engine Inop

WEIGHT 1000 LBS			LEVEL OFF ALTITUDE – FT		
START DRIFT DOWN	LEVEL OFF	OPTIMUM DRIFT DOWN SPEED	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
180	173	265	18800	17700	16700
170	163	258	20300	19300	18200
160	154	251	21700	20800	19800
150	144	243	23100	22300	21400
140	135	235	24700	23900	23000
130	125	226	26500	25600	24800
120	115	218	28400	27600	26700
110	106	209	30300	29600	28700

100 ft/min residual rate of climb

9 Driftdown Speed / Level Off - One Engine Inop

WEIGHT 1000 LBS			LEVEL OFF ALTITUDE – FT		
START DRIFT DOWN	LEVEL OFF	OPTIMUM DRIFT DOWN SPEED	ISA + 10°C & BELOW	ISA + 20°C	ISA + 30°C
180	173	267	18300	17100	15900
170	163	261	19800	18700	17500
160	154	252	21200	20200	19100
150	145	243	22600	21700	20700
140	135	234	24100	23200	22300
130	125	225	25900	24900	24000
120	116	216	27900	27000	26000
110	106	206	29900	29100	28100

100 ft/min residual rate of climb

③ 3 Altitude Capability - LRC - One Engine Inop
Max Continuous Thrust

WEIGHT 1000 LB	PRESSURE ALTITUDE - FT		
	ISA + 10°C BELOW	ISA + 15°C	ISA + 20°C
140	10,600	4,400	4,400
130	13,800	10,500	8,800
120	17,000	15,000	12,800
110	18,700	17,800	16,300
100	21,100	19,600	18,600
90	24,800	23,100	21,300
80	28,800	27,200	25,600
70	32,300	31,500	30,100

Based on A/C Auto (HIGH)

5 Altitude Capability - LRC - One Engine Inop
Max Continuous Thrust

WEIGHT 1000 LB	PRESSURE ALTITUDE		
	ISA + 10°C & Below	ISA + 15°C	ISA + 20°C
140	11,100	5,700	5,000
130	14,300	12,100	9,700
120	17,200	15,500	13,300
110	19,000	18,000	16,900
100	21,500	19,800	18,900
90	25,200	23,600	21,800
80	29,000	27,600	26,000

Based on A/C AUTO (HIGH)

7 Altitude Capability - LRC - One Engine Inop
Max Continuous Thrust

WEIGHT 1000 LB	PRESSURE ALTITUDE		
	ISA + 10°C & Below	ISA + 15°C	ISA + 20°C
155	18000	15500	12900
150	19300	16800	14400
145	20500	18000	15800
140	21600	19300	17100
135	22800	20900	18500
130	24000	22300	19900
125	25200	23600	21300
120	26400	24900	22700
115	27600	26300	24100

Based on A/C AUTO

8 Altitude Capability - LRC - One Engine Inop
Max Continuous Thrust

WEIGHT 1000 LB	PRESSURE ALTITUDE		
	ISA + 10°C & Below	ISA + 15°C	ISA + 20°C
180	15300	12800	10500
175	16300	13900	11700
170	17200	15300	12900
165	18200	16300	14100
160	19100	17300	15200
155	20100	18400	16200
150	20800	19400	17200
145	21500	20300	18200
140	22200	21100	19300
135	23000	21800	20200
130	23800	22600	21100
125	24600	23400	22000
120	25600	24300	22900

Based on A/C AUTO

9 Altitude Capability - LRC - One Engine Inop
Max Continuous Thrust

WEIGHT 1000 LB	PRESSURE ALTITUDE		
	ISA + 10°C & Below	ISA + 15°C	ISA + 20°C
180	15500	13500	10800
175	16500	14700	12000
170	17400	15700	13300
165	18300	16600	14600
160	19300	17600	15600
155	20100	18600	16600
150	20800	19600	17600
145	21600	20400	18700
140	22300	21200	19800
135	23100	22000	20600
130	23900	22800	21500
125	24700	23600	22400
120	25800	24500	23200

Based on A/C AUTO

③ 3 5 LRC Mach Schedule - One Engine Inop

WEIGHT 1000 LB	PRESSURE ALTITUDE - 1000 FT									
	12	14	16	18	20	22	24	26	28	30
140	.58	.59								
130	.56	.58	.59	.61						
120	.54	.56	.58	.59	.61					
110	.52	.54	.56	.57	.59					
100	.50	.52	.54	.56	.57	.59	.61			
90	.48	.49	.51	.53	.55	.57	.59	.60	.62	
80	.45	.47	.48	.50	.52	.54	.56	.58	.60	.61

7 LRC Mach Schedule - One Engine Inop

WEIGHT 1000 LB	PRESSURE ALTITUDE - 1000 FT									
	12	14	16	18	20	22	24	26	28	30
160	.54									
150	.52	.54	.57							
140	.51	.53	.55	.57	.59					
130	.49	.51	.53	.55	.57	.59				
120	.47	.49	.51	.53	.55	.57	.59			
110	.45	.47	.48	.51	.53	.55	.57	.59	.60	
100	.43	.45	.46	.48	.50	.52	.55	.57	.59	.60

8 LRC Mach Schedule - One Engine Inop

WEIGHT	PRESSURE ALTITUDE - 1000 FT									
1000 LB	12	14	16	18	20	22	24	26	28	30
180	.57	.59	.60							
170	.55	.57	.59	.61						
160	.53	.56	.58	.60	.61					
150	.52	.54	.56	.59	.60	.62				
140	.50	.52	.54	.56	.59	.60	.62			
130	.48	.50	.52	.54	.57	.59	.60			
120	.47	.48	.50	.52	.54	.57	.59	.61		
110	.45	.46	.48	.50	.52	.54	.57	.59	.61	
100	.43	.44	.46	.48	.50	.52	.54	.57	.59	.61

9 LRC Mach Schedule - One Engine Inop

WEIGHT	PRESSURE ALTITUDE - 1000 FT									
1000 LB	12	14	16	18	20	22	24	26	28	30
180	.56	.57	.59							
170	.55	.56	.58	.59						
160	.53	.55	.57	.58	.59					
150	.52	.54	.55	.57	.58	.60				
140	.51	.52	.54	.55	.57	.59				
130	.49	.51	.53	.54	.56	.57	.59			
120	.48	.49	.51	.53	.54	.56	.57	.59		
110	.46	.48	.49	.51	.52	.54	.56	.57	.59	
100	.44	.46	.47	.49	.51	.52	.54	.56	.57	.59

③ 3 5 Alternate Planning – One Engine Inoperative

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		80,000 to 90,000	90,000 to 100,000	100,000 to 114,000	
		Fuel – Lbs.			
100 & Less	:23	2040	2140	2280	19,000
150	:31	2710	2840	3030	19,000
200	:38	3390	3540	3770	19,000
300	:55	4740	4960	5270	19,000
400	1:11	6100	6380	6780	19,000
500	1:26	7470	7810	8290	19,000
600	1:42	8850	9250	9820	19,000

Conditions: Climb at 280/.74
Cruise at Single Engine LRC
Descent at .74/280

Note: 19000 ft. is used as an example only. Better fuel mileage will be obtained by flying optimum altitudes.

7 Alternate Planning – One Engine Inoperative

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		100,000 to 110,000	110,000 to 120,000	120,000 to 128,000	
		Fuel – Lbs.			
100 & Less	:23	2040	2140	2220	21,000
150	:31	2690	2810	2910	21,000
200	:40	3340	3480	3600	21,000
300	:56	4640	4840	5000	21,000
400	1:13	5950	6200	6390	21,000
500	1:29	7260	7560	7790	21,000
600	1:46	8590	8930	9200	21,000

Conditions: Climb at 280/.78
Cruise at Single Engine LRC
Descent at .78/280

Note: 21000 ft. is used as an example only. Better fuel mileage will be obtained by flying optimum altitudes.

8 Alternate Planning – One Engine Inoperative

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		120,000 to 130,000	130,000 to 140,000	140,000 to 144,000	
		Fuel – Lbs.			
100 & Less	:23	2310	2420	2460	19,000
150	:32	3050	3180	3230	19,000
200	:40	3790	3950	4010	19,000
300	:56	5290	5480	5560	19,000
400	1:13	6780	7030	7130	19,000
500	1:28	8290	8580	8690	19,000
600	1:44	9800	10140	10270	19,000

Conditions: Climb at 280/.78
Cruise at Single Engine LRC
Descent at .78/280

Note: 19000 ft. is used as an example only. Better fuel mileage will be obtained by flying optimum altitudes.

9 Alternate Planning – One Engine Inoperative

Distance To Alternate	Time To Alternate	Landing Weight – Lbs.			Cruise Altitude To Alternate
		120,000 to 130,000	130,000 to 140,000	140,000 to 146,300	
		Fuel – Lbs.			
100 & Less	:23	2330	2440	2510	19,000
150	:32	3080	3220	3300	19,000
200	:40	3830	3990	4100	19,000
300	:56	5350	5560	5690	19,000
400	1:11	6870	7130	7280	19,000
500	1:28	8400	8700	8890	19,000
600	1:44	9930	10290	10500	19,000

Conditions: Climb at 280/.78
Cruise at Single Engine LRC
Descent at .78/280

Note: 19000 ft. is used as an example only. Better fuel mileage will be obtained by flying optimum altitudes.

③③⑤ Holding - One Engine Inop

Based On:
V_{MIN} Drag
(210 Knots Lower Limit)
A/C Auto (High)
Flaps Up

%N_1
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1,000 LBS											
	135	130	125	120	115	110	105	100	95	90	85	80
30000												90.1 210 3410
25000								90.3 211 4040	88.7 210 3830	87.3 210 3660	86.1 210 3500	84.9 210 3360
20000					89.3 226 4630	88.0 220 4400	86.6 215 4180	85.2 210 3980	84.1 210 3810	82.9 210 3650	81.9 210 3510	80.9 210 3380
15000	89.4 243 5470	88.3 239 5240	87.2 234 5020	86.0 229 4800	84.9 224 4590	83.7 219 4390	82.5 214 4180	81.2 210 3990	80.1 210 3830	79.1 210 3680	78.1 210 3540	77.0 210 3420
10000	85.3 242 5450	84.3 237 5240	83.2 233 5030	82.1 229 4830	81.0 224 4620	79.9 219 4420	78.6 214 4220	77.3 210 4030	76.2 210 3880	75.1 210 3730	74.1 210 3600	73.1 210 3480
5000	81.5 242 5480	80.5 237 5280	79.4 233 5070	78.2 228 4870	77.0 223 4670	75.8 217 4470	74.5 212 4270	73.4 210 4100	72.2 210 3950	71.2 210 3810	70.1 210 3680	69.1 210 3570
1500	78.7 241 5520	77.6 236 5320	76.5 231 5120	75.4 226 4920	74.3 221 4720	73.0 216 4530	71.7 210 4330	70.6 210 4170	69.5 210 4030	68.4 210 3890	67.4 210 3760	66.4 210 3640

Note: Fuel flow is based on a racetrack pattern.

For holding in straight and level flight, reduce fuel flow values by 5%.

7 Holding - One Engine Inop

Based On:
V_{MIN} Drag
(Vref 40 + 70 Knots Lower Limit)
A/C Auto (High)
Flaps Up

%N_1
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1000 LBS							
	160	155	150	145	140	135	130	125
30000								
25000					98.2 225 5010	96.4 220 4730	94.5 216 4450	92.5 212 4200
20000	95.1 239 5480	93.6 235 5250	92.3 231 5040	91.0 227 4830	89.9 223 4630	88.8 219 4450	87.7 215 4260	86.6 210 4080
15000	89.0 237 5330	88.1 234 5140	87.1 230 4960	86.2 226 4780	85.2 222 4600	84.1 217 4420	83.1 213 4240	82.0 209 4070
10000	84.6 236 5260	83.7 232 5090	82.8 229 4910	81.8 225 4740	80.8 221 4570	79.8 217 4400	78.8 213 4230	77.6 209 4070
5000	80.2 236 5250	79.4 232 5080	78.5 228 4920	77.6 224 4750	76.6 220 4590	75.7 216 4420	74.7 212 4260	73.6 208 4090
1500	77.5 235 5270	76.6 231 5110	75.7 228 4940	74.8 224 4780	73.8 220 4610	72.7 216 4450	71.6 212 4290	70.5 208 4130

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PRESSURE ALTITUDE FT.	GROSS WEIGHT 1000 LBS						
	120	115	110	105	100	95	90
30000		98.9 204 4190	96.3 200 3890	94.0 195 3610	91.4 190 3360	89.1 185 3150	87.0 180 2940
25000	90.8 207 3980	89.2 203 3770	87.7 198 3580	86.4 193 3400	85.0 188 3220	83.5 183 3040	82.0 179 2870
20000	85.4 206 3900	84.2 201 3710	83.0 197 3540	81.7 192 3370	80.3 188 3200	78.9 183 3030	77.4 179 2870
15000	80.9 205 3890	79.7 201 3720	78.4 196 3560	77.1 192 3390	75.8 187 3230	74.5 182 3080	73.1 179 2920
10000	76.5 204 3900	75.4 200 3740	74.2 196 3580	73.0 191 3420	71.7 187 3260	70.2 182 3100	68.7 179 2950
5000	72.4 204 3930	71.2 199 3770	70.0 195 3610	68.7 190 3460	67.4 186 3300	66.1 182 3150	64.7 179 3010
1500	69.4 203 3971	68.3 199 3820	67.2 194 3670	66.0 190 3510	64.7 185 3360	63.4 182 3210	61.9 179 3060

Note: Fuel flow is based on a racetrack pattern. For holding in straight and level flight, reduce fuel flow values by 5%.

8 Holding - One Engine Inop

Based On:
V_{MIN} Drag
(Vref40 + 70 Knots Lower Limit)
A/C Auto (High)
Flaps Up

%N_1
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1000 LBS							
	180	175	170	165	160	155	150	145
30000								
25000								
20000		99.9 248 6330	98.4 245 6040	96.8 241 5760	95.2 237 5500	93.8 233 5270	92.4 229 5050	91.1 225 4840
15000	92.7 250 6120	91.8 246 5920	90.9 243 5720	90.1 239 5530	89.2 235 5340	88.2 231 5160	87.2 228 4970	86.3 224 4790
10000	88.1 249 6000	87.2 245 5820	86.4 242 5640	85.6 238 5460	84.7 234 5280	83.8 230 5110	82.9 227 4930	82.0 223 4760
5000	83.8 248 5970	83.0 244 5790	82.2 241 5620	81.3 237 5450	80.4 234 5280	79.5 230 5110	78.7 226 4950	77.8 222 4790
1500	80.8 247 5970	80.1 243 5810	79.3 240 5640	78.5 236 5480	77.7 233 5310	76.9 229 5150	76.0 225 4980	75.1 222 4820

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PRESSURE ALTITUDE FT.	GROSS WEIGHT 1000 LBS								
	140	135	130	125	120	115	110	105	100
30000							96.6 198 3910	94.3 193 3630	91.7 188 3370
25000		96.7 219 4750	94.7 214 4470	92.7 210 4210	91.0 205 3990	89.3 201 3790	87.9 196 3590	86.5 192 3410	85.2 187 3230
20000	90.0 221 4640	88.9 217 4460	87.8 213 4270	86.7 208 4090	85.5 204 3910	84.3 200 3730	83.1 195 3560	81.8 191 3390	80.5 186 3220
15000	85.3 220 4610	84.3 216 4440	83.2 212 4260	82.1 207 4090	81.0 203 3910	79.9 199 3740	78.6 195 3580	77.3 190 3420	76.0 186 3260
10000	81.0 219 4590	79.9 215 4420	78.9 211 4260	77.8 207 4100	76.7 202 3930	75.6 198 3770	74.5 194 3610	73.3 189 3450	72.0 186 3290
5000	76.9 218 4620	75.9 214 4460	74.9 210 4300	73.9 206 4130	72.7 202 3970	71.6 197 3810	70.3 193 3660	69.1 189 3500	67.8 186 3350
1500	74.1 218 4660	73.1 214 4500	72.0 209 4340	70.9 205 4180	69.8 201 4030	68.7 196 3880	67.6 192 3720	66.4 189 3570	65.1 186 3410

Note: Fuel flow is based on a racetrack pattern. For holding in straight and level flight, reduce fuel flow values by 5%.

9 Holding - One Engine Inop

Based On:
V_{MIN} Drag
(Vref40 + 70 Knots Lower Limit)
A/C Auto (High)
Flaps Up

%N_1
KIAS
FF/ENG LB/HR

PRESSURE ALTITUDE FEET	GROSS WEIGHT 1000 LBS							
	180	175	170	165	160	155	150	145
30000								
25000								
20000					97.3 237 5820	95.6 233 5530	94.0 229 5270	92.5 225 5040
15000	94.4 250 6450	93.3 246 6220	92.2 243 6000	91.3 239 5780	90.3 235 5580	89.4 231 5370	88.3 228 5170	87.3 224 4970
10000	89.4 249 6300	88.6 245 6100	87.7 242 5900	86.8 238 5700	85.9 234 5510	84.9 230 5310	83.9 227 5120	83.0 223 4930
5000	85.1 247 6260	84.3 244 6060	83.5 241 5870	82.6 237 5680	81.6 233 5490	80.6 229 5310	79.6 226 5120	78.6 222 4940
1500	82.2 247 6250	81.3 243 6060	80.4 240 5880	79.6 236 5690	78.7 232 5510	77.8 229 5330	76.9 225 5150	76.0 222 4980

9

PRESSURE ALTITUDE FT.	GROSS WEIGHT 1000 LBS								
	140	135	130	125	120	115	110	105	100
30000								95.2 193 3720	92.6 188 3440
25000			96.3 214 4660	94.1 210 4370	92.0 205 4110	90.2 201 3890	88.5 196 3680	87.1 192 3480	85.7 187 3290
20000	91.1 221 4820	89.8 217 4610	88.7 213 4410	87.5 208 4210	86.3 204 4020	85.0 200 3830	83.7 195 3640	82.3 191 3450	81.0 187 3280
15000	86.2 220 4780	85.2 216 4580	84.1 212 4390	82.9 207 4200	81.7 203 4020	80.5 199 3830	79.2 194 3660	77.9 190 3480	76.6 187 3330
10000	81.9 219 4750	80.9 215 4560	79.7 211 4380	78.5 206 4200	77.4 202 4030	76.2 198 3850	75.0 194 3680	73.8 190 3520	72.6 187 3360
5000	77.7 218 4770	76.7 214 4590	75.6 210 4410	74.6 206 4240	73.4 202 4060	72.1 197 3880	70.8 193 3720	69.6 190 3560	68.3 187 3410
1500	75.0 218 4800	73.9 214 4620	72.7 209 4440	71.5 205 4270	70.3 201 4100	69.1 197 3930	68.0 193 3770	66.8 190 3620	65.7 187 3480

Note: Fuel flow is based on a racetrack pattern. For holding in straight and level flight, reduce fuel flow values by 5%.

LANDING

NORMAL LANDING LIMITS – ACCULOAD

For dispatch purposes, FARs require that the flight must be planned to arrive at the destination at a weight, which does not exceed the aircraft Structural Landing Limit weight, the Approach Climb Limit weight, the Landing Climb Limit weight or the Landing Field Length Limit weight, for the forecast conditions at the planned destination airport and runway.

Normally, the Landing Limit is computed by ACCULOAD, which presents the most restrictive of the above based on forecast landing conditions, engine bleed for air conditioning ON (packs in AUTO), and the auto speed brakes armed and operative. Adjustments are made for, any non-normal configuration. No credit is taken for use of Thrust Reversers. If the weight limit in the landing regime is more restrictive than the Takeoff or Enroute weight limits, the letter "L" will follow the MAX GTOW on line 8 of the ACCULOAD. Tables are provided to manually calculate the Approach Climb Limit and Landing Field Length Limit for Landing Flap settings of 15, 30 and 40. This data is for dispatch purposes only. Once in flight, only operational limits and procedures apply.

Structural Weight Limit

Under normal circumstances, the landing weight of the B737 is limited by the maximum structural landing weight. Unusual circumstances may require the planned landing weight be reduced from this limit during dispatch.

Approach Climb Limit

The Approach Climb Limit is the maximum allowable planned landing weight for a missed approach with the critical engine inoperative, the gear retracted and the flaps in the approach configuration. This limit is calculated for dispatch purposes based on the altitude at the landing airport and the temperature expected at the time of landing using the scheduled flap setting. Anticipated ice accumulation, Engine and/or Wing Anti Icing penalties are taken into account and noted on line 9 of the ACCULOAD.

Note: The certified approach flap setting varies with aircraft type and planned landing flap setting. For planned landing flaps 30 the approach flap settings are ③ 3 5 – 10° and 7 8 9 – 15°. The landing flaps 40° approach flap setting is 15° for all models.

Crews must understand that the Approach Climb Limit is for dispatch planning only. It does not apply to, nor should it effect, normal operations, procedures and/or flap settings upon arrival. There is no need to "burn down" to the approach climb limit. The Approach Climb Limit is to meet FAR certification and dispatch requirements. It is not runway specific and does not guarantee terrain or obstacle clearance during a missed approach / go-around.

Landing Climb Limit

The Landing Climb Weight Limit is based on an "all engine operating" go around, and is therefore not a limiting factor in the B737 landing performance. Landing Climb Weight Limit data is not presented in this chapter.

Landing Field Length Limit (Runway Limit)

Landing Field Length Limit (Runway Limit) data is presented which provides the maximum weight for stopping on the planned destination runway based upon the forecast arrival conditions. These charts are used for dispatch planning and titled Runway Limit Landing Weight. Normally the Landing Field Length Limit is calculated by ACCULOAD. Adjustments noted on line 9 are made for any forecast head / tail winds, Anti-Skid inoperative, Ground Spoilers inoperative, and/or wet runway. No credit is taken for use of Thrust Reversers. "Landing distances" are further broken down as follows:

Touchdown to Stopping Distance – The manufacturer certified minimum distance from touchdown to a complete stop for that weight, temperature, altitude, and flap setting. This distance is determined under test conditions in an aircraft flown by a test pilot with touchdown at Ref minus 5 knots at the landing flap setting using maximum energy braking with no credit taken for Thrust Reversers. For anti-skid inoperative landing distance, the braking force assumed is reduced brake force determined to be the maximum a "prudent pilot" would use with the anti-skid system inoperative.

Unfactored Landing Distance (Actual Landing Distance) – The Touchdown to Stopping Distance plus distance covered from a threshold crossing height of 50' to the touchdown point (approximately 1000' additional).

Factored Landing Distance – This is Unfactored Landing Distance multiplied by a safety factor of 1.67. For dispatch purposes, the Unfactored Landing Distance for the expected arrival weight and conditions may not exceed the Effective Runway Landing Length for the planned arrival runway.

The FARs require for dispatch that the weight of an aircraft at takeoff, minus planned fuel burn-off, not exceed Effective Runway Landing Limit Weight for the planned arrival runway based upon Factored Landing Distance. The Landing Field Length Limit Weight is for dispatch planning only. Upon arrival at a destination airport, crews need only insure that the effective field length of the landing runway exceeds the Unfactored Landing Distance for their landing weight and conditions.

Caution: Safety margins are reduced when landing on runways shorter than Factored Distances. Crews should carefully evaluate runway conditions, winds, weather, and alternate runways prior to executing such a landing.

MANUAL CALCULATION OF LANDING DATA

In the absence of ACCULOAD the maximum dispatch Landing Limit Weight for a specific runway may be determined manually by flight crews using the following procedures:

1. Determine the maximum Structural Landing Weight for the series aircraft being flown from the Flight Manual, Chapter 1, Limitations.
2. Calculate the Approach Climb Limit Weight as described below.
3. Calculate the Runway Limit Landing Weight as described below.
4. Select the lesser of these three as the Landing Limit Weight.

Under normal circumstances the landing weight of the B737 is limited by the maximum structural landing weight. Only in non-normal cases with very high temperatures, extremely short runways, or with the anti-skid inoperative, will the maximum dispatch landing weight be below the maximum structural landing weight.

Approach Climb Limit

If ACCULOAD is not available, determine the Approach Climb Limit in the following manner:

1. Enter the Approach Climb Limit chart for the appropriate aircraft type and planned flap setting at the forecast ambient temperature, rounded up to the next 10 degree increment, and follow that temperature to the appropriate pressure altitude column. This is the normal Approach Climb Limit weight.
2. Review the notes below the chart and adjust the weight appropriately to derive the Approach Climb Limit Weight for the planned non-normal conditions.

Note: Interpolation is authorized between pressure altitude and temperature when absolute maximum weight is necessary.

③③ Approach Climb Limit Weight

APPROACH CLIMB LIMIT WEIGHT, LB. X 100
LANDING FLAPS 30

°F	PRESSURE ALTITUDE									
	S.L.	1000	2000	3000	4000	5000	5300	6000	7000	8000
-20	1358	1340	1322	1313	1316	1285	1275	1254	1211	1173
0	1356	1339	1320	1311	1314	1282	1272	1251	1208	1170
20	1355	1336	1317	1308	1311	1280	1270	1249	1205	1169
40	1351	1333	1314	1304	1306	1275	1266	1245	1203	1165
60	1345	1328	1310	1300	1304	1271	1261	1240	1200	1157
70	1344	1325	1305	1296	1300	1270	1260	1237	1195	1146
80	1340	1323	1302	1287	1296	1265	1252	1224	1158	1100
90	1320	1292	1260	1265	1264	1222	1207	1175	1110	1045
100	1273	1251	1216	1216	1205	1165	1151	1120	1061	1012
110	1220	1194	1170	1170	1153	1113	1099	1069	1010	953
120	1161	1136	1120	1120	1091	1030	1015	983	NA	NA

APPROACH CLIMB LIMIT WEIGHT, LB. X 100
LANDING FLAPS 40

°F	PRESSURE ALTITUDE									
	S.L.	1000	2000	3000	4000	5000	5300	6000	7000	8000
-20	1325	1307	1288	1278	1281	1247	1235	1212	1167	1129
0	1323	1305	1285	1276	1279	1245	1232	1210	1165	1126
20	1320	1304	1283	1272	1275	1243	1230	1208	1162	1124
40	1316	1300	1279	1269	1272	1238	1225	1204	1159	1120
60	1313	1295	1274	1264	1267	1234	1221	1200	1156	1115
70	1310	1292	1270	1260	1264	1231	1218	1196	1150	1104
80	1307	1288	1263	1251	1260	1228	1212	1182	1113	1055
90	1284	1253	1218	1228	1228	1180	1152	1130	1065	1004
100	1230	1214	1175	1175	1165	1112	1105	1075	1018	972
110	1175	1150	1125	1125	1106	1068	1050	1024	972	913
120	1117	1092	1075	1075	1045	990	967	944	NA	NA

- When icing conditions are forecast during **any** part of the flight, **and** the forecast landing temperature is below 46°F, apply the appropriate Enroute Icing Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- If icing conditions are forecast at the destination for the time of landing, apply the appropriate Anti-Ice Operation Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- For BLEEDS OFF, increase gross weight by 3,000 lbs.

5 Approach Climb Limit Weight

APPROACH CLIMB LIMIT WEIGHT, lb. X 100 LANDING FLAPS 30										
°F	PRESSURE ALTITUDE									
	S.L.	1000	2000	3000	4000	5000	6000	7000	8000	9000
-20	1350	1335	1316	1309	1312	1282	1248	1208	1168	1128
0	1350	1333	1313	1305	1309	1277	1245	1203	1165	1126
20	1346	1328	1310	1302	1305	1275	1243	1200	1163	1125
40	1343	1326	1308	1300	1302	1272	1240	1196	1160	1122
60	1340	1323	1304	1295	1298	1267	1237	1195	1154	1104
70	1337	1320	1300	1293	1295	1263	1233	1188	1143	1075
80	1334	1317	1293	1283	1293	1261	1217	1154	1091	1032
90	1313	1282	1254	1259	1259	1212	1168	1100	1039	985
100	1264	1237	1208	1208	1200	1157	1113	1055	1008	943
110	1210	1187	1161	1161	1147	1106	1060	1003	N/A	N/A
120	1154	1132	1112	1112	1080	1025	N/A	N/A	N/A	N/A

APPROACH CLIMB LIMIT WEIGHT, lb. X 100 LANDING FLAPS 40										
°F	PRESSURE ALTITUDE									
	S.L.	1000	2000	3000	4000	5000	6000	7000	8000	9000
-20	1323	1304	1285	1276	1278	1244	1211	1165	1126	N/A
0	1321	1302	1282	1273	1275	1242	1208	1163	1124	N/A
20	1317	1298	1278	1270	1272	1239	1206	1161	1122	N/A
40	1314	1295	1275	1267	1269	1236	1203	1158	1119	N/A
60	1310	1291	1271	1262	1264	1231	1198	1154	1113	N/A
70	1307	1288	1268	1259	1261	1228	1195	1147	1101	N/A
80	1304	1285	1260	1249	1258	1226	1181	1114	1053	N/A
90	1282	1250	1217	1226	1225	1175	1128	1062	1001	N/A
100	1230	1201	1171	1173	1164	1119	1075	1018	971	N/A
110	1173	1147	1122	1121	1108	1067	N/A	N/A	N/A	N/A
120	1116	1093	1073	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- When icing conditions are forecast during **any** part of the flight, **and** the forecast landing temperature is below 46°F, apply the appropriate Enroute Icing Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- If icing conditions are forecast at the destination for the time of landing, apply the appropriate Anti-Ice Operation Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- For BLEEDS OFF, increase gross weight by 2,900 lbs.

7 Approach Climb Limit Weight

APPROACH CLIMB LIMIT WEIGHT, LB. X 100 LANDING FLAPS 30 AND 40											
°F	PRESSURE ALTITUDE										
	S.L.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-20	1661	1629	1597	1563	1530	1498	1463	1429	1395	1359	1323
0	1659	1627	1595	1562	1528	1496	1461	1428	1393	1350	1322
20	1657	1624	1592	1559	1526	1494	1459	1426	1391	1356	1320
40	1653	1620	1587	1554	1521	1490	1455	1423	1389	1353	1317
60	1646	1613	1581	1548	1516	1485	1451	1419	1370	1316	1263
70	1642	1610	1578	1546	1513	1469	1410	1354	1302	1251	1199
80	1638	1607	1566	1500	1448	1392	1338	1286	1234	1183	1135
90	1601	1543	1485	1428	1374	1322	1270	1219	1170	1123	1078
100	1521	1464	1410	1357	1305	1255	1205	1157	1111	N/A	N/A
110	1442	1389	1337	1287	1239	1190	N/A	N/A	N/A	N/A	N/A
120	1366	1316	1267	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- When icing conditions are forecast during **any** part of the flight, **and** the forecast landing temperature is below 46°F, apply the appropriate Enroute Icing Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- If icing conditions are forecast at the destination for the time of landing, apply the appropriate Anti-Ice Operation Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- For BLEEDS OFF, increase gross weight by 2,800 lbs.

8 Approach Climb Limit Weight

APPROACH CLIMB LIMIT WEIGHT, LB. X 100 LANDING FLAPS 30 AND 40											
°F	PRESSURE ALTITUDE										
	S.L.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-20	1775	1734	1691	1639	1588	1539	1489	1441	1395	1350	1307
0	1774	1732	1689	1638	1586	1537	1488	1440	1394	1349	1305
20	1772	1730	1687	1635	1584	1535	1486	1438	1392	1346	1302
40	1767	1726	1683	1632	1580	1532	1483	1435	1389	1343	1298
60	1760	1720	1678	1327	1576	1528	1480	1432	1380	1327	1276
70	1757	1717	1675	1625	1574	1521	1463	1408	1356	1304	1252
80	1753	1713	1666	1602	1545	1486	1432	1378	1319	1266	1216
90	1718	1659	1605	1547	1496	1441	1383	1322	1261	1211	1160
100	1634	1580	1527	1476	1424	1377	1319	1256	1200	N/A	N/A
110	1556	1505	1455	1405	1351	1297	N/A	N/A	N/A	N/A	N/A
120	1481	1428	1371	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- When icing conditions are forecast during **any** part of the flight, **and** the forecast landing temperature is below 46°F, apply the appropriate Enroute Icing Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- If icing conditions are forecast at the destination for the time of landing, apply the appropriate Anti-Ice Operation Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- For BLEEDS OFF, increase gross weight by 2,800 lbs.

9 Approach Climb Limit Weight

APPROACH CLIMB LIMIT WEIGHT, LB. X 100 APPROACH FLAPS 15 / LANDING FLAPS 30 AND 40											
°F	PRESSURE ALTITUDE										
	S.L.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-20	1795	1753	1711	1659	1609	1560	1510	1460	1409	1364	1320
0	1793	1752	1709	1658	1607	1558	1509	1458	1408	1362	1318
20	1791	1750	1707	1655	1604	1556	1507	1456	1405	1359	1315
40	1787	1745	1703	1652	1601	1552	1503	1452	1403	1356	1311
60	1780	1740	1698	1647	1597	1548	1500	1448	1394	1340	1289
70	1776	1736	1695	1645	1594	1541	1483	1422	1369	1317	1264
80	1772	1733	1686	1622	1566	1507	1449	1391	1331	1278	1228
90	1737	1679	1625	1567	1516	1459	1396	1335	1273	1222	1171
100	1655	1601	1547	1496	1438	1390	1332	1268	1212	N/A	N/A
110	1577	1526	1474	1419	1364	1309	N/A	N/A	N/A	N/A	N/A
120	1502	1443	1384	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- When icing conditions are forecast during **any** part of the flight, **and** the forecast landing temperature is below 46°F, apply the appropriate Enroute Icing Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- If icing conditions are forecast at the destination for the time of landing, apply the appropriate Anti-Ice Operation Penalty to the Approach Climb Limit by the weight indicated in the **Operating in Icing Conditions** chart, this section.
- For BLEEDS OFF, increase gross weight by 3,100 lbs.

Runway Landing Limit Weight

If ACCULOAD is unavailable, use the following method to manually calculate the maximum dispatch Landing Field Limit Weight.

1. Select the Runway Landing Limit Weight chart for the appropriate aircraft type and planned flap setting.
2. Determine the Effective Runway Landing Length as described below.
3. Interpolating as necessary, reference this Effective Runway Landing Length with the Pressure Altitude of the selected runway to determine the normal, zero wind Runway Landing Limit Weight.
4. Adjust this weight for any forecast head / tail winds and non-normal conditions as specified below each individual chart.

Effective Runway Landing Length

The Effective Runway Landing Length is the available length used to calculate the aircraft maximum landing weights. This length is the physical length (as published by Jeppesen) corrected for threshold displacement, obstacle clearance requirements or glide slope displacement. The Effective Runway Landing Length for each of the runways for CAL airports is listed in ACCULOAD. For runways that have been temporarily shortened, consult the appropriate NOTAMS. If unable to contact Load Planning, Effective Runway Landing Length can be determined by the crew as the lesser of:

1. Jeppesen Published Runway Length (page 10-9).
2. Runway Length beyond Glide Slope touchdown point, plus 1000 feet.
3. Shortened Length indicated by current NOTAM.

③❸ Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 30 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet * **				
	4000	5000	6000	7000	8000 +
0	94200	118100	134000	134000	134000
1000	91200	116100	133200	134000	134000
2000	88500	114000	130800	134000	134000
3000	86000	112000	128500	134000	134000
4000	83600	110000	126300	134000	134000
5000	81300	107000	124000	134000	134000
6000	79000	104000	122000	134000	134000
7000	76800	101000	119800	132500	134000
8000	N/A	98000	117500	130200	134000

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- ** For Auto Speedbrakes inoperative subtract 600 ft. from the Effective Runway Landing Length, and use that adjusted length to determine the maximum weight for the original Effective Runway Landing Length. For a specific aircraft weight, add 600 ft. to the Effective Runway Landing Length for that weight to determine the minimum Effective Runway Landing Length for Auto Speedbrakes inoperative.
- Add 370 lb/kt for forecast headwind.
- Subtract 2000 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

③③ Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 40 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE				
Pressure Altitude	Effective Landing Length – Feet * **			
	4000	5000	6000	7000 +
0	98100	122500	138700	140000
1000	95100	120400	136500	140000
2000	92600	118400	134300	140000
3000	90200	116000	132300	140000
4000	88000	112800	129800	140000
5000	85100	110600	128000	140000
6000	82600	107800	126000	137900
7000	80500	105100	123800	135800
8000	78000	102400	121500	133500

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- ** For Auto Speedbrakes inoperative subtract 500 ft. from the Effective Runway Landing Length, and use that adjusted length to determine the maximum weight for the original Effective Runway Landing Length. For a specific aircraft weight, add 500 ft. to the Effective Runway Landing Length for that weight to determine the minimum Effective Runway Landing Length for Auto Speedbrakes inoperative.
- Add 390 lb/kt for forecast headwind.
- Subtract 2000 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

③③ Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 15 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet * **				
	4000	5000	6000	7000	8000+
0	84700	108000	123000	136000	140000
1000	82200	106200	120900	133700	140000
2000	80100	104400	119000	131400	140000
3000	77800	102500	116900	129300	139200
4000	75600	99500	115000	127100	136800
5000	N/A	96700	113000	124900	134700
6000	N/A	94000	111000	122900	132400
7000	N/A	91100	109100	120900	129900
8000	N/A	88500	107100	118800	127800

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- ** For Auto Speedbrakes inoperative subtract 650 ft. from the Effective Runway Landing Length, and use that adjusted length to determine the maximum weight for the original Effective Runway Landing Length. For a specific aircraft weight, add 650 ft. to the Effective Runway Landing Length for that weight to determine the minimum Effective Runway Landing Length for Auto Speedbrakes inoperative.
- Add 360 lb/kt for forecast headwind.
- Subtract 2000 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

5 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 30 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE				
Pressure Altitude	Effective Landing Length – Feet * **			
	4000	5000	6000	7000+
0	92000	117700	135000	140000
1000	89250	115500	132500	140000
2000	86750	113500	130000	140000
3000	84000	111200	127500	140000
4000	81600	106000	125300	139500
5000	79300	104750	122800	136800
6000	76750	101500	120500	134300
7000	74500	96400	118200	131500
8000	72250	95250	115750	129200

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- ** For Auto Speedbrakes inoperative subtract 450 ft. from the Effective Runway Landing Length, and use that adjusted length to determine the maximum weight for the original Effective Runway Landing Length. For a specific aircraft weight, add 450 ft. to the Effective Runway Landing Length for that weight to determine the minimum Effective Runway Landing Length for Auto Speedbrakes inoperative.
- Add 400 lb/kt for forecast headwind.
- Subtract 2000 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

(5) Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 40 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE				
Pressure Altitude	Effective Landing Length – Feet * **			
	4000	5000	6000	7000+
0	96200	123300	140000	140000
1000	93400	121000	139250	140000
2000	90500	118800	136600	140000
3000	87900	116250	134000	140000
4000	85300	113000	131500	140000
5000	82900	109500	129000	140000
6000	80250	106200	126500	140000
7000	77900	103000	124100	138000
8000	75500	99900	121500	135250

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- ** For Auto Speedbrakes inoperative subtract 450 ft. from the Effective Runway Landing Length, and use that adjusted length to determine the maximum weight for the original Effective Runway Landing Length. For a specific aircraft weight, add 450 ft. to the Effective Runway Landing Length for that weight to determine the minimum Effective Runway Landing Length for Auto Speedbrakes inoperative.
- Add 475 lb/kt for forecast headwind.
- Subtract 2100 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

5 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 15 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet * **				
	4000	5000	6000	7000	8000+
0	84000	108000	123500	137900	140000
1000	81600	106100	121300	135500	140000
2000	79200	104200	119100	133000	140000
3000	76800	101500	116800	130500	140000
4000	74600	98500	114700	128000	138100
5000	72300	95600	112500	125600	135600
6000	70100	92600	110500	123200	133100
7000	N/A	89900	108400	120800	130500
8000	N/A	87100	106400	118300	128000

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- ** For Auto Speedbrakes inoperative subtract 450 ft. from the Effective Runway Landing Length, and use that adjusted length to determine the maximum weight for the original Effective Runway Landing Length. For a specific aircraft weight, add 450 ft. to the Effective Runway Landing Length for that weight to determine the minimum Effective Runway Landing Length for Auto Speedbrakes inoperative.
- Add 190 lb/kt for forecast headwind.
- Subtract 2000 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

7 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 30 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet *				
	4000	5000	6000	7000	8000+
0	104900	134200	163100	180000	180000
1000	101800	131100	158700	180000	180000
2000	98700	128100	154500	176900	180000
3000	95700	125100	150500	173700	180000
4000	92800	122100	146500	170500	180000
5000	90000	119200	142800	167100	180000
6000	N/A	116400	139300	163400	180000
7000	N/A	113600	135800	158900	177100
8000	N/A	110600	132500	154600	173900
9000	N/A	107000	129200	150300	170500
10000	N/A	103500	126000	146100	167000

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 11,000 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 400 lb/kt for forecast headwind.
- Subtract 2500 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

7 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 40 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet *				
	4000	5000	6000	7000	8000+
0	107100	137800	167500	180000	180000
1000	103900	134700	162900	180000	180000
2000	100800	131600	158500	180000	180000
3000	97700	128600	154300	178500	180000
4000	94700	125500	150200	175200	180000
5000	91800	122400	146200	171600	180000
6000	N/A	119400	142400	166700	180000
7000	N/A	116200	138800	161900	180000
8000	N/A	112700	135400	157500	178000
9000	N/A	109100	132000	153100	174500
10000	N/A	105400	128600	148800	170400

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 10,300 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 400 lb/kt for forecast headwind.
- Subtract 3000 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

7 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 15 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet *				
	4000	5000	6000	7000	8000+
0	100300	127700	154400	173900	180000
1000	97200	124800	150500	170800	180000
2000	94300	121900	146600	167400	180000
3000	91400	119000	142900	164100	180000
4000	N/A	116200	139400	160900	177500
5000	N/A	113500	136100	157700	174300
6000	N/A	110800	132700	154600	171100
7000	N/A	108200	129500	150700	167600
8000	N/A	105600	126300	146700	164200
9000	N/A	102400	123200	142700	160800
10000	N/A	99100	120100	139100	157600

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 11,500 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 500 lb/kt for forecast headwind.
- Subtract 2500 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

8 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT
30 FLAPS ZERO WIND
ANTI-SKID OPERATIVE
AUTO GROUND SPOILER OPERATIVE

Pressure Altitude	Effective Landing Length – Feet *				
	4000	5000	6000	7000	8000+
0	96000	125400	151700	178800	190000
1000	93200	122600	147900	175300	190000
2000	90500	119700	144100	170700	190000
3000	N/A	116900	140600	166200	187300
4000	N/A	114200	137300	161800	183800
5000	N/A	110900	134000	157500	180400
6000	N/A	107600	130800	153300	177000
7000	N/A	104300	127700	149200	172500
8000	N/A	101100	124600	145300	167800
9000	N/A	97900	121500	141500	163200
10000	N/A	94900	118500	138000	158700

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 11,500 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 475 lb/kt for forecast headwind.
- Subtract 2100 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

8 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 40 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet *				
	4000	5000	6000	7000	8000+
0	104100	134400	163200	190000	190000
1000	101200	131400	159000	188000	190000
2000	98300	128400	154900	183700	190000
3000	95500	125500	150900	178800	190000
4000	92700	122600	147000	174000	190000
5000	90000	119600	143300	169400	190000
6000	N/A	116100	139900	164900	189300
7000	N/A	112700	136600	160400	185400
8000	N/A	109300	133300	156100	180400
9000	N/A	106000	130100	151900	175300
10000	N/A	102700	127000	147800	170300

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 9,000 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 500 lb/kt for forecast headwind.
- Subtract 2500 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

8 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 15 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE				
Pressure Altitude	Effective Landing Length – Feet *			
	5000	6000	7000	8000
0	117300	141200	166000	183700
1000	114600	138000	162900	180400
2000	111900	134700	158700	177100
3000	109300	131500	154500	173800
4000	106700	128400	150400	170600
5000	103900	125400	146500	167500
6000	100800	122400	142700	164300
7000	97700	119400	139200	160400
8000	94700	116500	135800	156000
9000	91700	113700	132500	151800
10000	N/A	110900	129200	147600

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 8,500 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 520 lb/kt for forecast headwind.
- Subtract 2300 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

9 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 30 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure	Effective Landing Length – Feet *				
Altitude	4000	5000	6000	7000	8000
0	90500	120600	150900	177000	190000
1000	N/A	117800	142800	173000	190000
2000	N/A	115000	139200	168700	188300
3000	N/A	111800	135800	164500	184900
4000	N/A	108400	132500	160300	181600
5000	N/A	105100	129200	156400	178400
6000	N/A	101800	126000	152400	174800
7000	N/A	98600	122900	144600	170400
8000	N/A	95500	119800	140300	166000
9000	N/A	92400	116800	136800	161700
10000	N/A	N/A	113800	133200	157500

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 12,500 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 610 lb/kt for forecast headwind.
- Subtract 2900 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

9 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 40 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE					
Pressure Altitude	Effective Landing Length – Feet *				
	4000	5000	6000	7000	8000
0	100200	132200	165300	190000	190000
1000	97200	129000	161300	188600	190000
2000	94300	125900	157400	184800	190000
3000	91400	122900	153500	180200	190000
4000	N/A	119800	148700	175600	190000
5000	N/A	116100	141500	171200	190000
6000	N/A	112500	137900	166900	189900
7000	N/A	109000	134500	162700	186500
8000	N/A	105500	131100	158500	181700
9000	N/A	102100	127800	154400	177000
10000	N/A	98800	124500	150400	172300

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 11,900 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 550 lb/kt for forecast headwind.
- Subtract 2700 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

9 Runway Landing Limit Weight

RUNWAY LANDING LIMIT WEIGHT 15 FLAPS ZERO WIND ANTI-SKID OPERATIVE AUTO GROUND SPOILER OPERATIVE				
Pressure Altitude	Effective Landing Length – Feet *			
	5000	6000	7000	8000
0	110900	134500	163000	179600
1000	108300	131200	159100	176500
2000	105700	128100	155200	173400
3000	102800	124900	151300	170300
4000	99600	121800	143100	167300
5000	96600	118900	139500	164400
6000	93600	115900	136000	160900
7000	90600	113100	132500	156800
8000	N/A	110200	129200	152800
9000	N/A	107400	125900	145500
10000	N/A	104700	122700	140600

- * For dispatch to a wet or slippery runway, divide the Effective Runway Landing Length by 1.15 and use that length to enter the chart.
- Subtract 12,200 lbs. from the Runway Landing Limit Weight when auto speedbrakes not operative.
- Add 500 lb/kt for forecast headwind.
- Subtract 2600 lb/kt for forecast tailwinds.
- Interpolation may be used in the tables.

Example Landing Problem – Pre-Departure (③)

The following example illustrates the manual (ACCULOAD unavailable) method to obtain the maximum allowable dispatch landing weight at a particular airport for the forecast landing conditions, ambient temperature, wind, terrain, etc.

Note: Examples for the non-normal operations such as anti-skid inoperative can be found in the non-normal portion of this section.

Destination Airport	----------	AAA
Field Elevation	----------	4,000 ft.
Runway Length	----------	7,000 ft.
Flap Setting	----------	30
Anti-Skid	----------	Normal
Auto Ground Spoilers	----------	Normal
Forecast Temperature	----------	27°C
Forecast Wind Dir./Vel.	----------	070/10
Forecast Rwy Condition	----------	Dry

Approach Climb Limit Calculation (-300):

From the Approach Climb Limit Weight chart for landing flap 30, the maximum approach climb limit weight at 4,000 ft. pressure altitude and 27°C is 129,600 lbs.

Runway Limit Calculation:

From the Runway Limit chart for flaps 30 degree landing, the zero wind maximum weight at 4,000 ft. pressure altitude and 7,000 ft. runway length is 134,000 lbs. The headwind correction for flaps 30 is 370 lbs./knot. For 10 knots headwind, the correction is 10 x 370 or 3,700 lbs. The maximum runway limit landing weight is then 134,000 + 3,700 = 137,700 lbs.

Answer:

The approach climb and runway limit weight are both well above the maximum structural weight. Therefore, the maximum structural landing weight of 114,000 lbs. is the landing weight limit.

③ ❸ $V_{(REF)}$ Speeds

WEIGHT	FLAPS		
1000 LB	15	30	40
135	160	149	147
132	158	147	145
128	155	144	142
124	153	142	140
120	151	140	137
116	148	138	135
112	145	135	132
108	142	133	129
104	140	130	126
100	137	127	123
96	134	124	120
92	130	122	118
88	127	119	115
84	124	116	112
82	121	115	111

❺ $V_{(REF)}$ Speeds

WEIGHT	FLAPS		
1000 LB	15	30	40
130	153	143	139
126	151	141	136
122	148	139	134
118	146	137	132
114	143	134	130
110	140	132	128
106	137	130	126
102	134	127	123
98	132	125	121
94	129	122	118
90	126	119	115
86	123	116	112
82	120	113	109
78	117	110	107

7 $V_{(REF)}$ Speeds

WEIGHT 1000 LB	FLAPS		
	15 *	30	40
170	159	153	151
160	155	149	147
150	150	144	142
140	145	140	137
130	139	134	132
120	133	129	126
110	127	123	120
100	121	117	114
90	115	111	108

* **Flaps 15 approaches**: If icing conditions are experienced or anticipated prior to landing, set Vref @ Vref + 10.

8 $V_{(REF)}$ Speeds

WEIGHT 1000 LB	FLAPS		
	15 *	30	40
180	174	165	157
170	169	160	153
160	164	156	148
150	159	151	144
140	154	146	139
130	148	141	133
120	142	135	128
110	135	129	122
100	129	123	116
90	122	116	109

* **Flaps 15 approaches**: If icing conditions are experienced or anticipated prior to landing, set Vref @ Vref + 10.

9 $V_{(REF)}$ Speeds

WEIGHT 1000 LB	FLAPS 15 *	FLAPS 30	FLAPS 40
180	176	165	156
170	171	161	150
160	166	156	146
150	160	151	141
140	158	149	139
130	152	143	134
120	146	138	129
110	140	132	123
100	133	125	117
90	126	119	111

* **Flaps 15 approaches**: If icing conditions are experienced or anticipated prior to landing, set Vref @ Vref + 10.

③ ③ ⑤ Max Go-Around % N1

VALID FOR 2 PACKS ON (AUTO) ENGINE A/I ON OR OFF											
OAT		TAT	AIRPORT PRESSURE ALTITUDE FEET								
°C	°F	°C	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	58	90.5	91.1	91.8	93.0	94.2	93.9	93.6	94.6	95.6
50	122	53	91.0	91.6	92.2	93.6	94.6	94.4	94.2	94.8	95.4
45	113	48	91.5	92.1	92.6	93.9	94.9	94.8	94.8	94.9	95.1
40	104	43	92.1	92.5	93.0	94.3	95.3	95.3	95.3	95.1	94.8
35	95	38	92.5	93.0	93.4	94.8	95.9	95.9	95.9	95.1	94.5
30	86	33	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	28	92.0	92.8	93.5	94.5	95.9	96.3	96.8	96.3	95.7
20	68	23	91.2	92.0	92.8	93.8	95.1	95.5	96.0	96.0	96.0
15	59	18	90.4	91.2	92.0	93.0	94.3	94.7	95.2	95.3	95.4
10	50	13	89.6	90.4	91.2	92.1	93.4	93.9	94.3	94.4	94.6
5	41	8	88.8	89.6	90.4	91.3	92.6	93.0	93.5	93.6	93.8
0	32	3	88.0	88.8	89.5	90.5	91.8	92.2	92.6	92.7	92.9
-10	14	- 8	86.4	87.2	87.9	88.8	90.1	90.5	90.9	91.0	91.2
-20	- 4	-18	84.8	85.5	86.2	87.1	88.3	88.8	89.2	89.3	89.5
-30	-22	-28	83.1	83.8	84.5	85.4	86.6	87.0	87.4	87.5	87.7
-40	-40	-38	81.3	81.2	82.7	83.6	84.8	85.2	85.6	85.7	85.9
-50	-58	-48	79.6	80.3	80.9	81.8	82.9	83.3	83.7	83.8	84.0

% N1 Bleed Adjustments

CONFIGURATION	TAT °C	
	-60	+60
BLEEDS OFF	+0.8	+1.0
WING A/I		
ALL ENGINES	-1.3	-1.6
1 ENGINE INOP	-2.1	-2.6

7 Max Go-Around % N_1

2 A/C PACKS ON, ENGINE AND WING A/I ON OR OFF													
OAT		TAT	AIRPORT PRESSURE ALTITUDE FEET										
°F	°C	°C	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
134	57	60	91.8	91.8	91.7	91.7	91.6	91.6	91.7	91.5	91.4	91.1	91.2
125	52	55	92.6	92.6	92.5	92.5	92.5	92.4	92.4	92.4	92.2	92.0	91.6
116	47	50	93.3	93.3	93.3	93.3	93.3	93.2	93.2	93.1	93.0	92.8	92.6
108	42	45	94.1	94.1	94.1	94.0	94.0	94.0	93.9	93.9	93.8	93.7	93.5
99	37	40	94.9	94.9	94.8	94.8	94.7	94.7	94.6	94.6	94.6	94.5	94.4
90	32	35	95.8	95.8	95.7	95.7	95.6	95.6	95.5	95.4	95.3	95.3	95.2
81	27	30	95.4	95.9	96.4	96.5	96.5	96.4	96.3	96.3	96.2	96.1	96.1
72	22	25	94.9	95.5	96.1	96.7	97.3	97.3	97.2	97.1	97.0	97.0	96.9
63	17	20	94.2	94.7	95.3	95.9	96.5	97.2	97.9	98.3	98.2	98.1	98.0
54	12	15	93.4	94.0	94.5	95.2	95.8	96.5	97.2	97.9	98.7	99.4	99.4
45	7	10	92.6	93.2	93.8	94.4	95.0	95.7	96.4	97.1	97.9	98.7	99.5
36	2	5	91.8	92.4	93.0	93.6	94.2	94.9	95.6	96.4	97.1	98.0	98.8
27	-3	0	91.0	91.6	92.2	92.8	93.4	94.1	94.8	95.6	96.4	97.2	98.1
18	-8	-5	90.2	90.8	91.4	92.0	92.6	93.3	94.0	94.8	95.6	96.4	97.3
9	-13	-10	89.4	90.0	90.6	91.1	91.8	92.5	93.2	94.0	94.8	95.7	96.5
1	-17	-15	88.6	89.2	89.7	90.3	90.9	91.7	92.4	93.2	94.0	94.9	95.8
-8	-22	-20	87.8	88.3	88.9	89.5	90.1	90.8	91.6	92.3	93.2	94.1	95.0
-17	-27	-25	86.9	87.5	88.1	88.6	89.3	90.0	90.7	91.5	92.3	93.3	94.2
-26	-32	-30	86.1	86.7	87.2	87.8	88.4	89.2	89.9	90.7	91.5	92.5	93.4
-35	-37	-35	85.2	85.8	86.3	86.9	87.6	88.3	89.0	89.8	90.7	91.6	92.6
-44	-42	-40	84.4	84.9	85.5	86.1	86.7	87.4	88.2	89.0	89.8	90.8	91.8
-53	-47	-45	83.5	84.1	84.6	85.2	85.8	86.6	87.3	88.1	89.0	90.0	90.1

%N_1 Bleed Adjustments

BLEED CONFIGURATION	PRESSURE ALTITUDE FEET						
	-2000	0	2000	4000	6000	8000	10000
BLEEDS OFF	0.7	0.7	0.7	0.8	0.8	0.8	0.9

8 9 Max Go-Around %N1

2 A/C PACKS ON, ENGINE AND WING A/I ON OR OFF													
OAT		TAT	AIRPORT PRESSURE ALTITUDE FEET										
°F	°C	°C	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
134	57	60	96.2										
125	52	55	96.7	96.6	96.8	97.5							
116	47	50	97.6	97.8	97.8	97.7	97.5	98.2					
108	42	45	98.4	98.5	98.6	98.7	98.8	98.7	98.5	98.5			
99	37	40	99.1	99.2	99.3	99.4	99.5	99.6	99.5	99.1	98.9	98.8	99.2
90	32	35	99.9	100.0	100.1	100.1	100.3	100.3	100.2	99.9	99.6	99.6	99.5
81	27	30	99.5	100.1	100.6	100.6	100.6	100.6	100.5	100.4	100.3	100.2	100.1
72	22	25	99.1	99.7	100.3	100.6	100.9	100.9	100.9	100.9	100.9	100.9	100.8
63	17	20	98.3	98.9	99.5	99.8	100.2	100.5	100.9	101.0	101.0	101.0	101.0
54	12	15	97.6	98.2	98.7	99.1	99.4	99.8	100.1	100.5	100.9	101.3	101.2
45	7	10	96.8	97.4	98.0	98.3	98.7	99.0	99.4	99.8	100.2	100.5	100.9
36	2	5	96.0	96.6	97.2	97.6	97.9	98.3	98.7	99.0	99.4	99.8	100.2
27	-3	0	95.2	95.8	96.4	96.8	97.2	97.5	97.9	98.3	98.7	99.0	99.4
18	-8	-5	94.4	95.0	95.6	96.0	96.4	96.8	97.2	97.5	97.9	98.3	98.6
9	-13	-10	93.6	94.2	94.8	95.2	95.6	96.0	96.4	96.8	97.1	97.5	97.9
1	-17	-15	92.8	93.4	94.0	94.4	94.8	95.2	95.6	96.0	96.4	96.7	97.1
-8	-22	-20	92.0	92.6	93.2	93.6	94.0	94.4	94.8	95.2	95.6	95.9	96.3
-17	-27	-25	91.1	91.8	92.4	92.8	93.2	93.6	94.1	94.4	94.8	95.2	95.5
-26	-32	-30	90.3	90.9	91.6	92.0	92.4	92.8	93.3	93.6	94.0	94.3	94.7
-35	-37	-35	89.4	90.1	90.7	91.1	91.6	92.0	92.4	92.8	93.2	93.5	93.9
-44	-42	-40	88.6	89.2	89.9	90.3	90.7	91.2	91.6	92.0	92.3	92.7	93.1
-53	-47	-45	87.7	88.3	89.0	89.4	89.9	90.3	90.8	91.2	91.5	91.9	92.2

%N1 Bleed Adjustments

BLEED CONFIGURATION	PRESSURE ALTITUDE FEET						
	-2000	0	2000	4000	6000	8000	10000
BLEEDS OFF	0.7	0.9	0.9	1.0	1.0	1.0	1.0

NON-NORMAL

ACCULOAD Adjustments

ACCULOAD will adjust the Max Landing Weight for known non-normal conditions. A code will appear on line 9 of the ACCULOAD Pilot Weight Manifest indicating which penalties have been applied. If conditions vary from those indicated by ACCULOAD the crew should inform Load Planning and obtain a new ACCULOAD that reflects the actual conditions.

Wet or Slippery Runway

For a definition of wet or slippery runway, refer to **Runway Condition** this chapter of the Flight Manual. Adjustments to the Runway Limit Landing Weight are made by dividing the available landing distance by 1.15 and entering the Runway Landing Weight Limit chart with this adjusted distance. Refer to the Continental Flight Operations Manual for conditions under which a wet or slippery should be anticipated and landing weight restricted.

Contaminated Runway

There are no additional penalties associated with landing on contaminated (cluttered) runways. Adjustments to the Runway Limit Landing Weight for wet or slippery runways are considered adequate for these conditions and should be applied.

Observe the following operational parameters when landing on contaminated runways:

- Maximum water / slush depth: 1 inch
- Maximum snow depth: 6 inches

Anti-Skid Inoperative

Flights may be dispatched with anti-skid inoperative to dry runways only. Under these conditions ACCULOAD will make the appropriate adjustment to the Runway Limited Landing Weight and reflect the penalty code on line 9.

WARNING: Landing on a wet or slippery runway with anti-skid inoperative is not authorized.

Should the anti-skid system fail enroute, a manual determination of the stopping distance will be required. This can be done with reference to the Actual Landing Distance (unfactored) tables. Stopping distances are based on Boeing Test Pilot performance using maximum manual braking, landing with flaps 40.

③ 3

ANTI-SKID INOPERATIVE RUNWAY LIMITED LANDING WEIGHT 40 FLAPS						
PRESS ALT	RUNWAY LENGTH					
	7000	8000	9000	10000	11000	12000
0	98000	114500	130400	140000	140000	140000
1000	95100	111500	127100	140000	140000	140000
2000	92400	108500	123700	138900	140000	140000
3000	89500	105600	120500	135300	140000	140000
4000	87000	102900	117400	131800	140000	140000
5000	84500	100000	114300	128200	140000	140000
6000	82000	97200	111400	125100	138600	140000
7000	79700	94400	108500	121800	134900	140000
8000	77400	91600	105500	118500	131300	140000

Add 400 lb/kt for forecast headwind.
Subtract 2500 lb/kt for forecast tailwinds.
Landing on a wet runway with the Anti-Skid Inoperative is not authorized.

5

ANTI-SKID INOPERATIVE RUNWAY LIMITED LANDING WEIGHT 40 FLAPS						
PRESS ALT	RUNWAY LENGTH					
	7000	8000	9000	10000	11000	12000
0	99900	119200	139500	140000	140000	140000
1000	97000	115600	135100	140000	140000	140000
2000	94100	112000	130700	140000	140000	140000
3000	91400	108600	126600	140000	140000	140000
4000	88700	105300	112600	140000	140000	140000
5000	86200	102100	118700	136000	140000	140000
6000	83600	98900	114900	131500	140000	140000
7000	81100	95800	111200	127200	140000	140000
8000	78600	92900	107700	123000	138800	140000

Add 400 lb/kt for forecast headwind.
Subtract 3200 lb/kt for forecast tailwinds.
Landing on a wet runway with the Anti-Skid Inoperative is not authorized.

7

ANTI-SKID INOPERATIVE RUNWAY LIMITED LANDING WEIGHT 40 FLAPS					
Pressure	RUNWAY LENGTH				
Altitude	8000	9000	10000	11000	12000
0	108000	125500	143000	162000	180000
1000	104600	121700	138600	156500	174700
2000	101400	117900	134400	151200	169100
3000	97900	114000	130200	145900	162900
4000	94300	110000	125700	140800	156900
5000	91200	106400	121500	136300	151400
6000	N/A	102900	117500	131800	146000
7000	N/A	99400	113600	127400	141000
8000	N/A	96000	110000	123200	136400
9000	N/A	92600	106100	119100	131800
10000	N/A	N/A	102200	114900	127300

Add 700 lb/kt for forecast headwind.
Subtract 3800 lb/kt for forecast tailwinds.
Landing on a wet runway with the Anti-Skid Inoperative is not authorized.

8

ANTI-SKID INOPERATIVE RUNWAY LIMITED LANDING WEIGHT 40 FLAPS					
Pressure	RUNWAY LENGTH				
Altitude	8000	9000	10000	11000	12000
0	105900	122200	138300	155800	174300
1000	102900	118700	134500	150900	168800
2000	99200	114700	130000	145500	162800
3000	95500	110600	125500	140400	156700
4000	91700	106400	121100	135600	150800
5000	N/A	103100	117300	131500	145700
6000	N/A	99700	113600	127400	141000
7000	N/A	96400	109900	123300	136700
8000	N/A	93100	106300	119400	132400
9000	N/A	N/A	102700	115500	128100
10000	N/A	N/A	99200	111600	124000

Add 790 lb/kt for forecast headwind.
Subtract 3500 lb/kt for forecast tailwinds.
Landing on a wet runway with the Anti-Skid Inoperative is not authorized.

9

ANTI-SKID INOPERATIVE
RUNWAY LIMITED LANDING WEIGHT
40 FLAPS

Pressure Altitude	RUNWAY LENGTH 8000	9000	10000	11000	12000
0	101200	117800	134600	156800	174400
1000	98100	114300	130600	152200	169200
2000	94400	110200	126000	142000	163500
3000	90700	106000	121400	136900	157800
4000	N/A	101800	116700	131800	152200
5000	N/A	98400	112900	127600	142300
6000	N/A	95000	109100	123300	137600
7000	N/A	91700	105400	119200	133100
8000	N/A	N/A	101800	115200	128600
9000	N/A	N/A	98200	111200	124300
10000	N/A	N/A	94700	107300	120000

Add 800 lb/kt for forecast headwind.
Subtract 3800 lb/kt for forecast tailwinds.
Dispatch to a wet runway with the Anti-Skid Inoperative is not authorized.

Actual Landing Distances (Unfactored)

All Continental Airlines flights are planned to arrive at their destination at a weight which yields a factored landing distance well within the Effective Runway Length for the planned runway. However, during an emergency, unscheduled diversion or other unusual circumstances, a safe landing with reduced safety margins can be made if the Actual Landing Distance (unfactored) for the planned conditions is within the Effective Runway Length for the planned runway. The following charts can be used to determine Actual Landing Distances for the conditions indicated.

③ 3 5

Advisory Data						
Actual Landing Distances (Unfactored)						
Condition	Lndg Flap	Approach Speed	Dry Distance (ft)		Wet Distance (ft)	
			110000 lb.	130000 lb.	110000 lb.	130000 lb.
Max Manual Braking	30	Vref30+5	2910	3420	3940	4430
Max Manual Braking	40	Vref40+5	2860	3330	3850	4360
Autobrake Max	30	Vref30+5	3720	4200	4600	5210
Autobrake Max	40	Vref40+5	3630	4110	4470	5100
Autobrake 3	30	Vref30+5	5470	6210	5470	6210
Autobrake 3	40	Vref40+5	5300	6080	5300	6080
One Engine Inoperative	15	Vref15+5	3310	3950	4530	5090
Hydraulic Systems A & B Inoperative	15	Vref15+5	5450	6180	5530	6280
Flaps Up	0	Vref40+55	4570	5830	5630	6340
Antiskid Inoperative (prudent manual braking)	40	Vref40+5	5010	5810	5010	5810

Valid for Sea Level airports.
ISA + 15 temperature (30°C), Zero wind, Zero runway slope.
Auto Speedbrakes except for Antiskid Inop. (Manual Speedbrakes).
Maximum Manual Braking, unless otherwise noted.
Maximum Reverse Thrust on operative engines.
Includes distances from 50 ft above threshold (1000 ft of air distance).
Wet distance based on Good Reported braking action on ungrooved runway surface.

Note: This data is Advisory only. It does not replace FAR Dispatch requirements to calculate FAR Landing Field Length Limit Weight (based on Factored data).

Caution: Safety margins are reduced when landing on runways shorter than Factored Landing Distances. Crews should carefully evaluate runway conditions, winds, weather and alternate runways prior to executing such a landing.

7

Advisory Data						
Actual Landing Distances (Unfactored)						
Condition	Lndg Flap	Approach Speed	Dry Distance (ft)		Wet Distance (ft)	
			130000 lb.	150000 lb.	130000 lb.	150000 lb.
Max Manual Braking	30	Vref30+5	3010	3500	4130	4580
Max Manual Braking	40	Vref40+5	2960	3320	4080	4520
Autobrake Max	30	Vref30+5	3730	4100	4280	4740
Autobrake Max	40	Vref40+5	3620	3970	4190	4640
Autobrake 3	30	Vref30+5	5310	5900	5320	5910
Autobrake 3	40	Vref40+5	5120	5680	5130	5700
One Engine Inoperative	15	Vref15+5	3110	3500	4400	4880
Hydraulic Systems A & B Inoperative	15	Vref15+5	4430	4930	5110	5720
Flaps Up	0	Vref40+55	4160	4920	5550	6110
Antiskid Inoperative (prudent manual braking)	40	Vref40+5	5030	5610	5640	6340

Valid for Sea Level airports.
ISA + 15 temperature (30°C), Zero wind, Zero runway slope.
Auto Speedbrakes except for Antiskid Inop. (Manual Speedbrakes).
Maximum Manual Braking, unless otherwise noted.
Maximum Reverse Thrust on operative engines.
Includes distances from 50 ft above threshold (1000 ft of air distance).
Wet distance based on Good Reported braking action on ungrooved runway surface.

Note: This data is Advisory only. It does not replace FAR Dispatch requirements to calculate FAR Landing Field Length Limit Weight (based on Factored data).

Caution: Safety margins are reduced when landing on runways shorter than Factored Landing Distances. Crews should carefully evaluate runway conditions, winds, weather and alternate runways prior to executing such a landing.

8

Advisory Data								
Actual Landing Distances (Unfactored)								
Condition	Lndg Flap	Approach Speed	Dry Landing Distance (ft)			Wet Landing Distance (ft)		
			130000 lb.	150000 lb.	170000 lb.	130000 lb.	150000 lb.	170000 lb.
Max Manual Braking	30	Vref30+5	3160	3540	3910	4350	4850	5320
Max Manual Braking	40	Vref40+5	3010	3370	3720	4170	4640	5080
Autobrake Max	30	Vref30+5	4040	4460	4860	4800	5330	5830
Autobrake Max	40	Vref40+5	3770	4160	4530	4560	5070	5540
Autobrake 3	30	Vref30+5	5740	6430	7050	5750	6440	7070
Autobrake 3	40	Vref40+5	5300	5930	6500	5310	5950	6510
One Engine Inoperative	15	Vref15+5	3300	3720	4200	4710	5270	5790
Hydraulic Systems A & B Inoperative	15	Vref15+5	4610	5150	5640	5600	6310	6980
Flaps Up	0	Vref40+55	4060	4780	6180	5630	6220	6770
Antiskid Inoperative (prudent manual braking)	40	Vref40+5	5260	5810	6360	5840	6490	7140

Valid for Sea Level airports.
ISA + 15 temperature (30°C), Zero wind, Zero runway slope.
Auto Speedbrakes except for Antiskid Inop. (Manual Speedbrakes).
Maximum Manual Braking, unless otherwise noted.
Maximum Reverse Thrust on operative engines.
Includes distances from 50 ft above threshold (1000 ft of air distance).
Wet distance based on Good Reported braking action on ungrooved runway surface.

Note: This data is Advisory only. It does not replace FAR Dispatch requirements to calculate FAR Landing Field Length Limit Weight (based on Factored data).

Caution: Safety margins are reduced when landing on runways shorter than Factored Landing Distances. Crews should carefully evaluate runway conditions, winds, weather and alternate runways prior to executing such a landing.

9

Advisory Data								
Actual Landing Distances (Unfactored)								
Condition	Lndg Flap	Approach Speed	Dry Landing Distance (ft)			Wet Landing Distance (ft)		
			130000 lb.	150000 lb.	170000 lb.	130000 lb.	150000 lb.	170000 lb.
Max Manual Braking	30	Vref30+5	3200	3540	3970	4410	4850	5390
Max Manual Braking	40	Vref40+5	3030	3370	3720	4200	4640	5080
Autobrake Max	30	Vref30+5	4110	4460	4940	4880	5330	5920
Autobrake Max	40	Vref40+5	3800	4160	4530	4600	5070	5540
Autobrake 3	30	Vref30+5	5870	6430	7200	5880	6440	7200
Autobrake 3	40	Vref40+5	5360	5930	6500	5370	5950	6510
One Engine Inoperative	15	Vref15+5	3390	3740	4260	4850	5300	5860
Hydraulic Systems A & B Inoperative	15	Vref15+5	4790	5200	5740	5810	6370	7100
Flaps Up	0	Vref40+55	4090	4780	6180	5660	6220	6770
Antiskid Inoperative (prudent manual braking)	40	Vref40+5	5310	5820	6330	5900	6500	7070

Valid for Sea Level airports.
ISA + 15 temperature (30°C), Zero wind, Zero runway slope.
Auto Speedbrakes except for Antiskid Inop. (Manual Speedbrakes).
Maximum Manual Braking, unless otherwise noted.
Maximum Reverse Thrust on operative engines.
Includes distances from 50 ft above threshold (1000 ft of air distance).
Wet distance based on Good Reported braking action on ungrooved runway surface.

Note: This data is Advisory only. It does not replace FAR Dispatch requirements to calculate FAR Landing Field Length Limit Weight (based on Factored data).

Caution: Safety margins are reduced when landing on runways shorter than Factored Landing Distances. Crews should carefully evaluate runway conditions, winds, weather and alternate runways prior to executing such a landing.

Operating In Icing Conditions

Enroute Icing Penalty

When dispatched to land at temperatures below 46°F and when enroute icing is forecast, use the following procedures to determine the Approach Climb Limit weight adjustment for accumulated airframe ice:

- Enter the chart labeled Approach Climb Limit for the desired landing flap setting. Read the Approach Climb Limit Weight.
- Reduce the Approach Climb Limit Weight by the following:

	③ $\boxed{3}$	$\boxed{5}$	$\boxed{7}$	$\boxed{8}$ $\boxed{9}$
FLAPS 30	9,600 lbs.	9,200 lbs.	15,300 lbs.	14,000 lbs.
FLAPS 40	10,800 lbs.	10,300 lbs.	15,300 lbs.	14,000 lbs.

Anti-Ice Operation Penalty

For dispatch planning, when icing conditions are forecast at the destination for the time of landing, subtract the appropriate anti-ice penalty from the Approach Climb Limit Weight for use of Engine or Engine & Wing Anti-Ice during approach.

Note: Wing Anti-Ice is operationally utilized as a de-ice system and only under the most severe icing conditions should this penalty be applied.

③ $\boxed{3}$

ANTI-ICE	FLAPS 30	FLAPS 40
ENGINE	1,000 lbs	1,000 lbs
ENGINE & WING	10,700 lbs	11,700 lbs

$\boxed{5}$

ANTI-ICE	FLAPS 30	FLAPS 40
ENGINE	1,000 lbs	1,000 lbs
ENGINE & WING	10,400 lbs	10,600 lbs

$\boxed{7}$

ANTI-ICE	FLAPS 30	FLAPS 40
ENGINE	500 lbs	500 lbs
ENGINE & WING	3,000 lbs	3,000 lbs

8

ANTI-ICE	FLAPS 30	FLAPS 40
ENGINE	500 lbs	500 lbs
ENGINE & WING	3200 lbs	3200 lbs

9

ANTI-ICE	FLAPS 30	FLAPS 40
ENGINE	600 lbs	600 lbs
ENGINE & WING	3100 lbs	3100 lbs

Sample Problem - Icing Conditions - Landing Flaps 30° ③ [3]

Airport	----------	AAA
Elevation	----------	200 Ft.
Wind	----------	Calm
Temperature	----------	20°F
Weather	----------	Icing Conditions
Anti-Ice	----------	Engine & Wing ON

- The Approach Climb Limit Weight is 135,500 lbs.
- For landing flap 30, the Engine and Wing Anti-Ice ON penalty is 10,700 lbs. and the penalty for operation in icing conditions is 9,600 lbs.
- 135,500 minus (10,700 + 9,600) = 115,200 lbs. Approach Climb Limit Weight.
- When comparing the approach climb, runway limited runway length, and maximum structural landing weight, the maximum structural landing weight is the least value of the conditions. Therefore, in this example the maximum structural landing weight of 114,000 lbs. is the maximum landing weight.

Auto Speedbrakes (Ground Spoilers) Inoperative

A dispatch penalty for auto speedbrakes inoperative is assessed by ACCULOAD. After dispatch, if the auto speed brakes system fails, and ACCULOAD is not available, manual calculation of appropriate landing penalties will be necessary as the landing roll-out may be longer than planned.

Apply the appropriate penalty in accordance with the notes found below the applicable LANDING RUNWAY WEIGHT LIMIT Chart:

③ [3] [5]: The penalty is a reduction (in feet) to the effective landing length.

[7] [8] [9]: The penalty is a weight reduction (in pounds) to the runway landing limit weight.

Quick Turn Around Weight Limit Charts

(Minimum Ground Time After Clearing Runway)

Use one of the following procedures:

- Max QTA Weight Charts – See this section.

  Following a landing where the landing weights exceed those in the Maximum Quick Turn Around Weight Charts, confirm the wheel thermal plugs have not melted after remaining on the ground a minimum of 53 minutes 3 3 5, 62 minutes 7 or 67 minutes 8 9.

- Brake Temperature Measurement – Maintenance function.

  Co-ordinate and confirm with maintenance that each brake pressure plate temperature, without artificial cooling, is determined to be less than 300°F 3 3 5 or 425°F 7 8 9 using approved methods.

  If each measured pressure plate temperature is less than these limits, immediate dispatch is allowed. If measured temperature is greater than these limits, the appropriate ground "wait" period applies.

Note: Refer to the adjustments and time references at the bottom of the appropriate Max QTA Charts.

Maximum Quick Turn Around Weight Limits

③ 3

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS									
FLAPS 30 LBS. X 1000									
	PRESSURE ALTITUDE - FEET								
°F	0	1000	2000	3000	4000	5000	6000	7000	8000
-10	134.0	131.0	129.0	126.5	124.0	121.51	119.0	117.0	114.8
0	132.5	130.0	127.5	125.0	122.5	20.0	117.5	115.5	113.0
10	131.0	128.5	126.0	123.5	121.0	118.8	116.3	114.3	111.8
20	129.5	127.0	124.5	122.0	119.5	117.5	115.0	113.0	110.5
30	128.0	125.5	123.0	120.8	118.3	116.3	113.8	111.8	109.5
40	126.5	124.0	121.5	119.5	117.0	115.8	112.5	110.5	108.5
50	125.0	122.8	120.3	118.3	115.8	113.8	111.5	109.5	107.5
60	123.5	121.5	116.0	117.0	114.5	112.5	110.5	108.5	106.5
70	122.5	120.3	118.0	115.8	113.5	111.5	109.5	107.3	105.5
80	121.5	119.0	117.0	114.5	112.5	110.5	108.5	106.0	104.5
90	120.3	117.8	115.8	113.5	111.5	109.5	107.5	105.3	103.5
100	119.0	116.5	114.5	112.5	110.5	108.5	106.5	104.5	102.5
110	118.0	115.5	113.5	111.5	109.5	107.5	105.5	103.5	NA
120	117.0	114.5	112.5	110.5	108.5	106.5	NA	NA	NA

③ 3

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS									
FLAPS 40 LBS. X 1000									
	PRESSURE ALTITUDE - FEET								
°F	0	1000	2000	3000	4000	5000	6000	7000	8000
-10	137.0	134.5	132.0	129.5	127.5	125.0	112.8	120.5	118.3
0	135.5	133.0	130.5	128.3	125.8	123.5	121.5	119.3	117.0
10	134.0	131.5	129.0	127.0	124.5	122.5	120.0	118.0	115.8
20	132.5	130.0	128.0	125.5	123.0	121.0	119.0	116.5	114.5
30	131.3	128.8	126.8	124.3	121.8	119.8	117.8	115.5	113.5
40	130.0	127.5	125.5	123.0	120.5	118.5	116.5	114.5	112.5
50	128.5	126.3	124.3	121.8	119.5	117.5	115.3	113.5	111.5
60	127.0	125.0	123.0	120.5	118.5	116.5	114.0	112.5	110.5
70	126.0	123.8	121.8	119.5	117.3	115.3	113.0	111.5	109.5
80	125.0	122.5	120.5	118.5	116.0	114.0	112.0	110.5	108.5
90	123.8	121.5	119.5	117.3	115.0	113.3	111.0	109.5	107.5
100	122.5	120.5	118.5	116.0	114.0	112.5	110.0	108.5	106.5
110	121.5	119.5	117.5	115.3	113.3	111.5	119.3	107.5	NA
120	120.5	118.5	116.5	114.5	112.5	110.5	NA	NA	NA

Slope - Add 1500 lbs./1% uphill slope
Subtract 2000 lbs./1% downhill slope
Wind - Add 400 lbs./knot headwind
Subtract 1400 lbs./knot tailwind
Time - If landing weight exceeds chart value, wait at least **53 min**. Then check wheel thermal plugs before making a subsequent takeoff.

Maximum Quick Turn Around Weight Limits

5

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS										
FLAPS 30 LBS. X 1000										
	PRESSURE ALTITUDE - FEET									
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
-10	136.2	133.4	130.8	128.2	125.5	122.9	120.4	117.8	115.4	113.0
0	134.6	131.9	129.3	126.6	124.2	121.4	119.0	116.5	114.1	111.6
10	133.2	130.4	127.8	125.2	122.7	120.1	117.7	115.2	112.9	110.5
20	131.4	129.0	126.3	123.8	121.3	118.8	116.3	114.0	111.6	109.4
30	130.0	127.5	125.0	122.5	120.0	117.5	115.2	112.8	110.5	108.3
40	128.7	126.2	123.6	121.2	118.8	116.3	114.0	111.6	109.4	107.3
50	127.4	124.8	122.4	120.0	117.5	115.2	112.8	110.5	108.3	106.2
60	126.1	123.6	121.1	118.7	116.3	114.0	111.6	109.4	107.3	105.1
70	124.8	122.3	120.0	117.5	115.2	112.9	110.6	108.4	106.2	104.2
80	123.5	121.2	118.7	116.3	114.0	111.7	109.6	107.4	105.3	103.2
90	122.3	120.0	117.5	115.2	112.9	110.7	108.5	106.3	104.3	102.3
100	121.1	118.7	116.4	114.1	111.7	109.6	107.5	105.4	103.3	101.3
110	120.0	117.5	115.3	113.0	110.7	108.6	106.4	-	-	-
120	118.8	116.4	114.2	111.9	-	-	-	-	-	-

5

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS										
FLAPS 40 LBS. X 1000										
	PRESSURE ALTITUDE - FEET									
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
-10	140.0	139.7	136.7	133.9	131.2	128.5	125.8	123.2	120.7	118.1
0	140.0	138.0	135.2	132.4	129.6	126.9	124.3	121.7	119.2	116.6
10	139.2	136.3	133.7	130.8	128.2	125.5	123.0	120.4	117.8	115.4
20	137.5	134.9	132.1	129.3	126.7	124.2	121.5	119.0	116.6	114.2
30	136.0	133.3	130.6	127.8	125.3	122.8	120.2	117.8	115.4	113.0
40	134.6	131.8	129.2	126.6	124.0	121.5	119.0	116.6	114.2	111.9
50	133.2	130.5	127.8	125.2	122.7	120.3	117.8	115.4	113.1	110.8
60	131.7	129.2	126.5	124.0	121.4	119.0	116.6	114.3	112.0	109.8
70	130.4	127.8	125.2	122.7	120.3	117.8	115.5	113.2	110.9	108.6
80	129.1	126.4	124.0	121.4	119.0	116.6	114.3	112.1	109.9	107.6
90	127.7	125.2	122.7	120.3	117.9	115.5	113.2	111.0	108.8	106.6
100	126.4	124.0	121.5	119.1	116.7	114.4	112.2	110.0	107.8	105.7
110	125.2	122.8	120.3	117.9	115.6	113.3	111.2	-	-	-
120	124.0	121.5	119.1	116.7	-	-	-	-	-	-

Slope - Add 1500 lbs./1% uphill slope
Subtract 2000 lbs./1% downhill slope

Wind - Add 400 lbs./knot headwind
Subtract 1400 lbs./knot tailwind

Time - If landing weight exceeds chart value, wait at least **53 min**. Then check wheel thermal plugs before making a subsequent takeoff.

Maximum Quick Turn Around Weight Limits

7

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS											
FLAPS 30 LBS. X 1000											
PRESSURE ALTITUDE - FEET											
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-10	177.9	174.4	171.0	167.4	163.8	160.4	157.1	153.8	150.6	147.4	144.2
0	175.9	172.4	168.9	165.3	161.8	158.5	155.3	152.0	148.8	145.7	142.6
10	173.9	170.5	166.9	163.3	160.0	156.7	153.5	150.3	147.1	144.0	141.1
20	172.0	168.5	164.9	161.5	158.2	155.0	151.8	148.6	145.5	142.5	139.6
30	170.2	166.5	163.0	159.7	156.5	153.3	150.1	147.0	143.9	141.0	138.1
40	168.2	164.6	161.3	158.0	154.8	151.6	148.5	145.4	142.4	139.5	136.7
50	166.3	162.8	159.6	156.3	153.1	150.0	146.9	143.8	141.0	138.1	135.3
60	164.5	161.1	157.9	154.7	151.5	148.5	145.4	142.4	139.6	136.8	134.0
70	162.8	159.5	156.3	153.1	150.0	146.9	143.9	141.0	138.2	135.4	132.7
80	161.1	157.9	154.7	151.6	148.5	145.5	142.5	139.7	136.9	134.1	131.4
90	159.5	156.3	153.2	150.1	147.0	144.0	141.2	138.4	135.6	132.9	130.2
100	157.9	154.8	151.7	148.6	145.6	142.7	139.9	137.1	134.4	N/A	N/A
110	156.4	153.2	150.2	147.2	144.2	141.4	N/A	N/A	N/A	N/A	N/A
120	154.9	151.8	148.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

7

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS											
FLAPS 40 LBS. X 1000											
PRESSURE ALTITUDE - FEET											
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-10	180.0	179.1	175.5	172.0	168.5	164.9	161.4	158.0	154.6	151.3	148.0
0	180.0	177.1	173.5	170.1	166.5	163.0	159.5	156.2	152.8	149.5	146.3
10	178.7	175.1	171.7	168.1	164.6	161.1	157.7	154.4	151.1	147.8	144.6
20	176.7	173.2	169.8	166.2	162.7	159.3	156.0	152.7	149.4	146.2	143.0
30	174.9	171.5	167.9	164.4	161.0	157.6	154.3	151.0	147.8	144.6	141.6
40	173.1	169.7	166.1	162.6	159.2	155.9	152.7	149.4	146.2	143.1	140.1
50	171.4	167.8	164.4	160.9	157.6	154.3	151.1	147.9	144.7	141.7	138.8
60	169.6	166.1	162.6	159.3	156.0	152.7	149.5	146.3	143.3	140.3	137.4
70	167.9	164.4	161.0	157.6	154.4	151.2	148.0	144.9	141.9	139.0	136.1
80	166.1	162.7	159.4	156.1	152.9	149.7	146.5	143.4	140.6	137.7	134.8
90	164.5	161.1	157.8	154.6	151.4	148.2	145.1	142.1	139.3	136.4	133.6
100	162.9	159.5	156.3	153.1	149.9	146.8	143.7	140.8	138.0	N/A	N/A
110	161.3	158.0	154.8	151.6	148.5	145.4	N/A	N/A	N/A	N/A	N/A
120	159.8	156.5	153.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Slope - Add 1400 lbs./1% uphill slope
Subtract 2500 lbs./1% downhill slope

Wind - Add 350 lbs./knot headwind
Subtract 1800 lbs./knot tailwind

Time - If landing weight exceeds chart value, wait at least **62 min**. Then check wheel thermal plugs before making a subsequent takeoff.

Maximum Quick Turn Around Weight Limits

8

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS											
FLAPS 30 LBS. X 1000											
PRESSURE ALTITUDE - FEET											
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-10	190.0	188.1	184.3	180.6	176.9	173.4	170.0	166.6	163.2	159.9	156.6
0	189.6	185.8	182.1	178.4	174.8	171.4	168.0	164.6	161.3	158.0	154.8
10	187.3	183.6	179.9	176.3	172.8	169.4	166.1	162.7	159.5	156.2	153.0
20	185.2	181.5	177.9	174.3	170.9	167.5	164.2	160.9	157.7	154.4	151.3
30	183.1	179.4	175.8	172.4	169.0	165.7	162.4	159.2	155.9	152.8	149.6
40	181.1	177.4	174.0	170.6	167.2	163.9	160.7	157.4	154.3	151.1	148.0
50	179.1	175.5	172.1	168.8	165.4	162.2	159.0	155.8	152.6	149.5	146.4
60	177.1	173.7	170.4	167.0	163.7	160.5	157.3	154.2	151.0	148.0	144.9
70	175.3	172.0	168.6	165.3	162.0	158.9	155.7	152.6	149.5	146.4	143.4
80	173.5	170.2	166.9	163.7	160.4	157.3	154.2	151.1	148.0	145.0	142.1
90	171.8	168.6	165.3	162.1	158.9	155.8	152.7	149.6	146.6	143.6	140.8
100	170.2	166.9	163.7	160.5	157.3	154.3	151.2	148.1	145.1	N/A	N/A
110	168.5	165.3	162.1	159.0	155.8	152.8	N/A	N/A	N/A	N/A	N/A
120	166.9	163.7	160.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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MAXIMUM QUICK TURN AROUND WEIGHT LIMITS											
FLAPS 40 LBS. X 1000											
PRESSURE ALTITUDE – FEET											
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-10	190.0	190.0	190.0	190.0	187.8	184.1	180.4	176.8	173.2	169.6	166.1
0	190.0	190.0	190.0	189.4	185.5	181.9	178.3	174.7	171.2	167.6	164.1
10	190.0	190.0	190.0	187.2	183.4	179.8	176.2	172.7	169.2	165.7	162.3
20	190.0	190.0	188.8	185.0	181.4	177.8	174.3	170.8	167.3	163.9	160.5
30	190.0	190.0	186.7	183.0	179.4	175.9	172.3	168.9	165.5	162.1	158.7
40	190.0	188.4	184.6	181.0	177.4	174.0	170.5	167.1	163.7	160.3	157.0
50	190.0	186.3	182.7	179.1	175.6	172.1	168.7	165.3	161.9	158.6	155.4
60	188.1	184.4	180.8	177.2	173.7	170.3	166.9	163.6	160.3	157.0	153.7
70	186.1	182.5	179.0	175.4	172.0	168.6	165.2	161.9	158.6	155.4	152.2
80	184.2	180.7	177.2	173.7	170.2	166.9	163.6	160.3	157.0	153.8	150.6
90	182.4	178.9	175.4	172.0	168.6	165.3	162.0	158.7	155.5	152.3	149.2
100	180.6	177.1	173.7	170.3	166.9	163.7	160.4	157.2	154.0	N/A	N/A
110	178.8	175.4	172.1	168.7	165.4	162.1	N/A	N/A	N/A	N/A	N/A
120	177.1	173.8	170.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Slope - Add 1500 lbs./1% uphill slope
Subtract 2700 lbs./1% downhill slope

Wind - Add 350 lbs./knot headwind
Subtract 1800 lbs./knot tailwind

Time - If landing weight exceeds chart value, wait at least **67 min**. Then check wheel thermal plugs before making a subsequent takeoff.

Maximum Quick Turn Around Weight Limits

9

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS											
FLAPS 30 LBS. X 1000											
PRESSURE ALTITUDE - FEET											
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-10	189.7	186.1	182.6	179.0	175.5	172.2	168.9	165.6	162.4	159.2	156.0
0	187.5	184.0	180.4	176.9	173.5	170.3	167.0	163.7	160.5	157.3	154.2
10	185.4	181.9	178.4	174.9	171.6	168.4	165.1	161.9	158.8	155.6	152.5
20	183.4	179.9	176.3	173.0	169.8	166.6	163.3	160.2	157.0	153.9	150.8
30	181.4	177.9	174.5	171.2	168.0	164.8	161.6	158.5	155.4	152.3	148.5
40	179.4	175.9	172.7	169.5	166.2	163.1	159.9	156.8	153.7	150.7	145.7
50	177.5	174.2	170.9	167.7	164.5	161.4	158.3	155.2	152.1	148.3	143.4
60	175.7	172.4	169.3	166.1	162.9	159.8	156.7	153.6	150.6	145.6	141.9
70	173.9	170.8	167.6	164.4	161.3	158.2	155.1	152.1	148.3	143.4	140.5
80	172.3	169.1	166.0	162.8	159.7	156.7	153.6	150.6	145.7	142.0	139.1
90	170.7	167.6	164.4	161.3	158.2	155.2	152.2	148.5	143.6	140.6	137.8
100	169.1	166.0	162.9	159.8	156.7	153.7	150.7	145.9	142.2	N/A	N/A
110	167.5	164.4	161.4	158.3	155.3	152.3	N/A	N/A	N/A	N/A	N/A
120	166.0	162.9	159.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

9

MAXIMUM QUICK TURN AROUND WEIGHT LIMITS											
FLAPS 40 LBS. X 1000											
PRESSURE ALTITUDE – FEET											
°F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
-10	190.0	190.0	190.0	190.0	188.5	184.8	181.3	177.7	174.3	170.8	167.4
0	190.0	190.0	190.0	190.0	186.2	182.7	179.2	175.7	172.3	168.9	165.5
10	190.0	190.0	190.0	187.8	184.2	180.7	177.2	173.8	170.4	167.0	163.7
20	190.0	190.0	189.4	185.7	182.2	178.8	175.3	171.9	168.5	165.2	161.9
30	190.0	190.0	187.3	183.8	180.3	176.9	173.4	170.1	166.7	163.4	160.1
40	190.0	189.0	185.4	181.9	178.4	175.0	171.6	168.3	165.0	161.7	158.5
50	190.0	187.0	183.5	180.0	176.6	173.2	169.9	166.5	163.3	160.0	156.8
60	188.7	185.1	181.7	178.2	174.8	171.5	168.1	164.9	161.6	158.4	155.3
70	186.7	183.3	179.9	176.5	173.1	169.8	166.5	163.2	160.0	156.9	153.7
80	184.9	181.5	178.1	174.7	171.4	168.1	164.9	161.7	158.5	155.3	152.2
90	183.2	179.8	176.5	173.1	169.8	166.5	163.3	160.1	157.0	153.8	150.8
100	181.5	178.1	174.8	171.5	168.2	165.0	161.8	158.6	155.5	N/A	N/A
110	179.7	176.4	173.2	169.9	166.6	163.5	N/A	N/A	N/A	N/A	N/A
120	178.1	174.8	171.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Slope - Add 1500 lbs./1% uphill slope
Subtract 2700 lbs./1% downhill slope

Wind - Add 350 lbs./knot headwind
Subtract 1800 lbs./knot tailwind

Time - If landing weight exceeds chart value, wait at least **67 min**. Then check wheel thermal plugs before making a subsequent takeoff.

Overweight Landing

In an emergency situation requiring a return after takeoff or a landing short of destination, a Captain may land at a weight in excess of the limitations and performance of this manual.

Aircraft certification under FAR's requires a demonstration that the aircraft can withstand a landing impact of ten feet per second at normal maximum landing weight. In addition, it must be capable of withstanding a landing impact of six feet per second at maximum takeoff weight. A normal landing sink rate averages one to two feet per second; therefore, a normal landing at maximum gross takeoff weight will not result in a structural problem.

Note: When a landing is made over the normal maximum landing weight, an entry is required in the aircraft logbook, and a hard landing maintenance inspection is mandatory.

MISCELLANEOUS

③ 3 5 Flight With Unreliable Airspeed

CONDITION	WEIGHT (1000 LB)					
	120	110	100	90	80	
CLIMB (280/.74). FLAPS UP, SET MAX CLIMB THRUST						
CLIMB 30000	4.7 +1200	4.8 +1500	4.9 +1800	5.1 +2200	5.3 +2600	PITCH V/S
CLIMB 20000	6.2 +1900	6.3 +2200	6.5 +2500	6.8 +2900	7.1 +3300	
CLIMB 10000	8.2 +2800	8.5 +3200	8.8 +3500	8.9 +4100	10.1 +4600	
CLIMB SEA LEVEL	10.5 +3600	11.1 +4000	11.7 +4500	12.6 +5100	13.6 +5800	
CRUISE (.70/280). FLAPS UP, LEVEL FLIGHT						
CRUISE 30000	3.9 81	3.5 80	3.1 79	2.8 78	2.4 78	PITCH %N1
CRUISE 10000	3.3 88	3.0 87	2.7 85	2.4 85	2.1 84	
DESCENT (280k). FLAPS UP, SET IDLE THRUST						
DESCENT 30000	-1.2 -3400	-1.7 -3500	-2.2 -3700	-2.8 -3900	-3.6 -4300	PITCH V/S
DESCENT 20000	0.0 -2200	-0.3 -2300	-1.0 -2500	-1.5 -2600	-2.2 -2900	
HOLDING. FLAPS UP, LEVEL FLIGHT						
HOLDING	245k	236k	220k	210k	210k	
10000	4.4 66	4.4 64	4.4 61	4.4 59	4.5 58	PITCH %N1
TERMINAL AREA (0-10000 Ft.). LEVEL FLIGHT						
Flaps 1 (Gear Up) 190k		7.0 61	6.3 58	5.6 57	4.8 56	PITCH %N1
Flaps 5 (Gear Up) 170k		7.6 62	6.7 59	5.8 56	4.9 54	
Flaps 15 (Gear Dn) 150k		8.1 69	7.0 66	6.0 64	4.9 62	
FINAL APPROACH (0-10000 Ft.). GEAR DOWN, 3 DEG G/S						
Flaps 15 Vref + 10		4.5 53	4.5 51	4.5 49	4.5 46	PITCH %N1
Flaps 30 Vref + 10		2.0 58	1.9 56	1.9 53	1.8 50	
Flaps 40 Vref + 10		0.3 65	0.4 63	0.4 60	0.5 57	

7 Flight With Unreliable Airspeed

CONDITION	WEIGHT (1000 LB)					
	170	150	130	110	90	
CLIMB (280/.76). FLAPS UP, SET MAX CLIMB THRUST						
CLIMB 30000	4.0 +900	4.0 +1200	4.0 +1500	4.0 +2000	4.0 +2500	PITCH V/S
CLIMB 20000	6.0 +1800	6.0 +2200	6.0 +2700	6.5 +3300	7.5 +4200	
CLIMB 10000	8.0 +2600	8.0 +3100	8.5 +3700	9.5 +4500	11.0 +5600	
CLIMB SEA LEVEL	10.0 +3300	10.5 +3800	11.5 +4500	12.5 +5400	14.5 +6700	
CRUISE (.76/280). FLAPS UP, LEVEL FLIGHT						
CRUISE 35000	3.5 92	3.0 88	2.5 85	2.0 83	1.5 81	PITCH %N1
CRUISE 25000	3.0 82	2.5 80	2.0 79	1.5 78	1.0 77	
CRUISE 15000	3.5 74	2.5 73	2.0 71	1.5 70	1.0 69	
DESCENT (.76/280). FLAPS UP, SET IDLE THRUST						
DESCENT 30000	0.0 -2100	-0.5 -2200	-1.0 -2400	-2.0 -2700	-3.0 -3100	PITCH V/S
DESCENT 20000	0.5 -1900	-0.5 -2000	-1.0 -2200	-2.0 -2400	-3.0 -2900	
DESCENT 10000	0.0 -1800	-0.5 -1900	-1.5 -2000	-2.5 -2300	-3.5 -2700	
HOLDING (V_M FLAPS 0). FLAPS UP, LEVEL FLIGHT						
HOLDING 10000	5.0 69	5.0 66	5.0 62	5.0 58	5.0 53	PITCH %N1
TERMINAL AREA (5000 Ft.). LEVEL FLIGHT						
Flaps 1 (Gear Up) V_M Flaps 1	6.5 67	6.0 63	6.0 60	5.5 56	5.0 51	PITCH %N1
Flaps 5 (Gear Up) V_M Flaps 5	7.0 68	6.5 65	6.5 61	6.0 56	5.5 52	
FINAL APPROACH (1500 Ft.). GEAR DOWN, 3 DEG G/S						
Flaps 15 Vref 15 + 10	4.0 56	4.0 53	3.5 50	3.5 47	3.5 43	PITCH %N1
Flaps 30 Vref 30 + 10	2.5 60	2.0 57	2.0 54	2.0 50	1.5 46	
Flaps 40 Vref 40 + 10	1.0 67	0.5 64	0.5 61	0.0 56	0.0 52	

8 Flight With Unreliable Airspeed

CONDITION	WEIGHT (1000 LB)					
	180	160	140	120	100	
CLIMB (280/.76). FLAPS UP, SET MAX CLIMB THRUST						
CLIMB 30000	4.0 +700	4.0 +1000	3.5 +1300	3.5 +1700	4.0 +2200	PITCH V/S
CLIMB 20000	6.0 +1600	6.0 +2000	6.0 +2400	6.0 +2900	6.5 +3600	
CLIMB 10000	7.5 +2400	8.0 +2800	8.0 +3300	9.0 +4000	10.0 +4900	
CLIMB SEA LEVEL	9.5 +3000	10.0 +3500	10.5 +4100	11.5 +4900	13. +5900	
CRUISE (.76/280). FLAPS UP, LEVEL FLIGHT						
CRUISE 35000		3.0 90	2.5 87	2.0 84	1.5 82	PITCH %N1
CRUISE 25000	3.0 83	2.5 82	2.0 80	1.5 79	1.0 78	
CRUISE 15000	3.5 75	3.0 74	2.5 73	2.0 71	1.5 70	
DESCENT (.76/280). FLAPS UP, SET IDLE THRUST						
DESCENT 30000	1.5 -1900	1.0 -1800	0.5 -1900	-0.5 -2000	-1.5 -2200	PITCH V/S
DESCENT 20000	2.0 -1700	1.5 -1600	0.5 -1700	-0.5 -1800	-1.5 -2000	
DESCENT 10000	2.0 -1500	1.5 -1400	0.5 -1500	-0.5 -1600	-1.5 -1800	
HOLDING (V_M FLAPS 0). FLAPS UP, LEVEL FLIGHT						
HOLDING 10000	5.0 71	5.0 68	5.0 64	5.0 60	5.0 56	PITCH %N1
TERMINAL AREA (5000 Ft.). LEVEL FLIGHT						
Flaps 1 (Gear Up) V_M Flaps 1	6.5 69	6.0 66	5.5 63	5.5 59	5.0 54	PITCH %N1
Flaps 5 (Gear Up) V_M Flaps 5	6.5 71	6.5 67	6.0 64	6.0 60	5.5 55	
FINAL APPROACH (1500 Ft.). GEAR DOWN, 3 DEG G/S						
Flaps 15 Vref 15 + 10	2.5 59	2.5 56	2.5 53	2.5 50	2.5 46	PITCH %N1
Flaps 30 Vref 30 + 10	1.0 64	1.0 61	1.0 58	1.0 54	1.0 50	
Flaps 40 Vref 40 + 10	0.0 71	0.0 68	0.0 64	0.0 60	0.0 55	

9 Flight With Unreliable Airspeed

CONDITION	WEIGHT (1000 LB)					
	180	160	140	120	100	
CLIMB (280/.76). FLAPS UP, SET MAX CLIMB THRUST						
CLIMB 30000	4.0 700	3.5 1000	3.5 1300	3.5 1600	4.0 2100	PITCH V/S
CLIMB 20000	6.0 1600	6.0 1900	6.0 2400	6.0 2900	6.5 3600	
CLIMB 10000	7.5 2400	8.0 2800	8.0 3300	9.0 4000	10.0 4900	
CLIMB SEA LEVEL	9.5 3000	10.0 3400	10.5 4000	11.5 4800	13.0 5900	
CRUISE (.76/280). FLAPS UP, LEVEL FLIGHT						
CRUISE 35000		3.0 90	2.5 86	2.0 84	1.5 83	PITCH %N1
CRUISE 25000	3.0 84	2.5 82	2.0 80	1.5 79	1.0 78	
CRUISE 15000	3.5 76	3.0 74	2.5 73	2.0 72	1.5 71	
DESCENT (.76/280). FLAPS UP, SET IDLE THRUST						
DESCENT 30000	0.5 -2100	0.5 -2100	-1.0 -2300	-1.5 -2500	-2.5 -2800	PITCH V/S
DESCENT 20000	0.5 -1800	0.0 -1900	-1.0 -2000	-1.5 -2200	-2.5 -2600	
DESCENT 10000	0.5 -1600	0.0 -1700	-1.0 -1800	-1.5 -2000	-3.0 -2300	
HOLDING (V_M FLAPS 0). FLAPS UP, LEVEL FLIGHT						
HOLDING 10000	5.0 71	5.0 68	5.0 64	5.0 60	5.0 56	PITCH %N1
TERMINAL AREA (5000 Ft.). LEVEL FLIGHT						
Flaps 1 (Gear Up) V_M Flaps 1	5.5 70	5.0 67	4.5 63	4.0 59	4.0 55	PITCH %N1
Flaps 5 (Gear Up) V_M Flaps 5	5.5 71	5.5 68	5.0 64	4.5 60	4.5 55	
FINAL APPROACH (1500 Ft.). GEAR DOWN, 3 DEG G/S						
Flaps 15 Vref 15 + 10	1.0 59	1.0 57	0.5 54	0.5 50	0.5 46	PITCH %N1
Flaps 30 Vref 30 + 10	0.0 65	0.0 62	-0.5 59	-1.0 55	-1.0 51	
Flaps 40 Vref 40 + 10	-1.5 71	-1.5 68	-1.5 65	-1.5 61	-1.5 56	

Temp °F - °C Conversion Chart

°C	°F
50	122
49	120
48	118
47	117
46	115
45	113
44	111
43	109
42	108
41	106
40	104
39	102
38	100
37	99
36	97
35	95

°C	°F
34	93
33	91
32	90
31	88
30	86
29	84
28	82
27	81
26	79
25	77
24	75
23	73
22	72
21	70
20	68
19	66

°C	°F
18	64
17	63
16	61
15	59
14	57
13	55
12	54
11	52
10	50
9	48
8	46
7	45
6	43
5	41
4	39
3	37

°C	°F
2	36
1	34
0	32
-1	30
-2	28
-3	27
-4	25
-5	23
-6	21
-7	19
-8	18
-9	16
-10	14
-11	12
-12	10
-13	9

°C	°F
-14	7
-15	5
-16	3
-17	1
-18	0
-19	-2
-20	-4
-21	-6
-22	-8
-23	-9
-24	-11
-25	-13
-26	-15
-27	-17
-28	-18
-29	-20

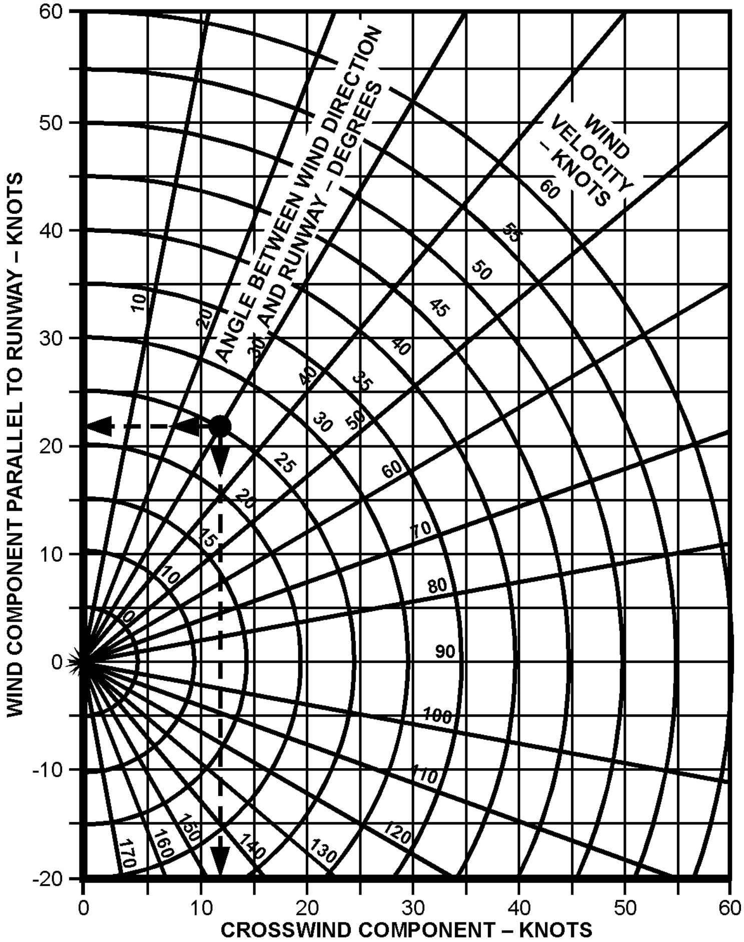
TAT vs. IAS Chart

Press Alt 1000'	INDICATED MACH NUMBER / TOTAL TEMPERATURE AT ISA - °C													
	0	.40	.50	.60	.70	.74	.78	.80	.82	.84	.86	.88	.90	.92
36-45	-56			-41	-35	-33	-30	-29	-27	-26	-24	-23	-21	-20
35	-54			-39	-33	-30	-28	-26	-25	-23	-22	-20	-19	-17
34	-52		-41	-36	-31	-28	-25	-24	-23	-21	-20	-18	-17	-15
33	-50		-39	-34	-29	-26	-23	-22	-20	-19	-17	-16	-14	-13
32	-48		-37	-32	-26	-24	-21	-20	-18	-17	-15	-14	-12	-10
31	-46		-35	-30	-24	-22	-19	-17	-16	-14	-13	-11	-10	-8
30	-44		-33	-28	-22	-19	-17	-15	-14	-12	-11	-9	-7	-6
29	-42		-31	-26	-20	-17	-14	-13	-11	-10	-8	-7	-5	-3
28	-40		-29	-24	-18	-15	-12	-11	-9	-8	-6	-4	-3	-1
27	-38		-27	-22	-15	-13	-10	-8	-7	-5	-4	-2	0	1
26	-37		-25	-19	-13	-11	-8	-6	-5	-3	-2	0	2	4
25	-35		-23	-17	-11	-8	-5	-4	-2	-1	1	2	4	6
24	-33	-25	-21	-15	-9	-6	-3	-2	0	1	3	5	6	8
23	-31	-23	-18	-13	-7	-4	-1	0	2	4	5	7	9	11
22	-29	-21	-16	-11	-5	-2	1	3	4	6	8	9	11	13
21	-27	-19	-14	-9	-2	0	3	5	7	8	11	12	13	
20	-25	-17	-12	-7	0	3	6	7	9	10	12	14		
19	-23	-15	-10	-5	2	5	8	9	11	13	14			
18	-21	-13	-8	-2	4	7	10	12	13	15				
17	-19	-11	-6	0	6	9	12	14	16					
16	-17	-8	-4	2	8	11	15	16						
15	-15	-6	-2	4	11	14	17	18						
14	-13	-4	0	6	13	16	19							
13	-11	-2	2	8	15	18	21							
12	-9	0	4	10	17	20								
11	-7	2	7	12	19	22								
10	-5	4	9	15	21									
9	-3	6	11	17	24									
8	-1	8	13	19	26									
7	1	10	15	21	28									
6	3	12	17	23	30									
5	5	14	19	25	32									
4	7	16	21	27										
3	9	18	23	29										
2	11	20	25	32										
1	13	22	27											

Meters To Feet Conversion

METERS	FEET
0.3	1.0
1.0	3.3
3m	10’
10m	32.8’
30.5m	100’
50m	164.1’
100m	328’
150m	492’
200m	656’
250m	820’
300m	984’
400m	1312’
500m	1640’
600m	1968’
700m	2297’
800m	2625’
900m	2953’
1000m	3280’

Wind Component Chart



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12 NOV 2002
Don R. Klos
DON KLOS
Principal Operations Inspector

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AIRCRAFT GENERAL

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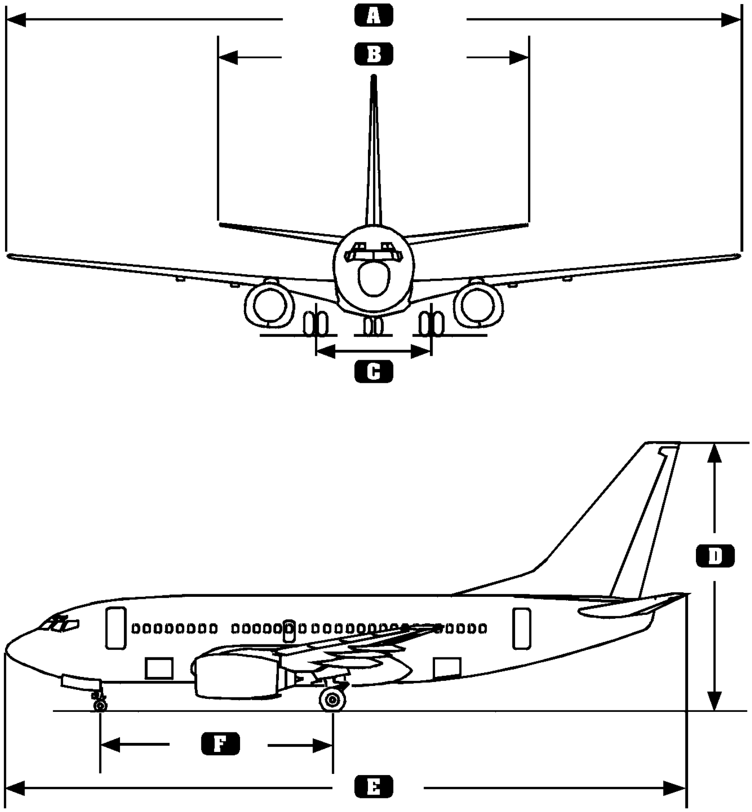
AIRCRAFT GENERAL

PRINCIPAL DIMENSIONS

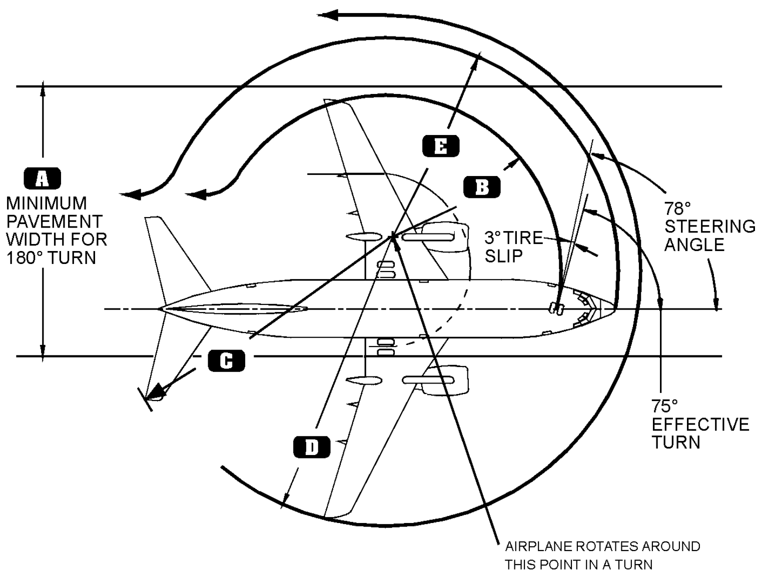


77376001

	③ 3	5	7	8	9
A	94 ft. 9 in.	94 ft. 9 in.	112 ft. 7 in.	112 ft. 7 in.	112 ft. 7 in.
B	41 ft. 8 in.	41 ft. 8 in.	47 ft. 1 in.	47 ft. 1 in.	47 ft. 1 in.
C	17 ft. 2 in.	17 ft. 2 in.	18 ft. 9 in.	18 ft. 9 in.	18 ft. 9 in.
D	36 ft. 6 in.	36 ft. 6 in.	41 ft. 3 in.	41 ft. 2 in.	41 ft. 2 in.
E	109 ft. 7 in.	97 ft. 9 in.	110 ft. 4 in.	129 ft. 6 in.	138 ft. 2 in.
F	40 ft. 10 in.	36 ft. 4 in.	41 ft. 3 in.	51 ft. 2 in.	56 ft. 4 in.

GROUND MANEUVER CAPABILITY

CAUTION: Landing gear geometry and sweep back of 737 airplane wings result in an outward motion of the wing tips and tail during turns.



NOTE:
- Turn initiated with airplane in motion.
- Approximately idle thrust on both engines.
- No differential braking.

77376002

	③ 3	5	7	8	9
A	65 ft.	58 ft. 7 in.	66 ft. 4 in.	77 ft. 1 in.	85 ft. 5 in.
B	43 ft.	38 ft.	43 ft. 8 in.	51 ft. 9 in.	58 ft. 10 in.
C	64 ft.	60 ft.	65 ft. 5 in.	74 ft. 9 in.	78 ft. 4 in.
D	60 ft.	59 ft.	69 ft. 6 in.	71 ft. 6 in.	73 ft. 5 in.
E	55 ft.	50 ft.	55 ft. 9 in.	65 ft. 9 in.	70 ft. 11 in.

This turning radius illustration shows the minimum turning radius capability. The tail describes the largest arc while turning and determines the minimum obstruction clearance path except for the 7.

Note: The wing tip and tail travel outboard up to 10 feet in front of the nose.

FLIGHT DECK ARRANGEMENT

PILOT SEAT ADJUSTMENT

Adjust the seat position with the appropriate controls to obtain the optimum eye reference position. Use the handhold above the forward window to assist.

③ On Non-EFIS Aircraft, the following sight references are used to establish an appropriate eye reference position:

A Sight along the upper surface of the glareshield with a small amount of the aircraft nose structure visible.

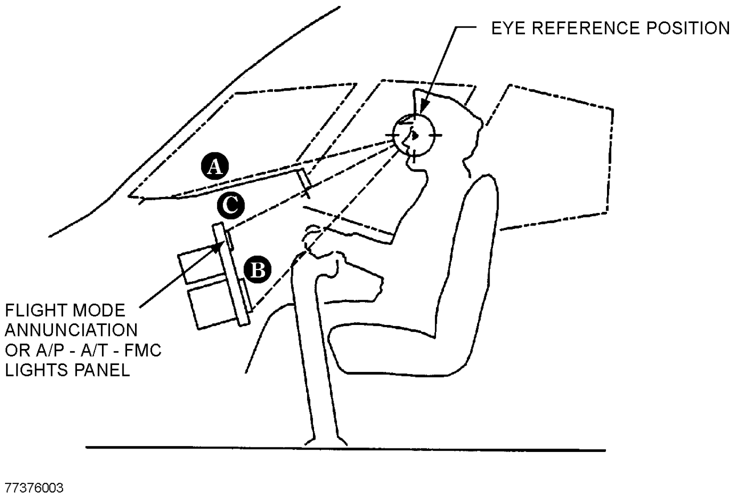
C Sight under the lightshield to view the topmost flight mode annunciators.

3 5 7 8 9 On EFIS Aircraft, the following sight references are used:

A Sight along the upper surface of the glareshield with a small amount of the aircraft nose structure visible.

B Sight over the control column until the bottom of the EHSI or outboard display unit is visible.

C Sight under the lightshield to view the A/P-A/T-FMC Lights Panel.



PILOT SEAT ADJUSTMENT

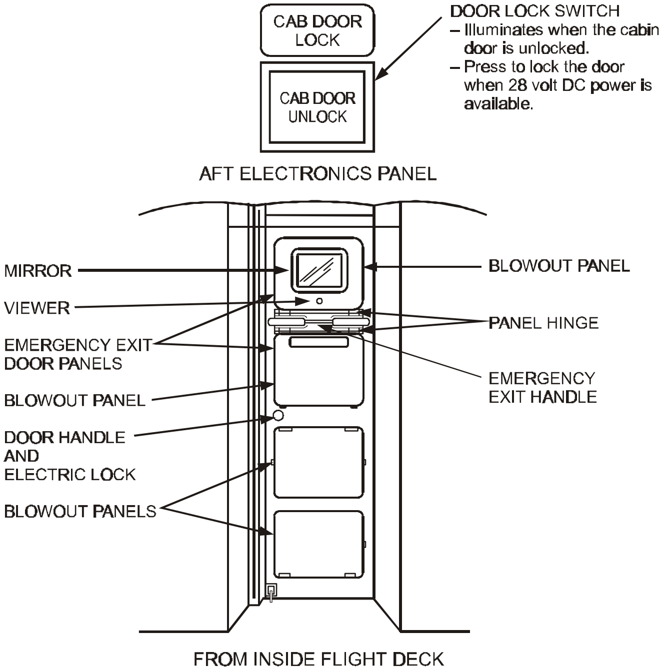
FLIGHT DECK DOOR

An electrical and keyed lock permits the door to be opened, closed, and locked from either side. With 28 volt DC power available, the door may be electrically locked or unlocked by pressing the door lock switch on the control stand; entrance from the passenger cabin requires a key when the door is electronically locked. The door cannot be locked without electrical power. An amber **CAB DOOR UNLOCKED** light is located on the aft electronics panel. Illumination indicates the door is unlocked.

There are four blowout panels located in the flight deck door. In the event of a sudden depressurization of the flight deck, the blowout panels hinge out from the door. This uncovers openings in the door and allows the air pressure on the flight deck and passenger cabin to equalize.

An emergency exit feature is also provided which permits the release and removal of the two upper blowout panels from the door. To operate, pull on the release handle while pressing on the panel below the release handle. Panel will not release unless both ends of handle have been pulled away from their locked position.

Flight Deck Door



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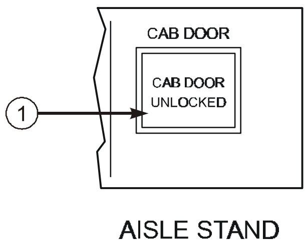


7376-1025

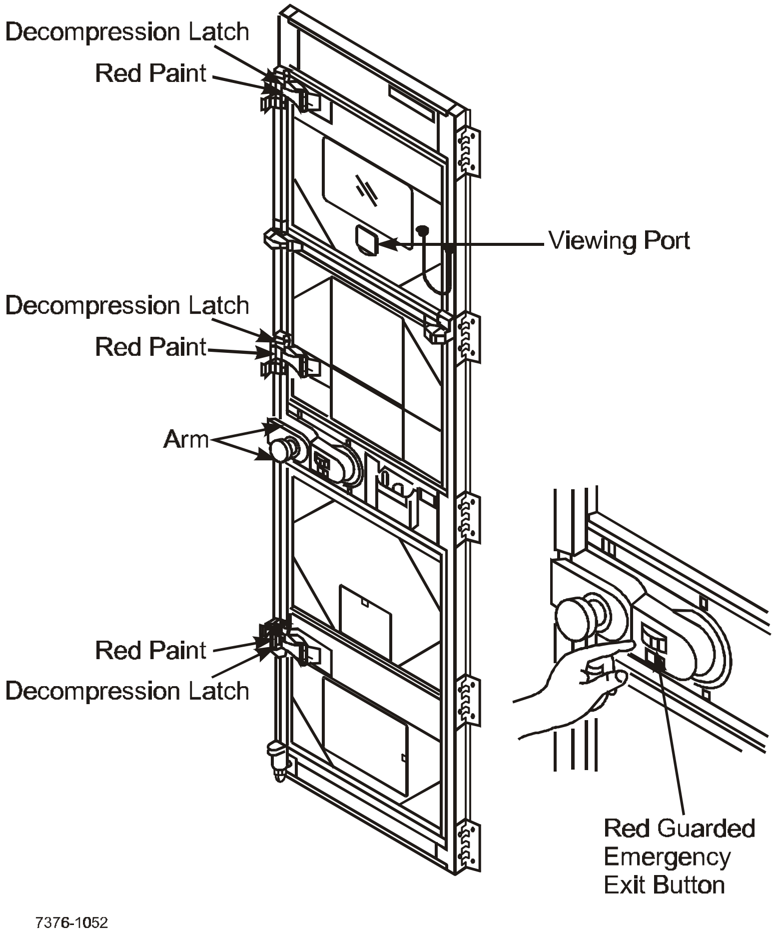
① Flight Deck Door (CAB DOOR) Lock Switch

Illuminated (amber) – Flight deck door is unlocked.

Push – With DC power available, locks flight deck door.

ENHANCED FLIGHT DECK DOOR (If Installed)

The aircraft is equipped with an enhanced flight deck door and integrated security system. When properly locked, this door is able to defend against unauthorized entry by brut force, penetration by bullets, or exposure to small explosive devices.



Overview

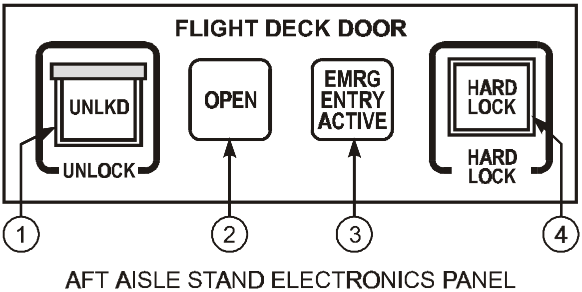
The door is controlled and monitored by a FLIGHT DECK DOOR control panel located on the aft aisle stand electronics panel. It is normally locked by two independent electrical solenoids, either one of which will provide normal locking functions. The door is electrically unlocked by the control panel or by rotating the flight deck side doorknob in either direction. The cabin side door handle is designed to limit pulling forces on the door to 250 lbs. maximum and will not unlock the door.

The door is equipped with four blowout panels controlled by mechanical pressure sensitive latches, which automatically open the panels during rapid depressurization events. A red guarded emergency exit button, located adjacent to the flight deck doorknob and two red panel retainers on the upper door panel allow the blowout panels to serve as an emergency exit if the door becomes jammed. There are instructional placards on the door for use of the emergency exit system and resetting of the door after an emergency exit or depressurization event. There is an independent MECHANICAL LOCK (pin) installed on the flight deck side of the door for use during a system fault or for additional lock redundancy during a ***significant security event***. The door is equipped with a viewing port, which allows a 150° view of the area immediately outside the door.

There is a cabin side FLIGHT DECK DOOR EMERGENCY ENTRANCE panel located by the right side of the door for emergency access to the flight deck or for use as a "panic button" warning during significant security events. A "DOOR, DOOR, DOOR" warning is emitted from dual speakers installed in the flight deck overhead panel when this system is activated.

The door and integrated security system (including control panel, status lights, and warning function) is powered from 28 Volt DC Bus 1 and 28 Volt DC Bus 2. Either bus will power the entire system. With loss of both of these buses (such as standby electrical power operations or with the aircraft unpowered on the ground) the door will be electrically unlocked and all system electrical components including control panel, status lights, and warning functions will be inoperative. Door system faults result in illumination of a red **FLIGHT DECK DOOR** annunciator light located on the forward instrument panel and the red **UNLKD** light on the door control panel.

Flight Deck Door Control Panel



7376-1044

① UNLOCK push button switch, status light, and coverguard.

Raise coverguard, push and hold down switch – electrically unlocks flight deck door. Door will automatically electrically lock anytime switch is released and door is in fully closed position.

UNLKD Light (red):

- Illuminates STEADY:
  - When UNLOCK switch is held down, indicating door is unlocked *(normal condition)*. Also illuminates red **FLIGHT DECK DOOR** light on forward instrument panel.
  - When both solenoids have failed and door is unlocked *(non-normal condition)*. Also illuminates red **FLIGHT DECK DOOR** light on the forward instrument panel.
- Illuminates FLASHING:
  - Indicates a fault in the door system or status lights and security of the door is unknown *(non-normal)*. Also illuminates red flashing **FLIGHT DECK DOOR** light on forward instrument panel.

Note: With both **UNLKD** and **FLIGHT DECK DOOR** lights illuminated *(non-normal condition)*, pushing the HARD LOCK switch extinguishes the lights but does not activate HARD LOCK mode. **This action does not ensure door security, therefore the mechanical lock must be engaged.**

② Door **OPEN** Status Light

Illuminated (amber) – The door is not closed against the door jam.

③ **EMRG ENTRY ACTIVE** Status Light

Illuminates flashing (red) – The cabin mounted FLIGHT DECK DOOR EMERGENCY ENTRANCE switch has been pressed. The status light will flash and "DOOR, DOOR, DOOR" warning message will be heard for 30 seconds or until HARD LOCK or UNLKD switch is pushed.

④ HARD LOCK Push Button Switch, Status Light, and Coverguard

Raise coverguard and push switch – overrides the FLIGHT DECK DOOR EMERGENCY ENTRANCE system:

- Illuminates **HARD LOCKED** status light.
- Extinguishes flashing **EMERG ENTRY ACTIVE** status light.
- Stops "DOOR, DOOR, DOOR" warning message.
- Stops door emergency entrance unlock function that would occur after 30 seconds, thus keeping door electrically locked.
- Makes cabin mounted FLIGHT DECK DOOR EMERGENCY ENTRANCE switch inactive while in HARD LOCKED mode.
- System stays in HARD LOCKED mode for 30 minutes and then automatically comes out of mode and turns off **HARD LOCKED** status light. Timer can be reset to start over for another 30 minutes at any point in time by pushing the HARD LOCK switch again.
- Mode can be disabled at any time by momentarily turning the flight deck doorknob to open (do not need to open door).
- If the **UNLKD** light and **FLIGHT DECK DOOR** light are illuminated (indicating a system fault), pushing the HARD LOCK switch will:
  - Extinguish the **UNLKD** light
  - Extinguish the **FLIGHT DECK DOOR** light
  - *Not* engage HARD LOCK mode
  - *Not* illuminate **HARD LOCK** light
  - *Not* ensure the door is locked.

Flight Deck Door Warning Light

FORWARD INSTRUMENT PANEL

7376-1045

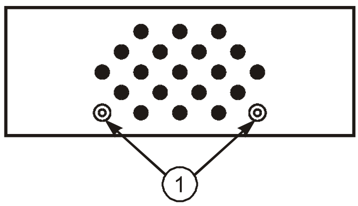
Illuminates steady or flashing (red) for:

The UNLOCK push button switch on the control panel is being held down *(normal)*.

or

There is a fault / failure in the door system *(non-normal)*. Can be extinguished by pushing the HARD LOCK switch.

Door Dual Warning Speakers



FLIGHT DECK OVERHEAD PANEL

7376-1046

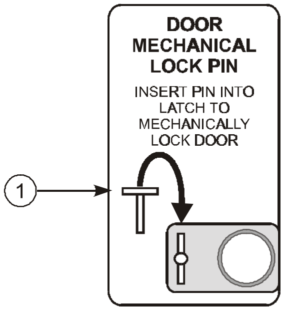
① LED Test Diodes

Illuminate (green) whenever there are electrical inputs into the dual warning speakers, which announce “DOOR, DOOR, DOOR.”

Door Mechanical Lock

In the event the mechanical lock must be used due to a ***system failure***, a flight attendant, working crew member, or other authorized ACM / jumpseat rider will have to remain inside the flight deck to engage / disengage the lock anytime there is only one pilot on the flight deck. This is to insure access to the flight deck in the event the one pilot becomes incapacitated.

If the mechanical lock is to be used during a ***significant security incident*** the flight deck door should not be opened regardless of the number of pilots on the flight deck until the incident is stabilized.



STORED ON INSIDE FLIGHT DECK DOOR

7376-1047

① Mechanical Lock (pin)

- Instructional placard near doorknob
- Insert pin into hold on door latch to mechanically lock the door
- Serves as a redundant lock during a ***significant security incident***
- Does not rely on electrical power
- Retains depressurization blowout panel functions
- Retains flight deck emergency exit functions
- Will not allow door to be opened by FLIGHT DECK DOOR EMERGENCY ENTRANCE system.

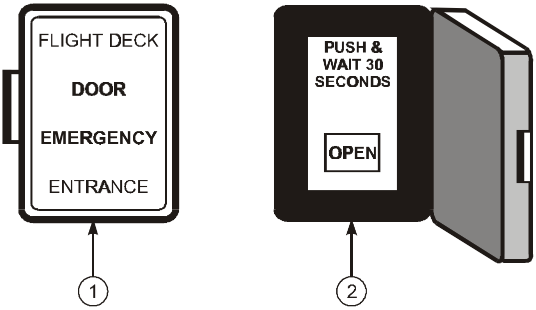
Emergency Entrance System

Note: This emergency system is never to be used for normal entrance to the flight deck. (The system may be used by a pilot or maintenance technician if the door has been inadvertently locked while on the ground.)

The primary function for the cabin mounted emergency entrance system is to afford access to the flight deck after all attempts to contact the flight deck have failed and the assumption is made that all pilots are incapacitated. Open the access door on the FLIGHT DECK DOOR EMERGENCY ENTRANCE panel located in the cabin near the door and push the OPEN switch. If no pilot action is taken it presumes that all pilots are incapacitated, and after 30 seconds the alert warning will stop and the door will be unlocked for ***only 5 seconds*** to allow opening. If the door is not opened during this time, it will relock and the process will have to be repeated.

This same system may be used as an alternate means of alerting the flight crew of a ***significant security incident*** if interphone communications are not possible or timely (panic button feature). Provided both pilots are not incapacitated, they will immediately engage the HARD LOCK mode. The door will remain locked and the flight crew will immediately begin attempts to communicate with the cabin to determine the problem. If communications with the cabin are not possible and the flight crew is unable to determine the severity of the incident, it will be considered a *LEVEL 4 SECURITY INCIDENT*.

Flight Deck Door Emergency Entrance Panel



CABIN MOUNTED PANEL TO RIGHT OF DOOR

7376-1048

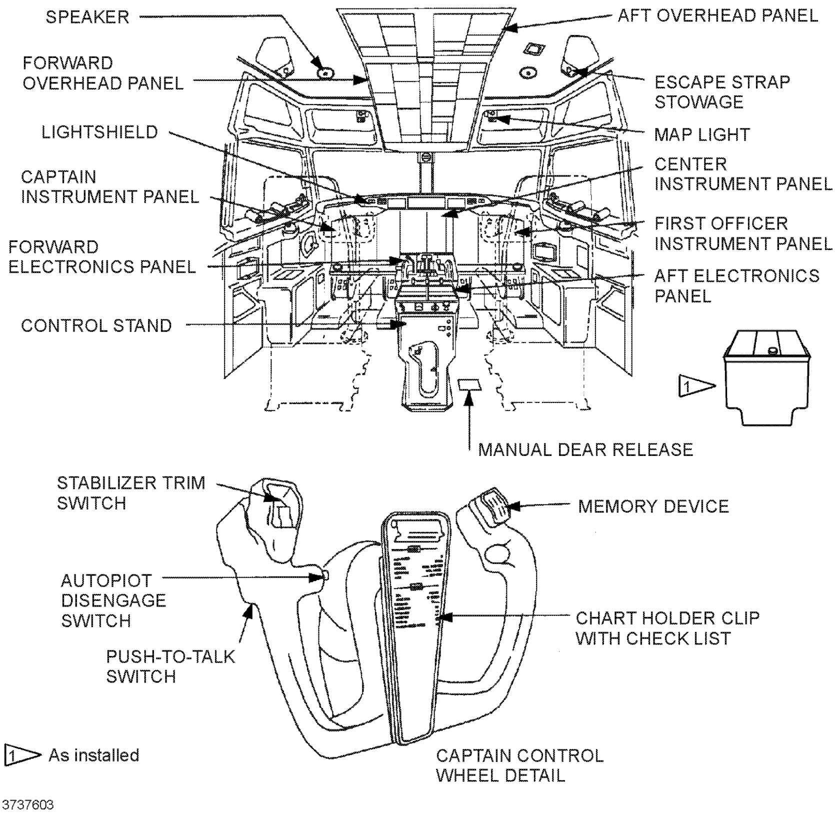
Flight deck emergency entrance switch and door cover.

① Open door

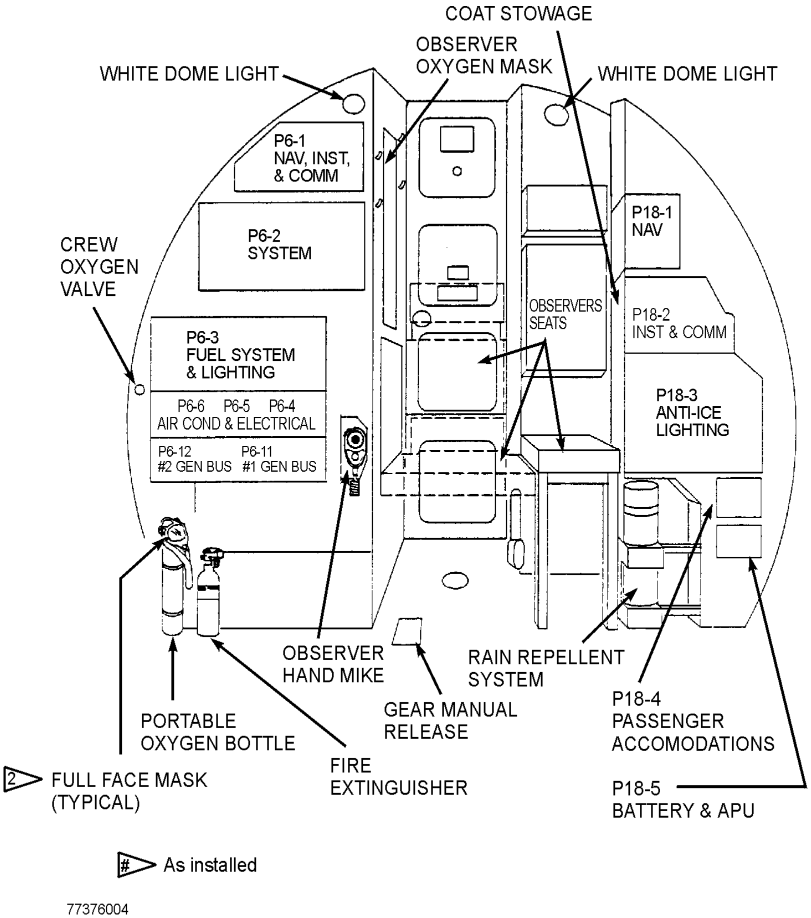
② Push switch:

- Illuminates flashing (red) flight deck control panel **EMRG ENTRY ACTIVE** light
- "DOOR, DOOR, DOOR" warning message will be heard for 30 seconds
  - If flight crew *intervenes* during the 30 seconds by pushing flight deck control panel HARD LOCK switch, warning message will stop and emergency entrance system is deactivated for 30 minutes or more as determined by flight crew. The flight crew may, at any time, reset the system by rotating the flight deck doorknob to open (no need to open door).
  - If flight crew *does not intervene*, after 30 seconds the "DOOR, DOOR, DOOR" warning message will stop and the door will electrically unlock for only **5 seconds** to allow access, after which it will automatically relock if closed.

    Note: If the MECHANICAL LOCK (pin) has been engaged, use of the emergency entrance system will not allow the door to be opened.

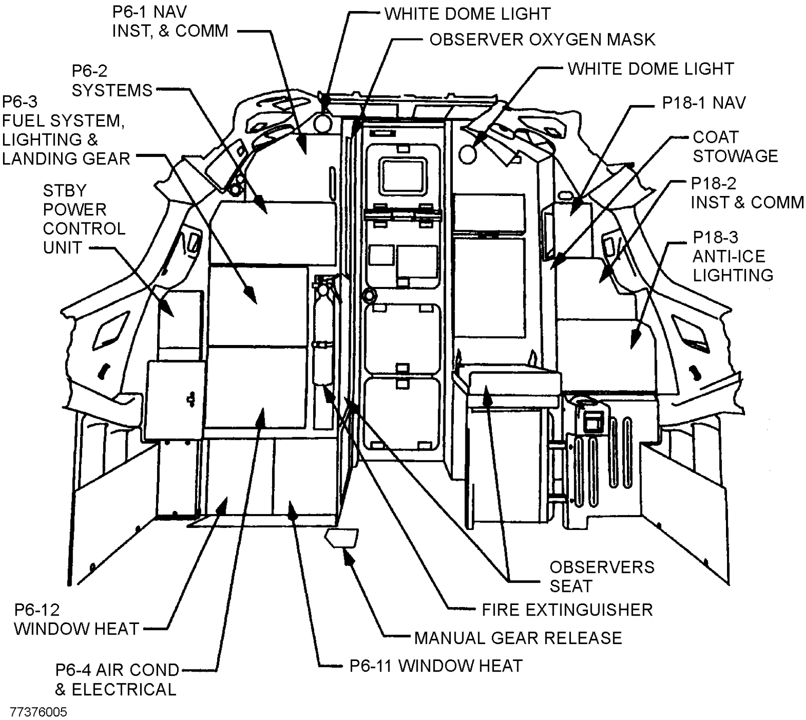


PANEL ARRANGEMENT



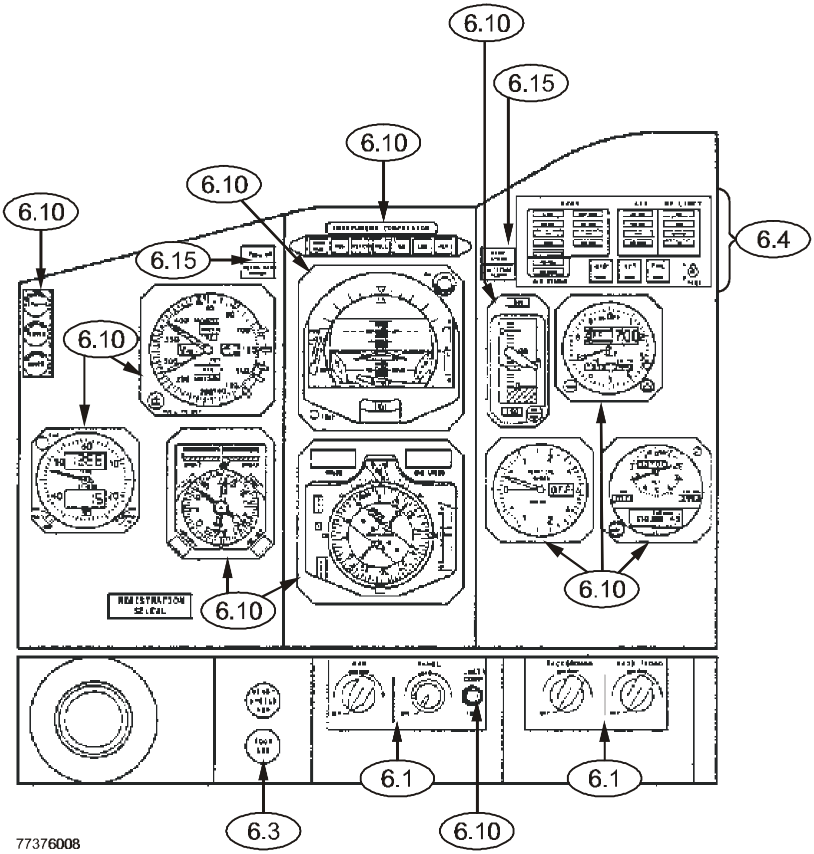
AFT FLIGHT DECK OVERVIEW

③ 3 5



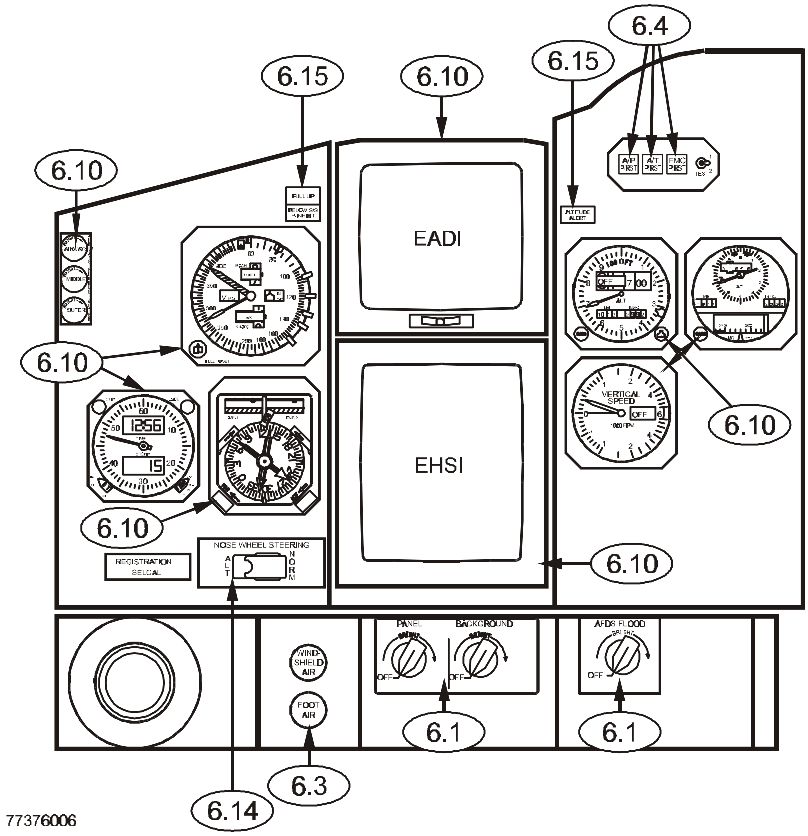
AFT FLIGHT DECK OVERVIEW

7 8 9



CAPTAIN INSTRUMENT PANEL

③



CAPTAIN INSTRUMENT PANEL

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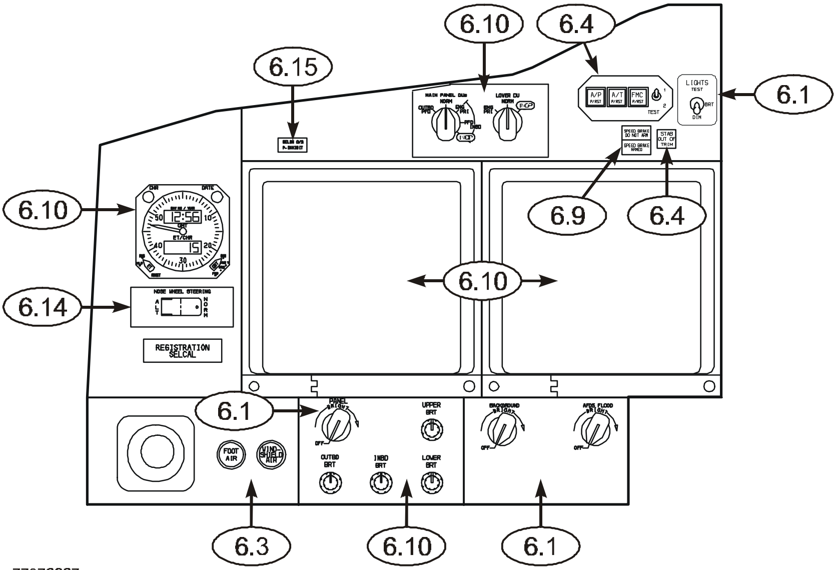

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CAPTAIN INSTRUMENT PANEL

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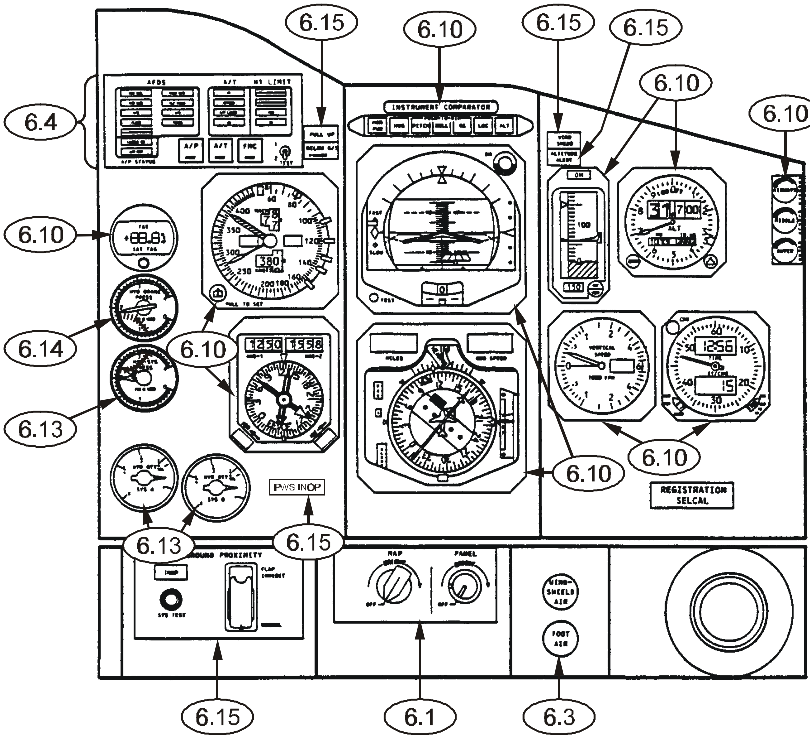

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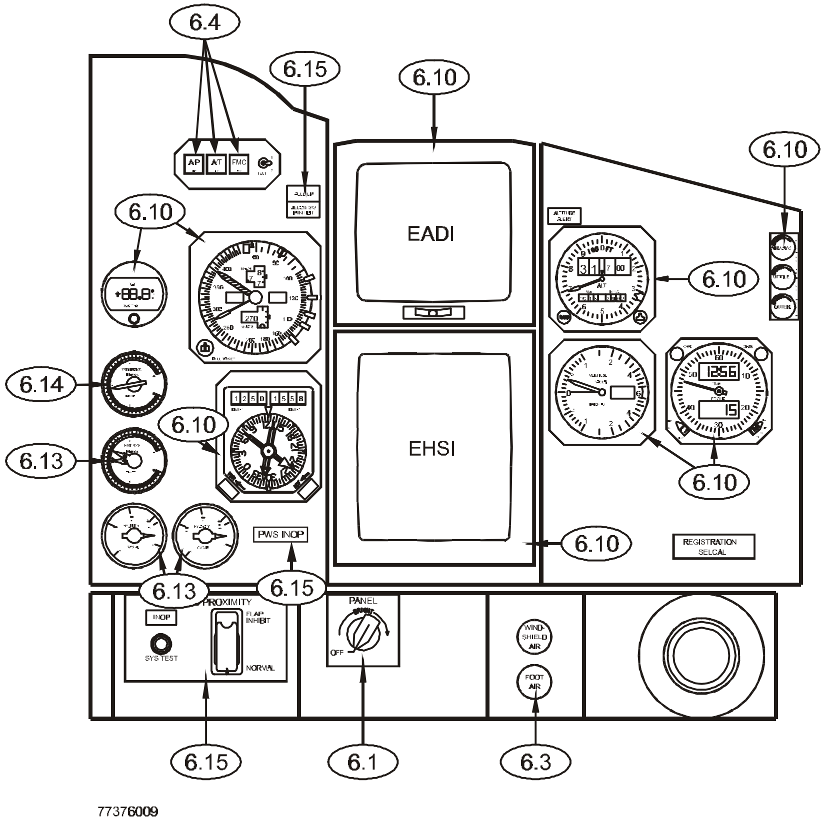
FIRST OFFICER INSTRUMENT PANEL

③



FIRST OFFICER INSTRUMENT PANEL

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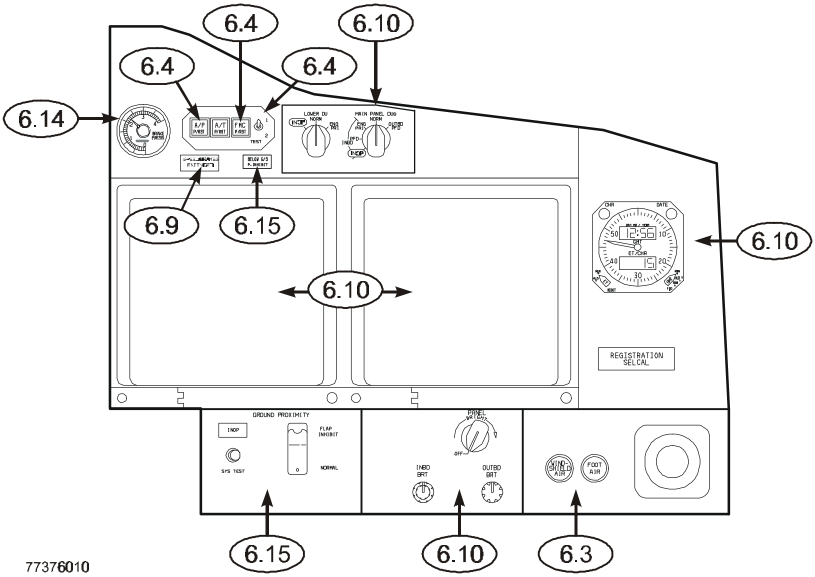

FIRST OFFICER INSTRUMENT PANEL

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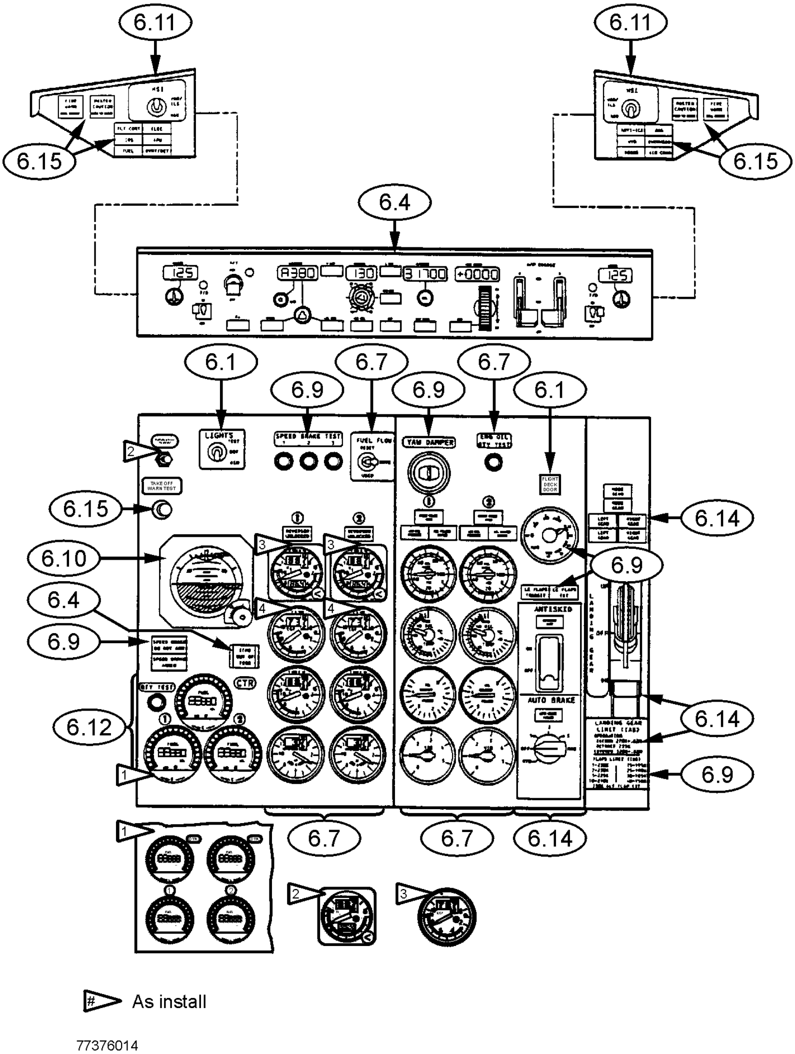
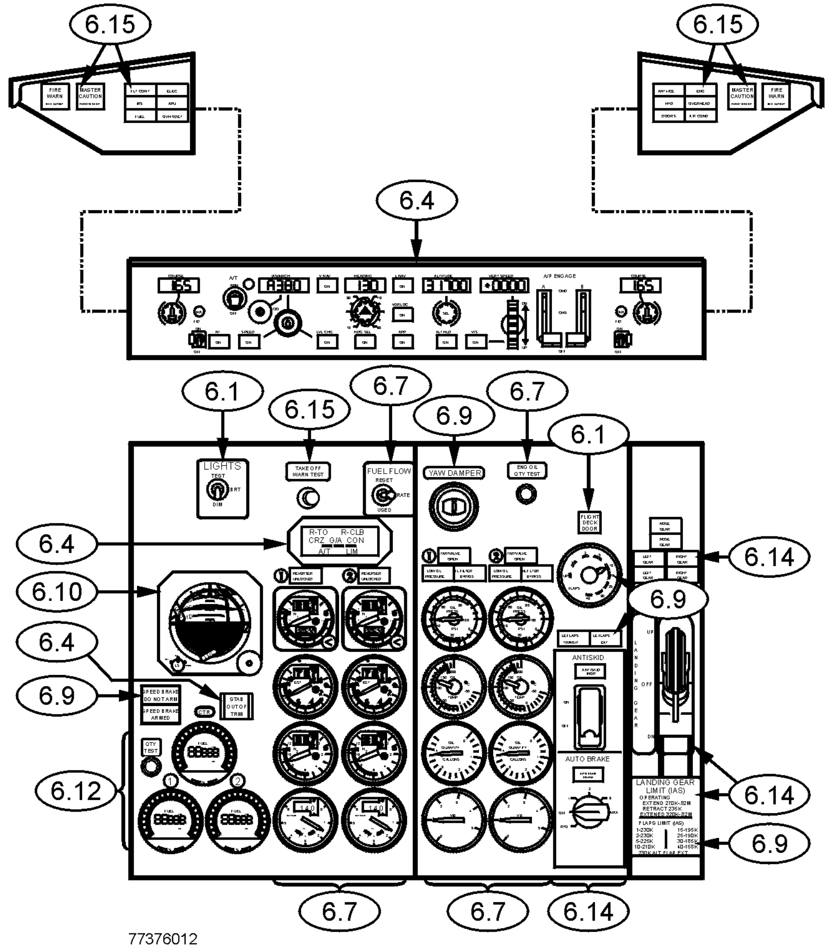


CENTER INSTRUMENT PANEL & LIGHT SHIELD

③



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CENTER INSTRUMENT PANEL & LIGHT SHIELD

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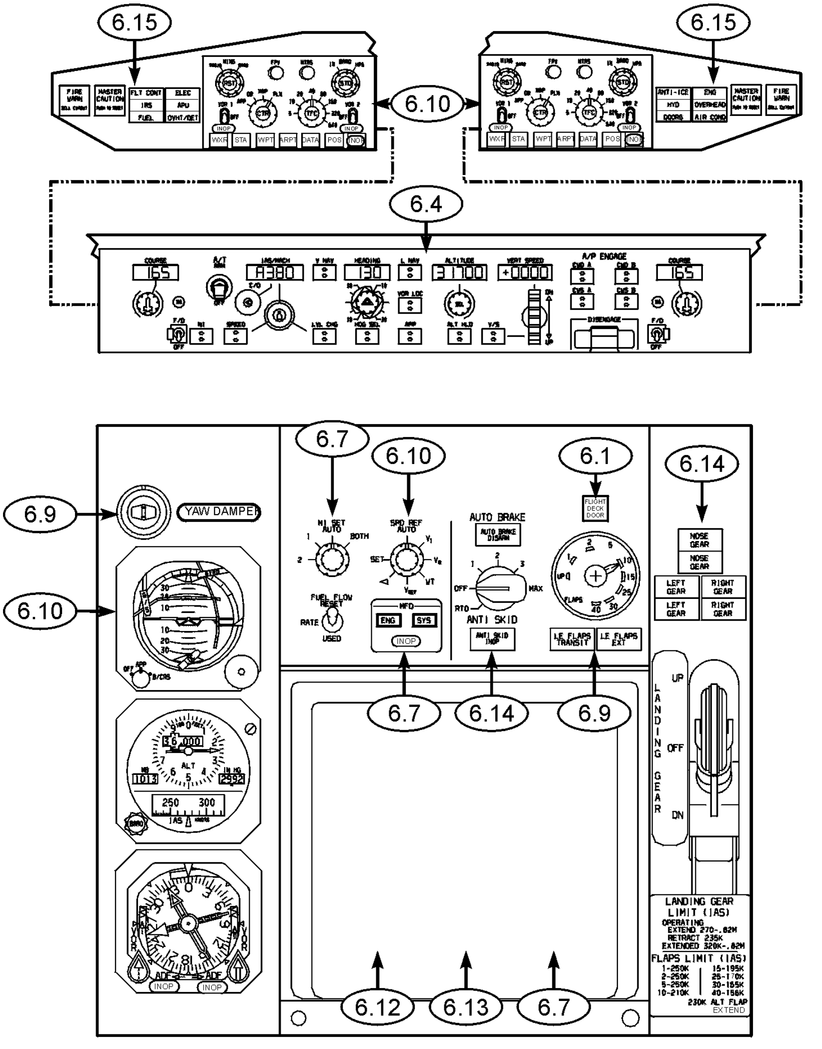

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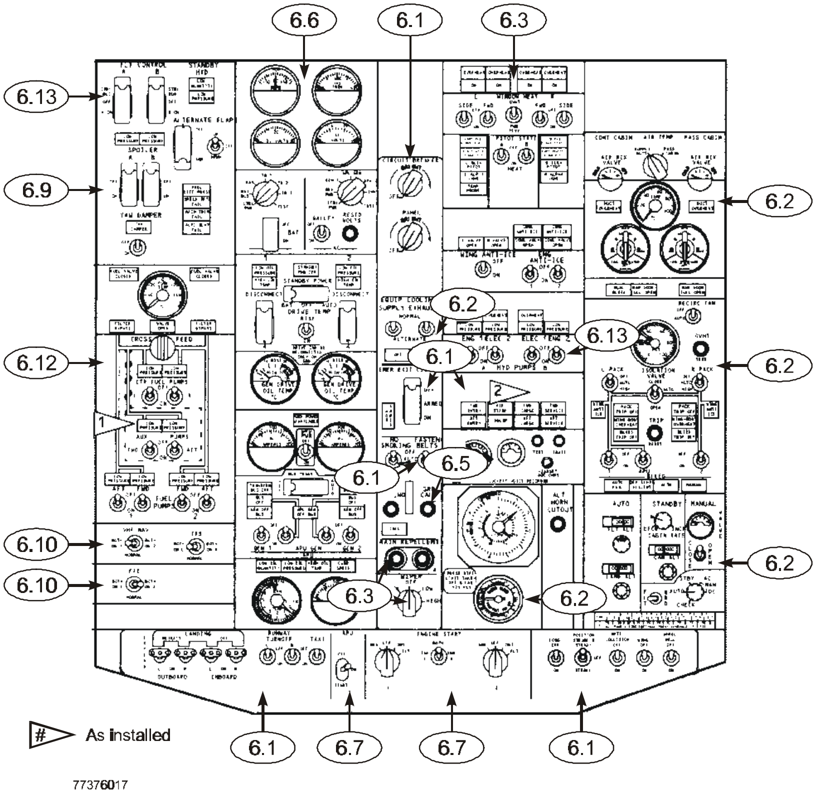
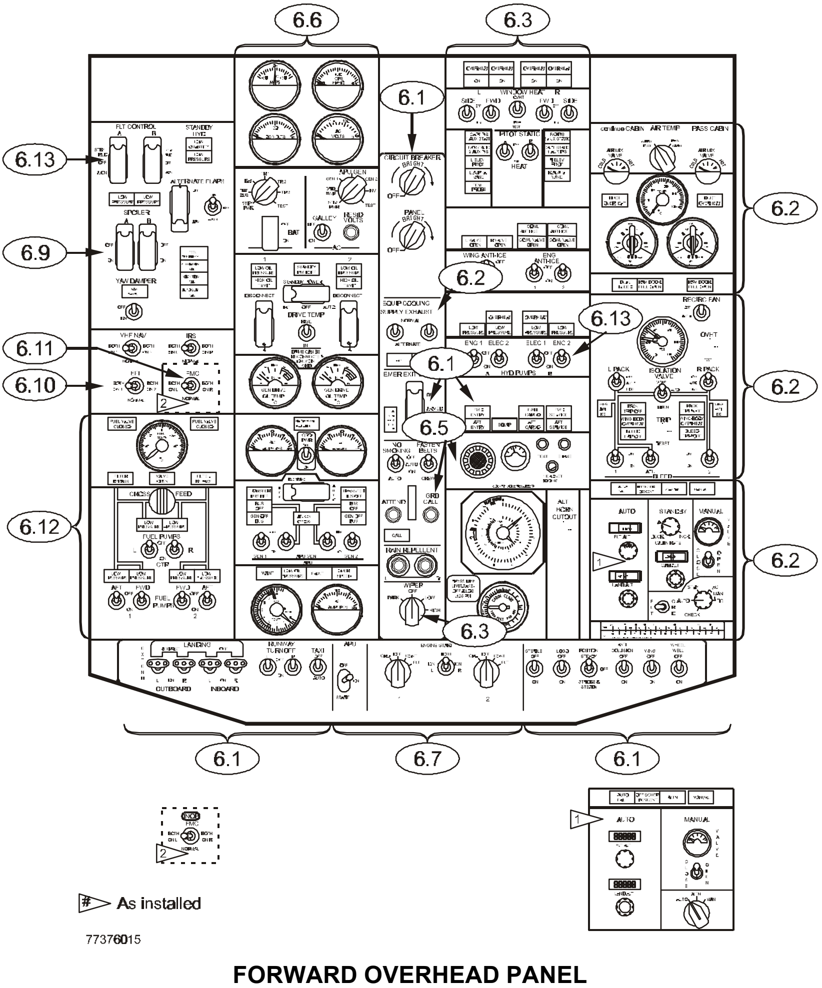
CENTER INSTRUMENT PANEL & LIGHT SHIELD

7 8 9



FORWARD OVERHEAD PANEL

③



FORWARD OVERHEAD PANEL

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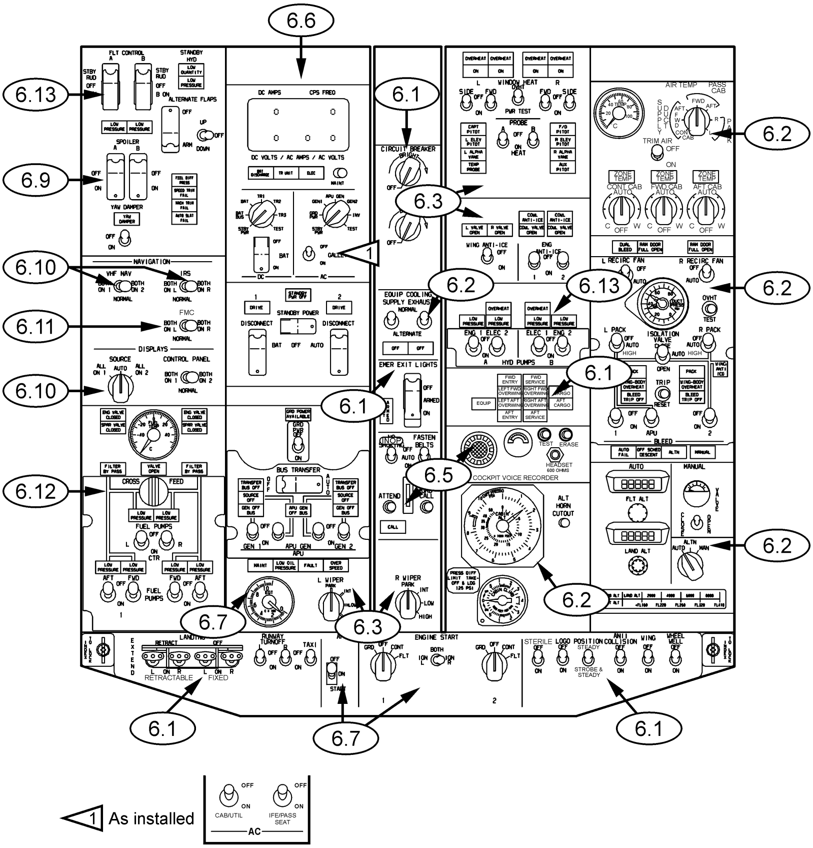

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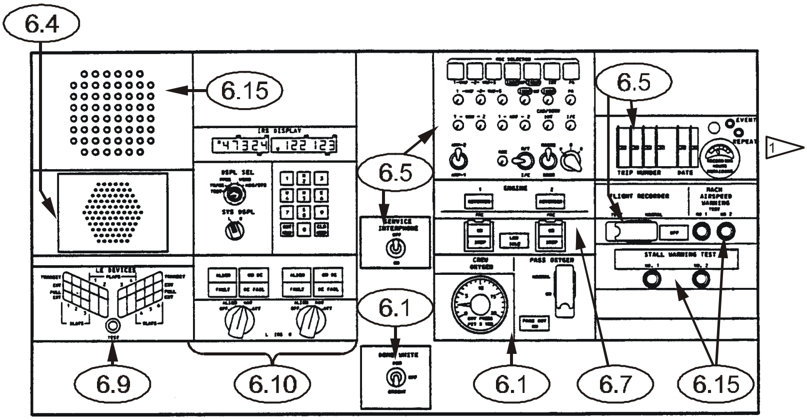
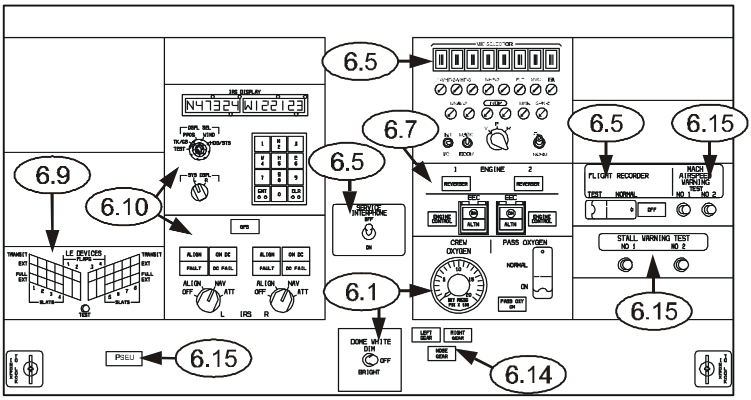
FORWARD OVERHEAD PANEL



1 As installed

3 3 5



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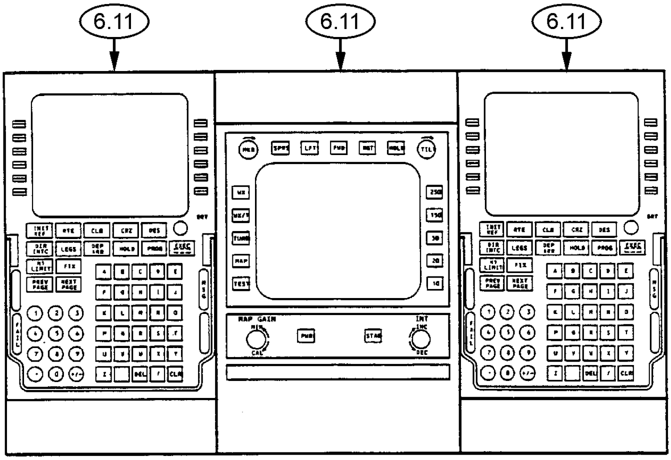
AFT OVERHEAD PANELS



FORWARD ELECTRONIC PANEL

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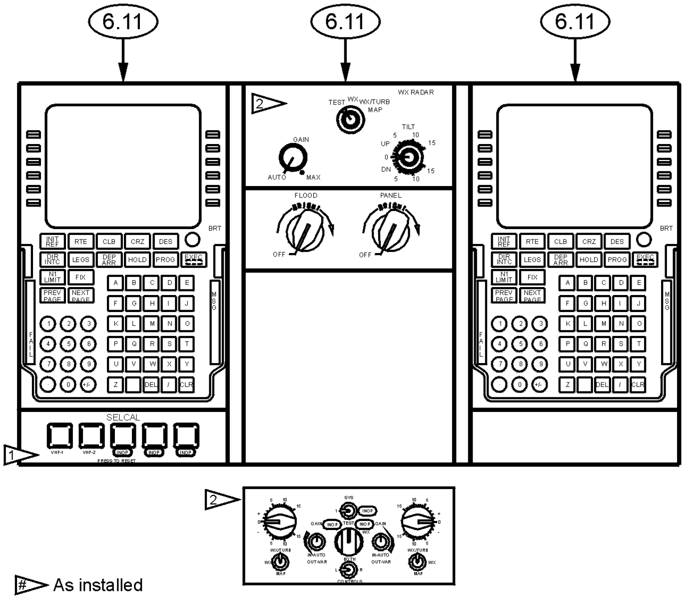

As installed

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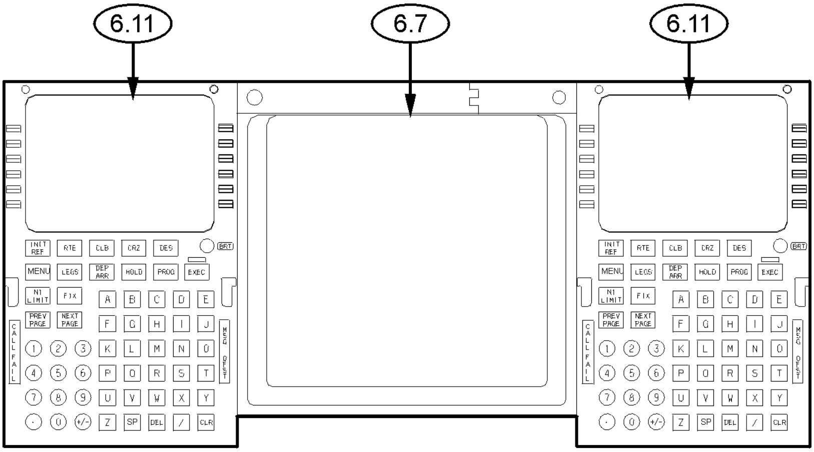
FORWARD ELECTRONIC PANEL

3 5

FORWARD ELECTRONIC PANELS



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FORWARD ELECTRONIC PANEL

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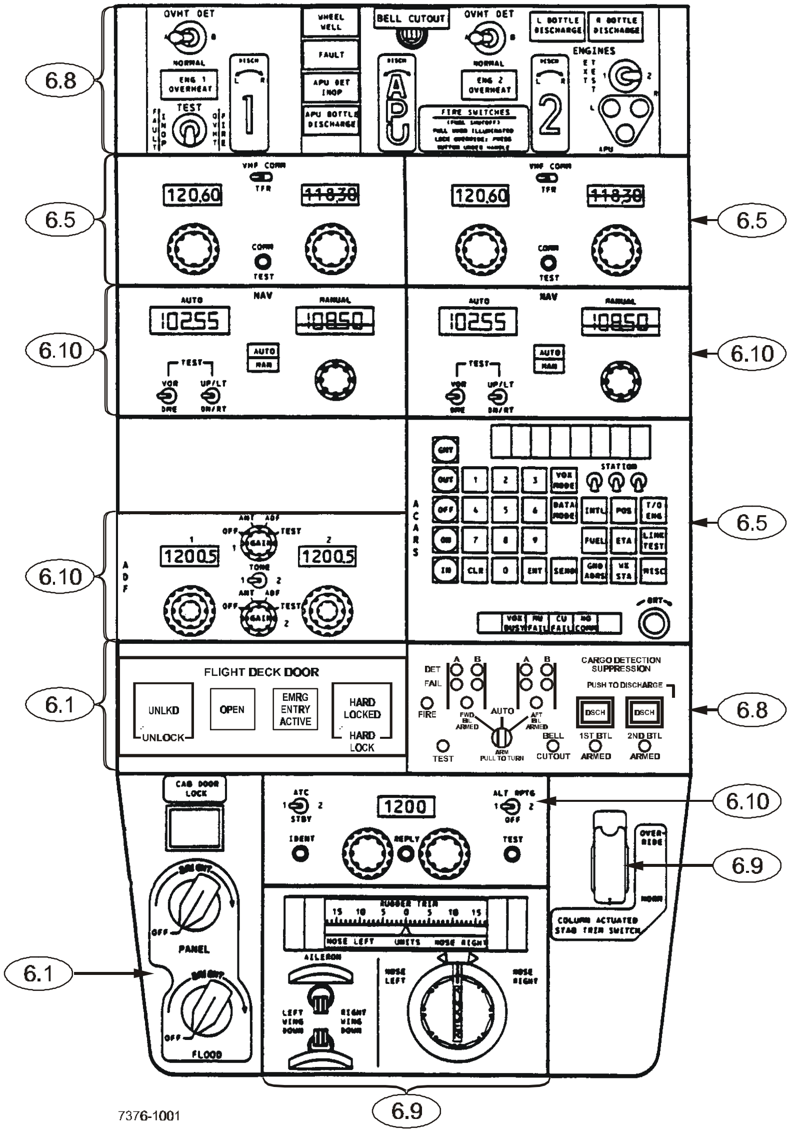

AFT ELECTRONIC PANEL

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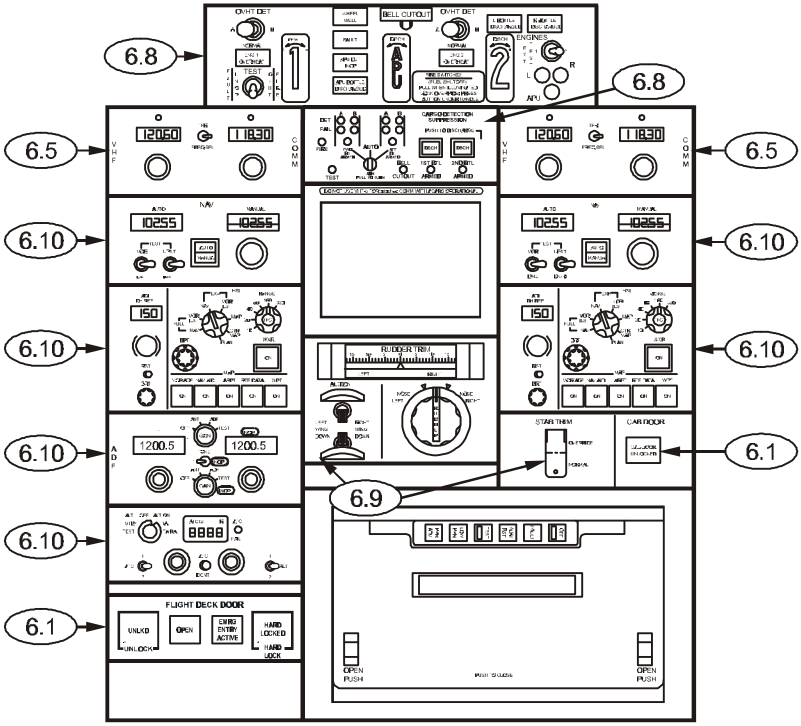
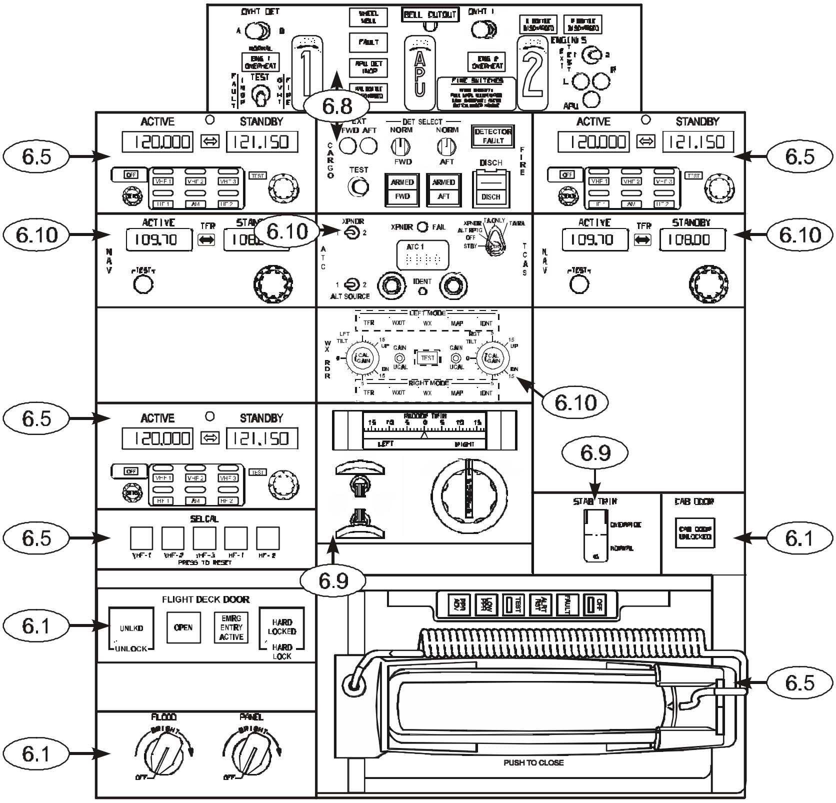


7376-1002

AFT ELECTRONIC PANEL

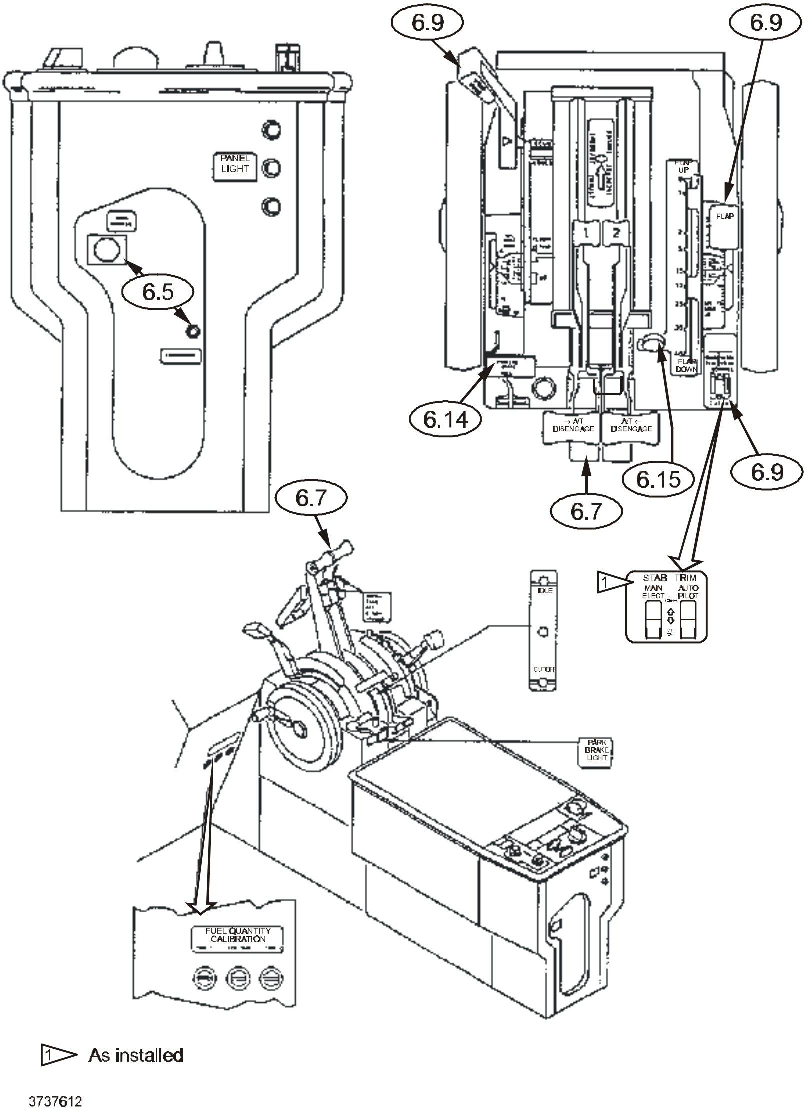
3 5



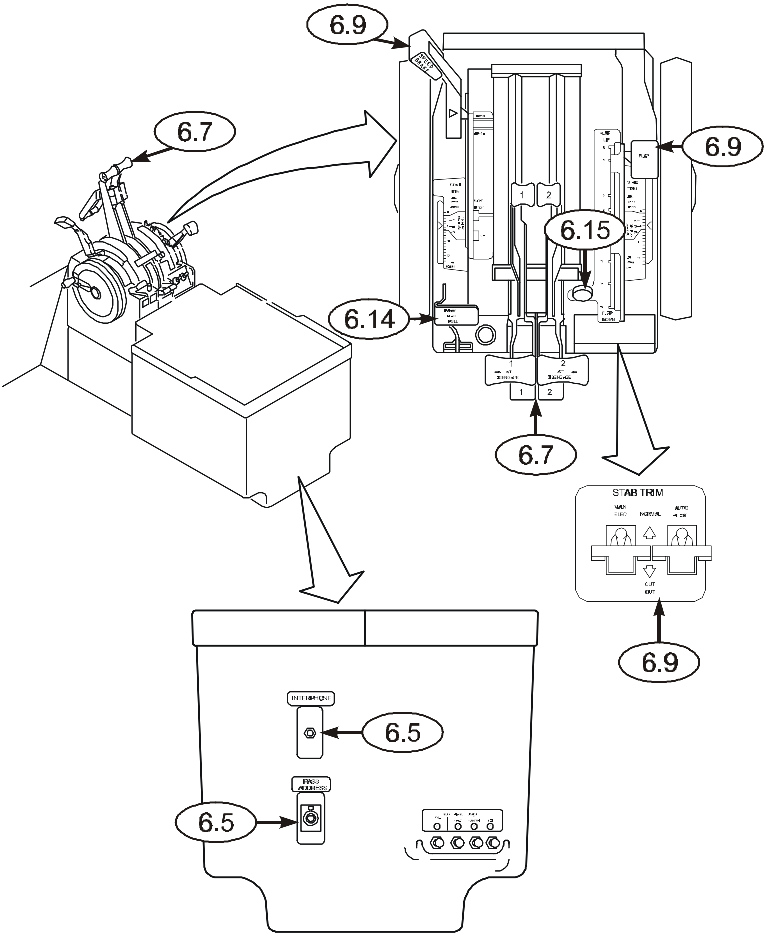
7376-1003

AFT ELECTRONIC PANEL

7 8 9



CONTROL STAND
③



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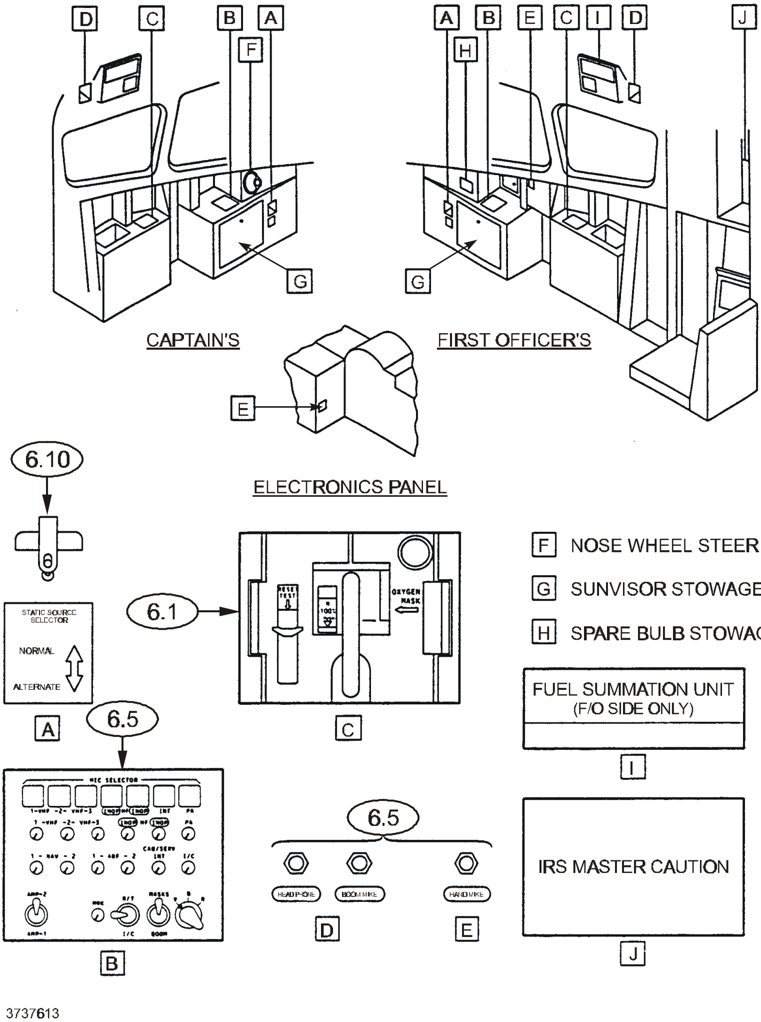
7376-1004

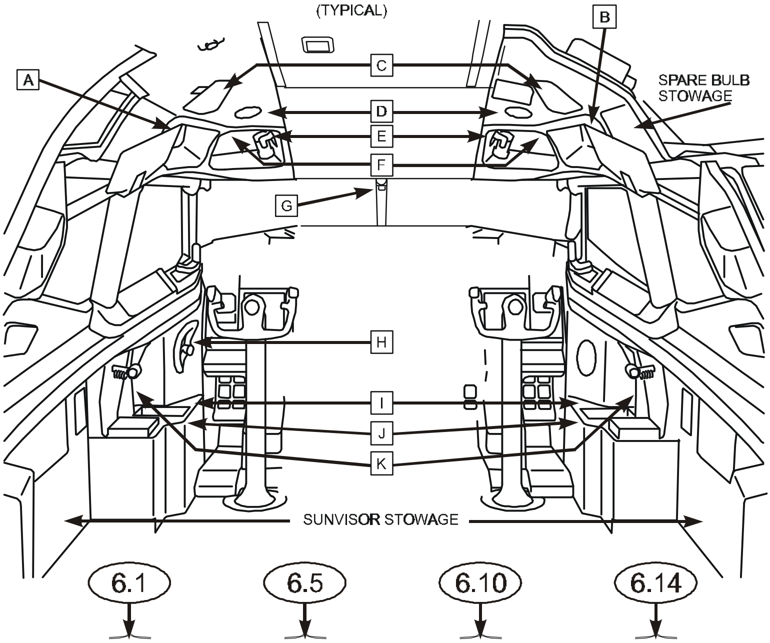
CONTROL STAND

3 5 7 8 9



AUXILIARY PANELS

③

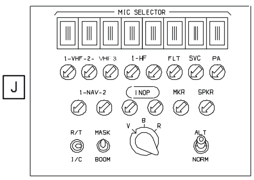


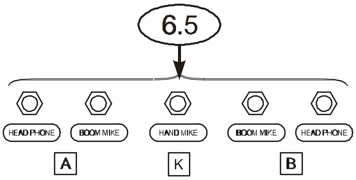
C ESCAPE STRAP STOWAGE
E MAP LIGHT
F CHART LIGHT
I CHART AND MAP LIGHT CONTROLS
J OXYGEN MASK AND AUDIO CONTROL PANELS

D SPEAKER
J AUDIO CONTROL PANELS

G STANDBY MAGNETIC COMPASS

H NOSE WHEEL STEERING





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7376-1005

AUXILIARY PANELS

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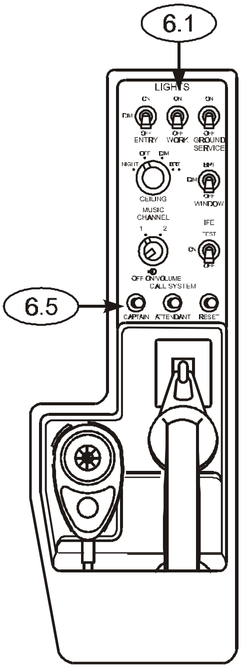
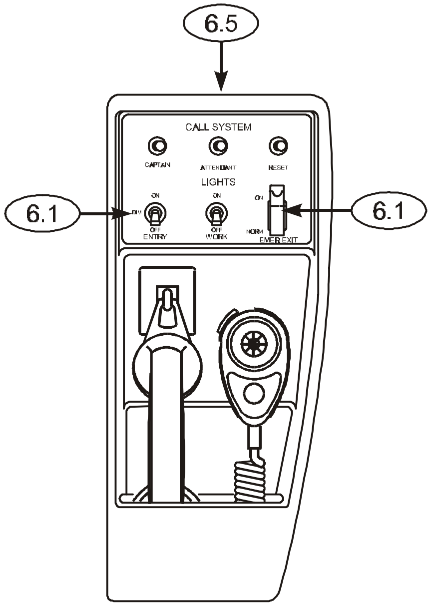


FORWARD ATTENDANT
PANEL



AFT ATTENDANT PANEL

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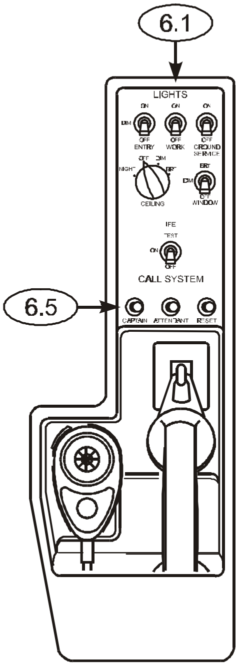
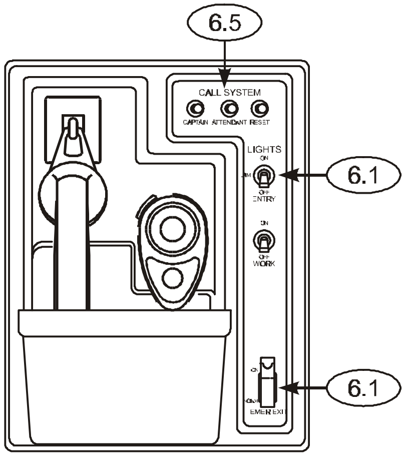
7376-1006



FORWARD ATTENDANT
PANEL



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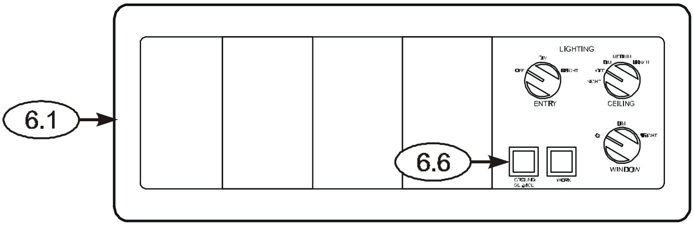
7376-1007



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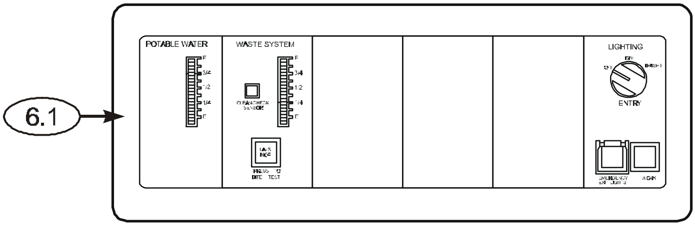
FORWARD ATTENDANT PANEL



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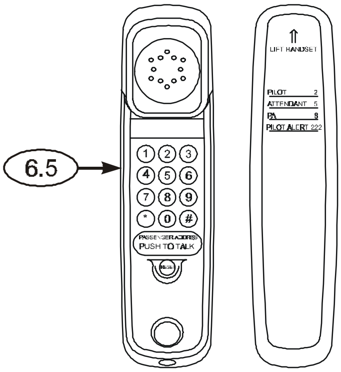
7376-1009

AFT ATTENDANT PANEL



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7376-1010

ATTENDANT HANDSET

7 8 9

LOWER CARGO COMPARTMENTS

The lower cargo compartments are designed and constructed to satisfy United States Federal Aviation Administration (FAA) category class C compartment requirements. The cargo compartment classification was changed from D to C with the installation of the smoke detection and fire suppression system. The compartments are sealed and pressurized but do not have fresh air circulation and temperature control as do the upper passenger compartments.

There are two cargo compartment doors on the lower right side of the fuselage. Both are plug type, inward-opening pressure doors, hinged at their upper edges and operated manually from either inside or outside the aircraft. Except for slight difference in shape, both doors are similar in design and operation. The door is locked closed by four latches. Each door has a "balance mechanism" which creates door-open force slightly more than equal to the weight of the door. The door can therefore, with little or no manual effort, be swung open until it engages a mechanical uplock. The door can be closed easily by pulling a lanyard attached to the door, releasing the uplatch, grasping the handle and closing the door.

Note: When the doors are not locked, the **MASTER CAUTION** light and **DOOR ANNUNCIATOR** are illuminated.

A pressure equalization valve is in the aft bulkhead of each compartment. The valves let only enough air flow into or out of the cargo compartments to keep the pressures nearly the same as the cabin pressure.

Blowout panels in the lower cargo compartments provide pressure relief at a greater rate than the pressure equalization valve in case the aircraft should suddenly lose pressurization.

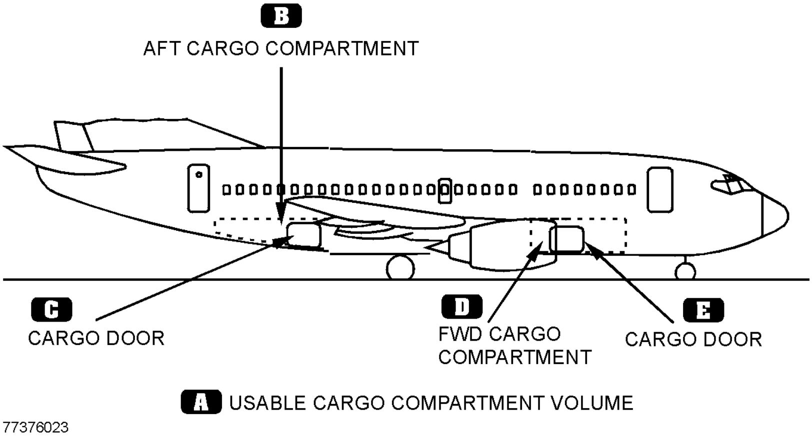
9 SLIDING CARPET CARGO LOADING SYSTEM

A sliding carpet cargo loading system is installed on the B737-900 aircraft. The sliding carpet cargo system installed in the forward and aft cargo bays will allow one person in the bay to load and unload baggage in a shorter time than previously experienced.

A "bulkhead" attached to a continuous loop "carpet" moves from the extreme end of the cargo bay to the loading door on the aircraft. As the baggage fills the space from the bottom of the bay to the top, the "bulkhead" is moved toward the back / front of the compartment with the baggage on the carpet. When all baggage is loaded, a cargo net is installed to hold the cargo in place to prevent shifting in flight. To unload the bags, the "bulkhead" direction is reversed, and as the "bulkhead" moves toward the cargo-loading door, the bags are quickly and efficiently unloaded from the "carpet."

These loading systems are designed to be operated on the ground only. Electrical logic is provided to remove power from each system when the respective cargo door is closed.

Flight deck control over the system is through two circuit breakers located on the lower P6/11 panel labeled CARGO LOADER CONTROL AFT and CARGO LOADER CONTROL FWD. To activate the system, 115V AC and 28V DC electrical power must be available. With the battery switch ON, ground power selected ON, and the two circuit breakers set, power will be available to the control panels in the respective cargo bays for use by the ground personnel.



	3 3	5	7	8	9
A	1068 Cu. Ft.	816 Cu. Ft.	946 Cu. Ft.	1530 Cu. Ft.	1827 Cu. Ft.
B	643 Cu. Ft.	535 Cu. Ft.	580 Cu. Ft.	883 Cu. Ft.	1002 Cu. Ft.
C	33” x 48”	33” x 48”	33” x 48”	33” x 48”	33” x 48”
D	425 Cu. Ft.	281 Cu. Ft.	366 Cu. Ft.	647 Cu. Ft.	825 Cu. Ft.
E	35” x 48”	35” x 48”	35” x 48”	35” x 48”	35” x 48”

LOWER CARGO COMPARTMENTS

WATER AND WASTE SYSTEMS – WATER SYSTEM

GENERAL

The potable aircraft water system is supplied from a single tank located behind the aft cargo compartment. Fresh water is supplied to the galleys and lavatory sinks. All water is filtered.

QUANTITY INDICATION AND SYSTEM OPERATION

③ 3 5 A quantity indicator is located above the aft service door. When PUSH BUTTON on the indicator is pressed, lights illuminate to show the water level. When full, approximately 20 U.S. gallons will be available.

7 8 9 The potable water quantity indicator is located on the aft flight attendant panel. The water quantity shows continuously, there is no button.

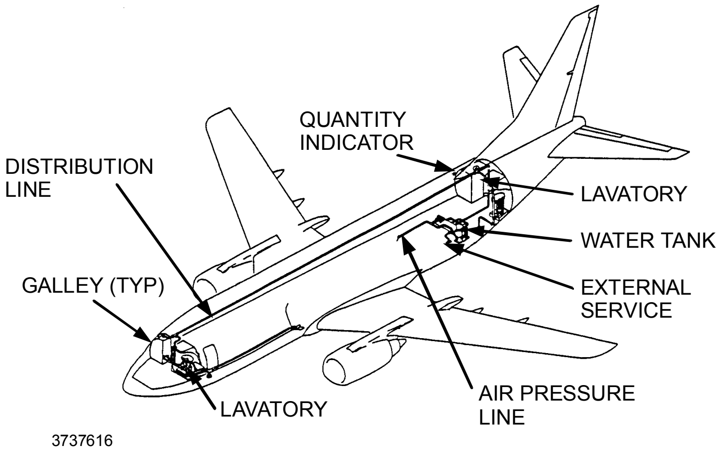
The system is pressurized when the left engine or the APU is running. A shutoff valve is located in the cabinet below the sink in each lavatory. The drain position of this valve is used to drain all water overboard. Normally, the drain shutoff valves will be ON.

HOT WATER

Hot and cold water is available in the lavatories. The water heater is located below the lavatory sink and maintains a water temperature of 125°F (52°C) to 133°F (56°C). When emptied, it will heat a new water charge in four minutes. An amber light is illuminated when the heater is operating normally. The heater has an overheat switch which turns off the heating element at 190°F (88°C). The heater may be turned off at any time by using a manual switch on the heater. Hot and cold water is also supplied at the galleys.

SERVICING

The system is serviced from an exterior panel on the aft fuselage. Pressure filling is required. Wastewater from the galleys and lavatory wash basins is drained overboard through two heated drain masts. The drain masts are on the bottom of the fuselage; one forward and one aft.



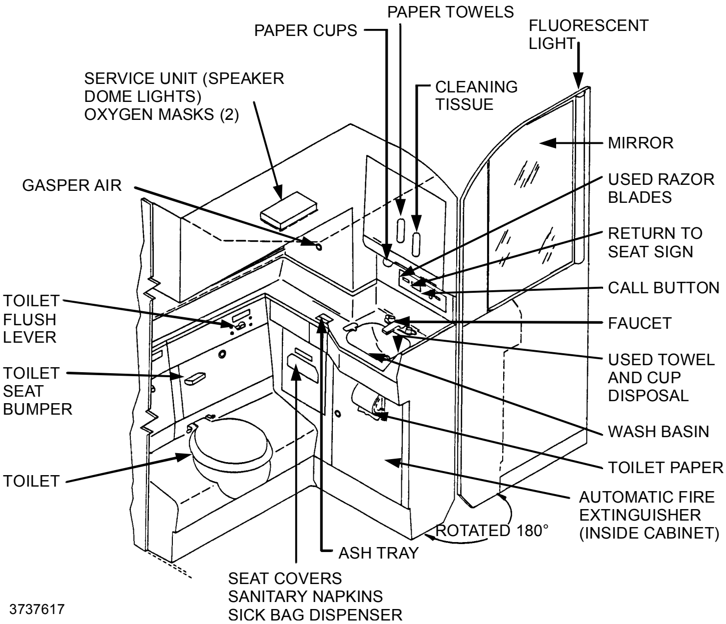
WATER AND WASTE SYSTEM

WATER AND WASTE SYSTEM – WASTE SYSTEM

③ 3 5 Each lavatory has an independent toilet waste system. Toilet waste is stored in a toilet tank in each lavatory. During ground servicing the toilet tanks are drained, rinsed and a chemical precharge is added. The tanks are vented to the lavatory vent system.

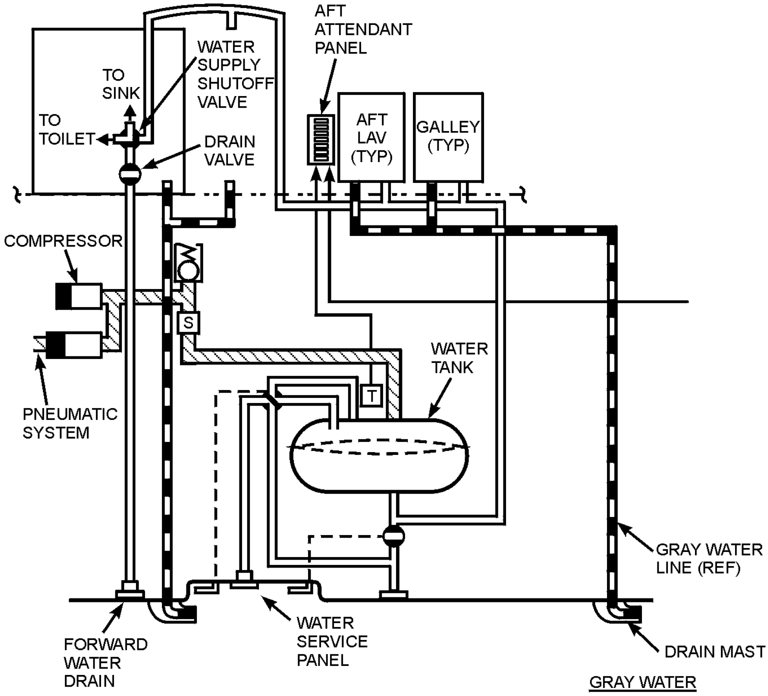
A stainless steel toilet bowl attaches to the top of each tank. A separator between the tank and toilet bowl prevents passengers from seeing into the tank and liquid in the tank from sloshing up into the bowl.

Each toilet waste tank has a motor-pump filter unit that pumps filtered flushing fluid into the toilet bowl. Activating the toilet flush handle powers the pump for ten seconds.



7 8 9 WATER AND WASTE SYSTEM – WATER SYSTEM

The water and waste system in the new generation B737 has a much larger water tank than earlier models. In addition to galley water and lavatory sinks, water is used for waste disposal.



WATER SYSTEM

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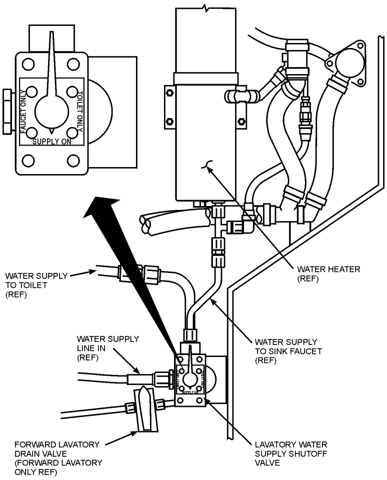
The water tank is located beneath the cabin floor and behind the aft cargo compartment. The tank is pressurized by pneumatic system air, which forces the water up and out of the tank. If no pressure is available from the pneumatic system, an AC motor driven compressor turns on automatically and builds the tank pressure. As long as pressure is available from the pneumatic system, the compressor will not run.



SINK CABINET
(DOOR OPEN)

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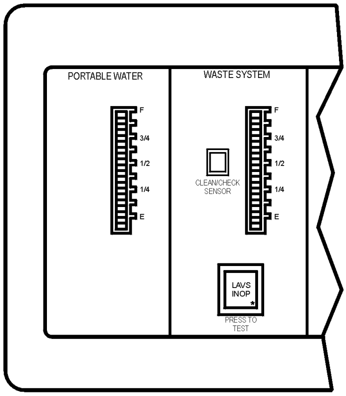

AFT ATTENDANT PANEL

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The water service panel is on the bottom of the aft right side of the fuselage. Opening the door operates a switch which disables the compressor. Once the water hose is connected, opening the fill and overflow valve vents tank pressure and allows water to fill the tank and come out the overflow. There is also a drain valve handle for draining the tank. Both valve handles must be in the closed position or the service panel access door will not close. A panel at the aft flight attendant station shows the quantity of water in the tank.

Each lavatory has a water shutoff valve beneath the sink. With the valve in the SUPPLY ON position water is provided to the lavatory sink and the toilet. The OFF position shuts off water to the sink and toilet. Two other positions allow water to the faucet only or the toilet only. There is a drain valve for draining each lavatory water system. Water is also supplied to each galley.

7 8 9 WATER AND WASTE SYSTEM - WASTE SYSTEM

Drain water from the galleys and lavatory sinks goes out a forward and aft drain mast. Each mast is automatically heated to prevent water freezing in the drain.

Waste from each toilet goes to a single waste collection tank behind the aft baggage compartment. The waste is moved to the tank by water and differential air pressure. When a toilet is flushed, a measured amount of water rinses the toilet bowl through the rinse valve. The flush valve opens to allow the toilet bowl contents into the vacuum drain line to the waste tank. Air is evacuated from the waste tank through a liquid separator by a vacuum blower, which keeps the tank at a lower pressure than the cabin. Above 16,000 feet, the blower does not operate, as cabin to exterior differential pressure is sufficient.

A continuous level sensor in the waste tank sends signals to a quantity indicator on the aft flight attendant panel. Two point level sensors determine when the tank is full. Water and flush valves for all toilets are shut off when the tank is full.

If a flush valve should fail in the open position, differential pressure would escape overboard continuously. The shroud around the toilet assembly has a cutout at the bottom. This gives access to a handle, which can manually close the flush valve for that toilet.

The waste tank is emptied through a waste drain valve operated from a service panel on the aft lower left fuselage. After the tank is drained, it is rinsed by water through two rotating nozzles in the top of the tank. This should clean the sensors along with the rest of the tank. A light on the aft flight attendant waste panel illuminates when a sensor is dirty. If both point level sensors are dirty, a full tank signal may be generated. This would illuminate a lavatories inop light on the aft flight attendant panel and disable all toilet rinse valves and flush valves. Once the tank has been rinsed and emptied, a chemical precharge is added.

GALLEYS

Galleys are located in the passenger cabin so as to provide convenient and rapid service to the passengers. Generally, they are installed in the cabin adjacent to the forward and aft galley service doors.

In general the equipment of the galley unit consists of the following main items:

- high-speed ovens
- hot beverage containers
- hot cup receptacles
- refrigeration and main storage compartments.

Electrical control panel switches and circuit breakers to operate the above equipment are conveniently located. Storage space, miscellaneous drawers and waste containers are also integrated in the galley units.

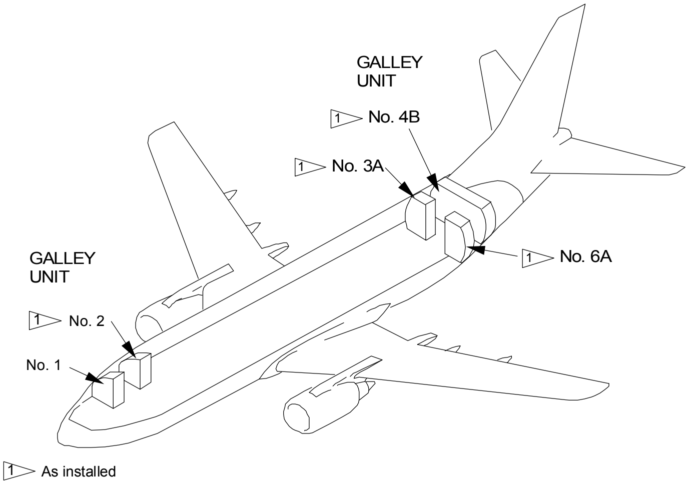
Electrical Power

③ 3 5 Electricity for the galleys is 115V AC 400 H_z supplied from the aircraft generator busses and controlled by a switch on the overhead panel. Circuit breakers are located on the galleys and on the P-6 circuit breaker panel.

7 8 9 Electricity for the galleys is 115V AC supplied from the aircraft transfer busses and controlled by a switch on the overhead panel. Circuit breakers are located in the lower E/E bay as part of the power distribution panels.

WATER SERVICE

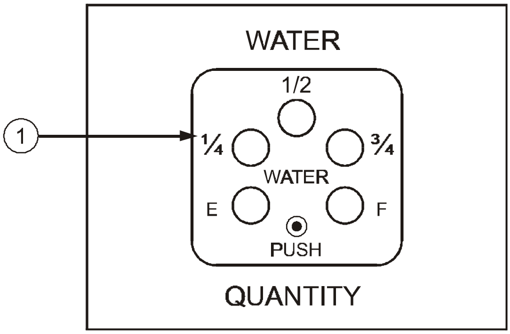
Water is supplied to the galleys from the aircraft pressurized water system and, in an emergency, may be shut off at the galleys.



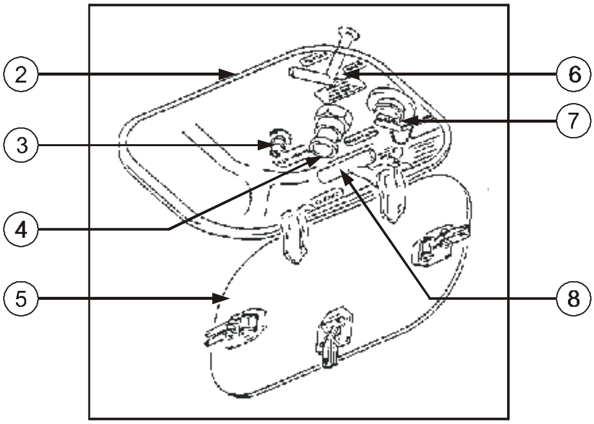
3737614

GALLEYS

③❸❺ Water System Controls



GALLEY AREA



BELOW AFT ENTRY DOOR

3737618

① Water Quantity Indicator

Push – Lights illuminate to indicate quantity of water in reservoir.

Example: With reservoir half full, the **E**, ¼, and ½ lights illuminate.

② Water System Service Panel

③ Air Valve

Pressurizes tank and system when normal pressure sources are not available.

④ Overflow Fitting

Prevents overfilling of tank and allows venting of tank when gravity draining.

⑤ Access Panel

Cannot be closed unless the fill and overflow valve and tank drain valve handles are in the closed position.

⑥ Fill and Overflow Valve Handle

OPEN – Enables filling or gravity-draining water tank.

CLOSED – Normal position.

⑦ Fill Fitting

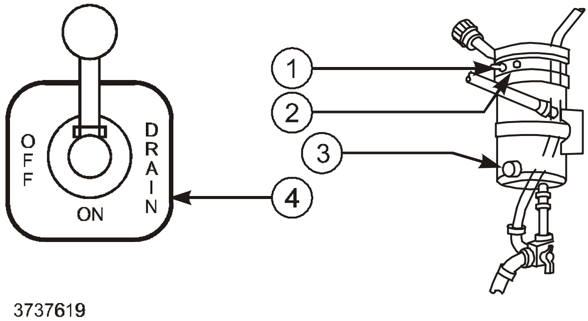
Used to fill tank.

⑧ Tank Drain Valve Handle

OPEN – Drains water from tank.

CLOSED – Normal position.

③ 3 5 Lavatory Controls



LAVATORY SINK CABINET

① Water Heater Switch

ON – Activates the water heater.

② Water Heater Light

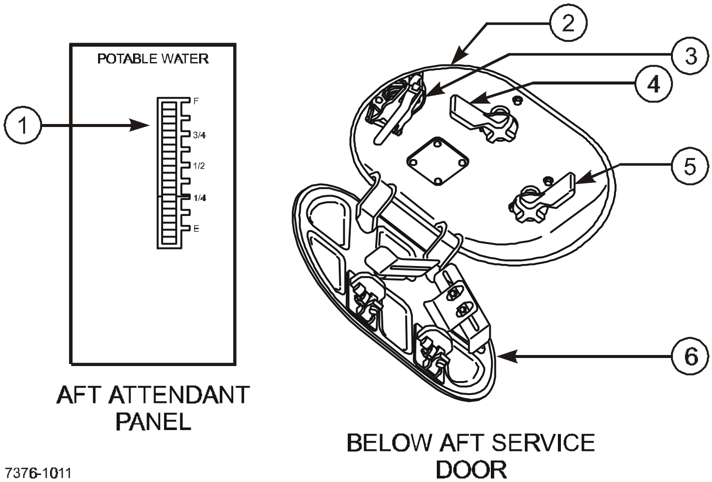
Illuminated – Heater operating.

③ Temperature Control Switch

④ Water Shutoff and Drain Valve Control

- ON – Provides water to lavatory sink faucets and heater (normal position).
- OFF – Shuts off water to lavatory sink faucets and heater.
- DRAIN – Drains water overboard through respective drain fitting.

7 8 9 Water System Controls



① Water Quantity Indicator

Indicates quantity of water in reservoir.

② Water System Service Panel

③ Fill Fitting

Used to fill tank.

④ Fill and Overflow Valve Handle

OPEN – Enables filling or gravity-draining water tank.

CLOSED – Normal position.

⑤ Tank Drain Valve Handle

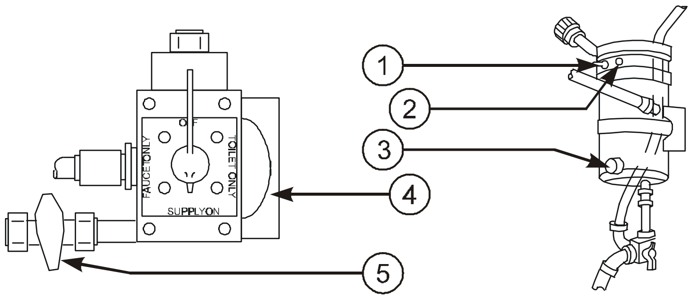
OPEN – Drains water from tank.

CLOSED – Normal position.

⑥ Access Panel

Cannot be closed unless the Fill and Overflow Valve and Tank Drain Valve Handles are in the closed position.

7 8 9 Lavatory Controls



LAVATORY SINK CABINET

7376-1012

① Water Heater Switch

ON – Activates the water heater.

② Water Heater Light

Illuminated – Heater operating.

③ Temperature Control Switch

④ Water Supply Selector Valve

SUPPLY ON – Provides water to lavatory sink faucets and water heater (normal position).

FAUCET ONLY – Water is supplied to faucet only.

OFF – Shuts off water to lavatory sink faucets and water heater.

TOILET ONLY – Water is supplied to toilet only.

⑤ Drain Valve

Located in the forward lavatory

LIGHTING

EXTERIOR

Exterior lights include the landing, runway turnoff, taxi, navigation, anti-collision, strobe, wing and wheel well illumination lights. Controls are located on the forward overhead panel.

Service lights are located at various work areas including each wheel well and cargo compartment. Controls are located at the individual service areas.

OUTBOARD LANDING LIGHTS

③ 3 5 Retractable landing lights are installed in the outboard flap track fairings. The lights are designed to extend from the flap track and shine forward parallel to the waterline of the aircraft, regardless of flap position. The lights may be extended at any aircraft speed.

7 8 9 Retractable landing lights are installed in the fuselage fairings. The lights are designed to extend and shine forward, parallel to the waterline of the aircraft. The lights may be extended at any speed.

INBOARD LANDING LIGHTS

Two fixed landing lights are in the wing leading edge with the runway turnoff lights. The lights shine forward and down in a fixed position. The lights are protected by an aerodynamically contoured glass window.

RUNWAY TURNOFF LIGHTS

Runway turnoff lights are inboard of the inboard landing lights. The lights shine outward approximately 30° and have a beam width of 50°.

TAXI LIGHT

The taxi light is mounted on the nose wheel strut and will point in the same direction as the nose wheel. The light will not extinguish automatically when the nose gear is retracted. For increased service life of the taxi light, it is recommended that the taxi light not be used for takeoffs and landings.

LOGO LIGHTS

③❸❺ A white light is installed in each wing tip for illuminating the aircraft insignia on each side of the vertical fin.

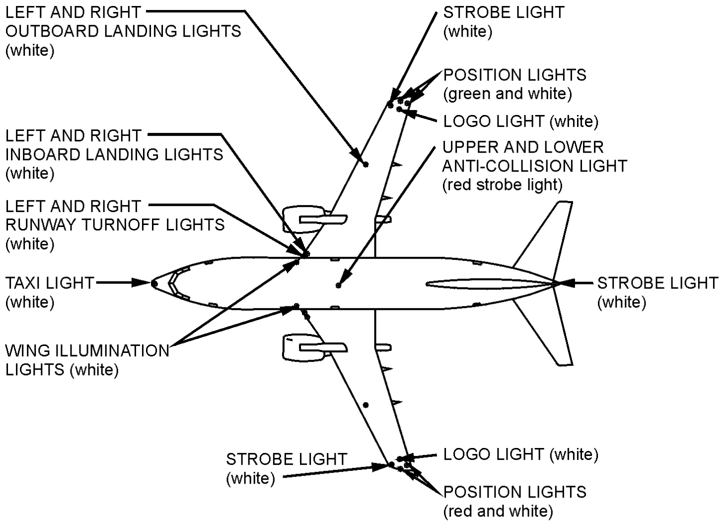
❼❽❾ Logo lights are located on the top of each horizontal stabilizer surface to point light on both sides of the vertical stabilizer.

POSITION LIGHTS

Position (navigation) lights to indicate position, direction, and attitude are mounted in the wing tips and tail cone. The lights consist of:

- One high intensity white strobe light and two fixed green lights, one facing outboard and one facing forward in the right wing tip.
- One high intensity white strobe light and two fixed red lights facing outboard and one facing forward in the left wing-tip.
- An aft facing fixed white light on each wing-tip trailing edge.
- A strobe light located on the fuselage tail cone above the APU exhaust.

These lights are controlled by a three-position switch, located on the forward overhead panel. Placing the position switch to STROBE and STEADY turns on the strobe lights and fixed colored navigation lights. The white strobe lights flash at approximately 60 flashes per minute. Placing the position switch to STEADY turns on the colored navigation lights and the white trailing edge wing tip lights. With a loss of all generators, the colored navigation lights and the white trailing edge wing-tip lights will operate only if the switch is in the STEADY position. Placing this switch to STEADY will power the colored lights and trailing edge wing-tip lights from the battery bus for towing if no other power is on the aircraft. The battery switch must be ON.



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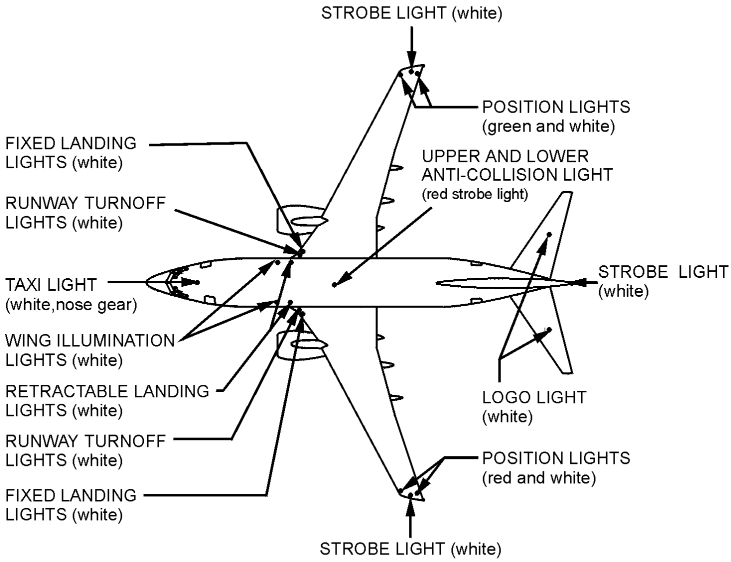

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7 8 9

EXTERIOR LIGHTING

ANTI-COLLISION LIGHTS

Two anti-collision lights are externally mounted on the upper and lower fuselage. The anti-collision lights are high intensity strobe lights. These red flashing lights flash approximately once per second. On the ground, illumination of the lights is an indication to ground personnel that the engines are ready for start or are operating.

WING ILLUMINATION LIGHTS

Two white wing lights are mounted flush with the fuselage forward of the wing. Primarily, they are used to scan the wing leading edge for icing; they also provide light to assist in ground service of the aircraft.

WHEEL WELL LIGHTS

A light located in each wheel well provides illumination to check the condition of the landing gear down and locked stripes in the event the landing gear is manually extended.

FLIGHT DECK LIGHTING

Flight deck lighting is provided for panel illumination, area lighting, and localized illumination. Dome lights supply general flight deck flood lighting. The glareshield supplies background light for the main instrument panels. Each instrument and instrument panel has its own integral lights. Floodlights are installed for the MCP, aisle stand, and aft circuit breaker panel.

Map lights, chart lights, and utility lights are available at the pilot stations, each with individual controls.

If normal electrical power is lost, the standby compass light, dome lights, instrument floodlights and selected system information, and warning lights are available from the battery bus.

PANEL AND BACKGROUND LIGHTS

The variable intensity switch marked BACKGROUND on the Captain's instrument panel provides control of the background instrument floodlights. Rotating the switch clockwise varies the intensity of these fluorescent lights from OFF to BRIGHT to illuminate the Captain, First Officer, and center instrument panels.

The controls marked PANEL turn on the integral instrument white lighting for the associated panel. The center instrument panel integral lights are controlled by the Captain's panel control.

STERILE COCKPIT LIGHT SWITCH

A switch located on the forward overhead panel controls a blue light over the flight deck door. Positioning the sterile light to **ON** illuminates the light to alert the flight attendants not to enter the flight compartment.

NO SMOKING AND FASTEN BELT LIGHTS

The passenger signs in the cabin (**NO-SMOKING**, **FASTEN BELT** and **RETURN TO SEAT**) are operated by a three position switch on the forward overhead panel. With AUTO selected, the signs are controlled automatically by reference to landing gear and flap positions.

NO SMOKING Signs:

- Illuminate when the landing gear is extended.
- Extinguish when the gear is retracted.

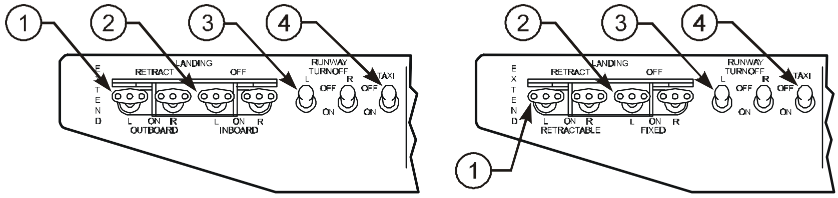
FASTEN BELT and **RETURN TO SEAT**:

- Illuminate when the flaps or gear are extended.
- Extinguish when the flaps and gear are retracted.

Either sign may be manually operated by positioning the switch to the desired position, OFF or ON. When either sign changes, automatically or manually, a low tone chime sounds over the P.A. system.

EXTERIOR LIGHTING

Landing, Runway Turnoff And Taxi Lights



7376-1013

FORWARD OVERHEAD PANEL

③ 3 5

① OUTBOARD LANDING Light Switch

RETRACT – Outboard Landing lights are retracted and extinguished.

EXTEND – Outboard landing lights are extended and extinguished.

ON – Outboard landing lights are extended and illuminated.

③ 3 5

② INBOARD LANDING Light Switch

OFF – Inboard landing lights are extinguished.

ON – Inboard landing lights are illuminated.

7 8 9

① RETRACTABLE LANDING Light Switch

RETRACT – Retractable landing lights are retracted and extinguished.

EXTEND – Retractable landing lights are extended and extinguished.

ON – Retractable landing lights are extended and illuminated.

7 8 9

② FIXED LANDING Light Switch

OFF – Fixed landing lights are extinguished.

ON – Fixed landing lights are illuminated.

③ RUNWAY TURNOFF Light Switch

OFF – Runway turnoff lights located in leading edge of wing root are extinguished.

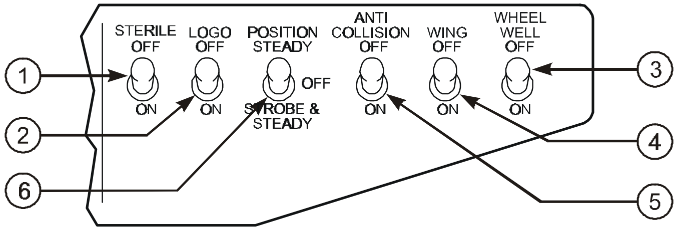
ON – Runway turnoff lights are illuminated.

④ TAXI Light Switch

OFF – Nose wheel taxi light extinguished.

ON – Nose wheel taxi light illuminated.

Miscellaneous Exterior Lights



FORWARD OVERHEAD PANEL

① LOGO Light Switch

OFF – Logo lights extinguished.

ON – Logo lights illuminated.

② POSITION Light Switch

STEADY – Red and green wing-tip position lights and white trailing edge wing-tip lights illuminated.

OFF – Red and green wing-tip position lights, white trailing edge wing-tip lights and wing tip and tail strobe lights extinguished.

STROBE & STEADY – Red and green wing-tip position lights, white trailing edge wing-tip lights and wing-tip and tail strobe lights illuminated.

③ WHEEL WELL Light Switch

OFF –Wheel well lights extinguished.

ON – Wheel well lights illuminated.

④ WING Illumination Switch

OFF – Wing leading edge lights on fuselage forward of wing extinguished.

ON – Wing leading edge lights illuminated.

⑤ ANTI-COLLISION Light Switch

OFF – Red rotating beacon lights on upper and lower fuselage extinguished.

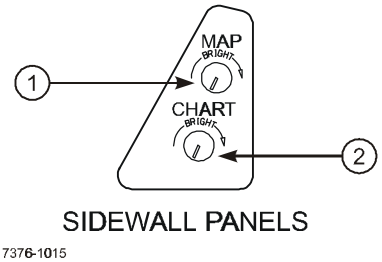
ON – Red rotating beacon lights illuminated.

⑥ STERILE Light Switch

ON – Illuminates a blue light above the flight deck door to alert flight attendants not to enter flight deck.

FLIGHT DECK LIGHTING

Map And Chart Light Controls



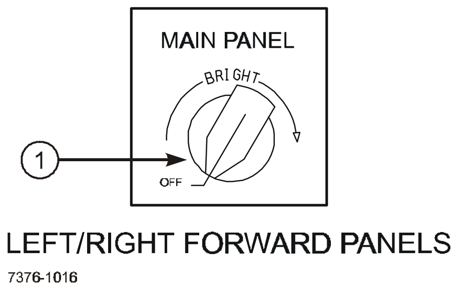
① MAP Light Control

Rotate – Adjusts brightness of Captain / First Officer map lights.

② CHART Light Control

Rotate – Adjusts brightness of Captain / First Officer chart lights.

Main Panel Lighting

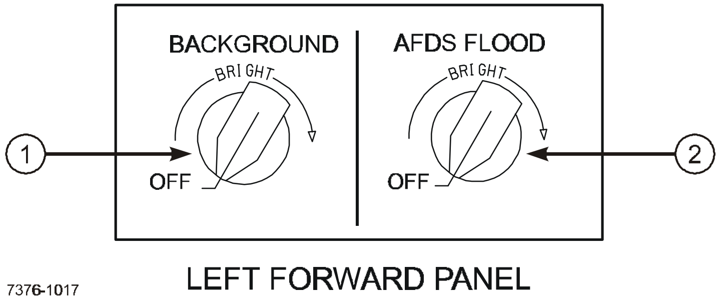


① MAIN PANEL Light Control

Rotate –

- Captain – Controls brightness of Captain's panel and instrument lighting, center instrument panel, and AFDS panel displays lighting.
- First Officer – Controls brightness of First Officer's panel and instrument lighting.

Background And AFDS Flood Light Control



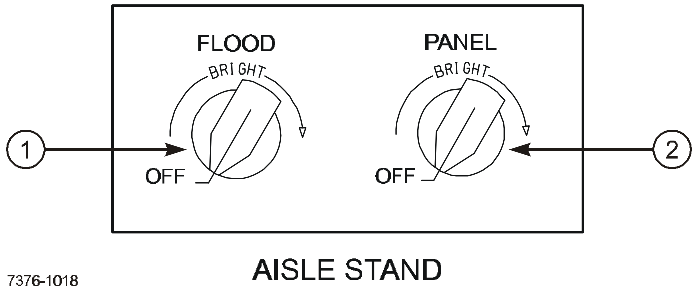
① BACKGROUND Light Control

Rotate – Controls incandescent lighting brightness for Captain's panel, First Officer's panel, and center panel.

② AFDS FLOOD Light Control

Rotate – Controls brightness of lighting directed at AFDS panel.

Flood And Aft Electronics Light Controls



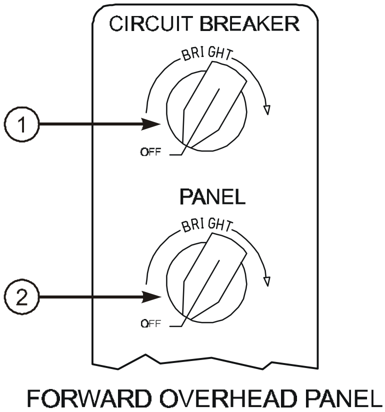
① FLOOD Light Control

Rotate – Controls overhead spotlight brightness directed at thrust lever quadrant.

② PANEL Light Control

Rotate – Controls forward and aft electronic control panel lights brightness.

Overhead / Circuit Breaker Panel Light Controls



7376-1019

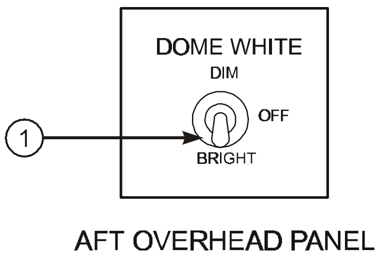
① CIRCUIT BREAKER Light Control

Rotate – Controls P-6 and P-18 circuit breaker panels light brightness.

② PANEL Light Control

Rotate – Controls forward and aft overhead panel lights brightness.

Dome Light Control



7376-1020

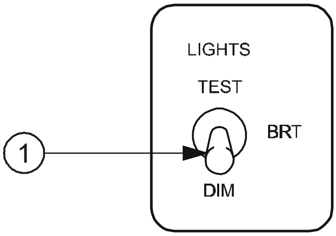
① DOME Light Control

DIM – Sets overhead dome lights to low brightness.

OFF – Overhead dome lights are extinguished.

BRIGHT – Sets overhead dome lights to full brightness.

Master Lights Test And Dim Switch



LEFT FORWARD PANEL

7376-1021

① Master LIGHTS TEST and DIM SWITCH

TEST – Illuminates all system lights on forward and aft overhead panels, and some lights on Captain and First Officer instrument panels to full brightness.

BRT (bright) – Sets all system lights on forward and aft overhead panels, and some lights on Captain and First Officer panels to full brightness.

DIM – Sets all system lights on forward and aft overhead panels, and some lights on Captain and First Officer panels to low brightness.

Lights Test Switch

Certain flight deck indicator lights may be tested with a switch on the forward instrument panel. The switch has three positions:

TEST - The majority of the flight deck indicators will illuminate “bright”.

- The master caution system will not “recall” with the switch in the TEST position. All segments of the displays on the Autopilot Flight Director Mode Control Panel constantly flash.

BRT - Light intensity is bright.

DIM - Light intensity is dim for the majority of the indicator lights.

Note: Marker Beacon lights, NAV/COMM Radio Frequencies, Transponder Code, Clock LCD, Auto Throttle / Auto Pilot annunciator, all fire related lights, and MCP Panel ON lights do not test in TEST position.

Passenger Cabin

Passenger cabin lighting is accomplished by use of white incandescent lights and white fluorescent lights. General cabin illumination is provided by window lights, ceiling lights, and entry lights. These are supplemented by reading lights in the passenger service units, lavatory lights and separately controlled lights in the galley areas.

Power Sources

Flight deck and passenger cabin lights are divided between the two main AC busses so that failure of either bus will result in only partial loss of lighting.

Hot Battery Bus

With the battery switch OFF, and external power connected, the dim entry lights will be illuminated from the hot battery bus. The fluorescent mirror lights in the lavatories can also be illuminated from the 115 VAC ground service bus.

Battery Bus

Loss of all AC power will leave only the following lights powered from the battery bus:

Flight Deck Lights:

- Standby compass light
- White dome lights
- Background instrument flood lights
- Selected system information and warning lights

Passenger Cabin Lights:

- Lavatory dome light

Emergency Exit Lights:

- Emergency exit lights and signs are powered from separate emergency power supplies installed in the passenger cabin.

Note: Failure of AC Transfer Bus No. 2 (**TRANSFER BUS OFF** light illuminated) will automatically illuminate the background instrument floodlights at a preset intensity.

Emergency Exit Lights

Clearly marked exit lights are located throughout the passenger cabin to indicate the approved emergency exit routes. All of the lights are powered by individual Nicad batteries with a charging, monitoring, and voltage regulator circuit. Charging occurs with the switch OFF or ARMED with normal power on the aircraft and the aft flight attendant panel switch NORMAL.

The system is controlled by a switch on the overhead panel. The switch has three positions, OFF, ARMED and ON and is guarded to the ARMED position. With the switch in the ARMED position, the emergency exit lights will normally be extinguished. If electrical power to the 28 volt DC bus No. 1 fails or if AC power has been turned off, the emergency exit lights illuminate automatically.

The emergency exit lights may also be illuminated by a switch on the aft attendant's panel. This switch has two positions, NORMAL and ON, and is guarded to the NORMAL position.

With the switch in the NORMAL position, the lights are controlled from the flight deck. With the switch in the ON position, the cabin attendant may override the flight deck controls and illuminate all the emergency lights. Control from this panel is available in the event of failure of the automatic control.

The flight deck aft Dome Light contains a separate bulb that is powered by the emergency lighting system to provide illumination for flight deck evacuation.

Interior emergency exit lights are located:

- In the bullnose of the stowage bins to illuminate the aisle;
- Over the entry / service and overwing emergency hatches to indicate the door and hatch exits;
- In the ceiling to locate the exits and provide general illumination in the area of the exits. Self-illuminating exit locator signs are installed at the forward, the middle, and aft end of the passenger cabin.

Exterior emergency lights illuminate the escape slides. The fuselage installed escape slide lights are adjacent to the forward and aft service and entry doors. Two lights are also installed on the fuselage to illuminate the overwing escape routes and ground contact area.

③ EMERGENCY ESCAPE PATH AISLE LIGHTS

The floor level emergency escape path lighting system operates in conjunction with the existing emergency light system. The escape path and exit indicators are designed to motivate the passengers to quickly locate the nearest exit during emergency evacuations when low visibility conditions exist in the cabin. The system includes special cues for overwing exit locations and one-way egress routes. Input power is provided by two 6.0-volt battery packs activated in conjunction with the existing aircraft emergency lighting system.

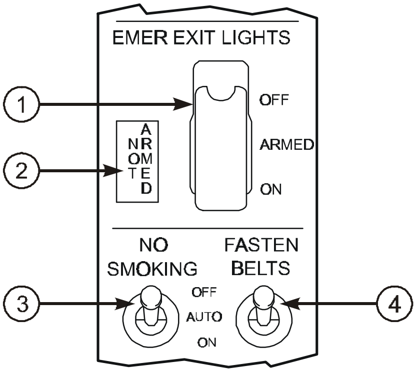
The floor level light tracks are installed on the right side of the aisle if facing forward. The lights are clear and spaced at 20-inch intervals. Opposite each overwing exit are four red lights spaced at four-inch intervals to identify these exits. The last two lights in the track at either end of the cabin are red and spaced four inches apart. The system is armed or activated through the flight deck emergency exit light switch (OFF-ARMED-ON). The aisle lighting is considered tested when the emergency exit light system is tested.

3 5 7 8 9 EMERGENCY ESCAPE PATH AISLE LIGHTS

The floor proximity emergency escape path aisle lighting has been moved from the floor to an integral mounting on the aisle-side of the passenger seats.

EMERGENCY LIGHTING AND PASSENGER SIGNS

Flight Deck



FORWARD OVERHEAD PANEL

7376-1022

① Emergency Exit Lights (EMER EXIT LIGHTS) Switch (guarded)

OFF – Prevents emergency lights system operation if aircraft electrical power fails or is turned off.

ARMED – All emergency lights illuminate automatically if aircraft electrical power to DC bus No. 1 fails or AC power is turned off.

ON – All emergency lights illuminate.

② Emergency Exit Lights (**EMER EXIT LIGHTS**) **NOT ARMED** Light

Illuminated (amber) – EMER EXIT LIGHTS switch not in ARMED position.

③ NO SMOKING Lights Switch

OFF – The **NO SMOKING** signs are not illuminated.

AUTO – The **NO SMOKING** signs are illuminated or extinguished automatically with reference to aircraft configuration.

ON – The **NO SMOKING** signs are illuminated.

④ SEAT BELTS Switch

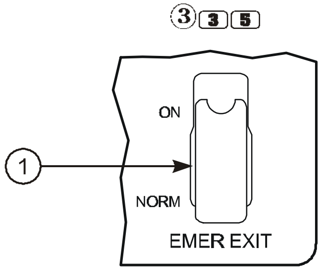
OFF – The **FASTEN SEAT BELTS** and **RETURN TO SEAT** signs are not illuminated.

AUTO – The **FASTEN SEAT BELTS** and **RETURN TO SEAT** signs are illuminated or extinguished automatically with reference to aircraft configuration.

ON – The **FASTEN SEAT BELTS** and **RETURN TO SEAT** signs are illuminated.

Passenger Cabin

③ 3 5



AFT FLIGHT ATTENDANT PANEL

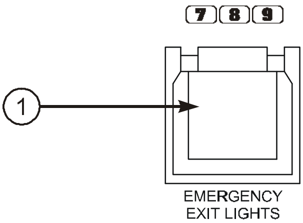
7376-1024

① Passenger Cabin Emergency Exit Lights Switch (guarded, red)

ON – All interior and exterior emergency lights are illuminated.

NORM – Emergency lights OFF unless activated by the flight deck switch.

7 8 9

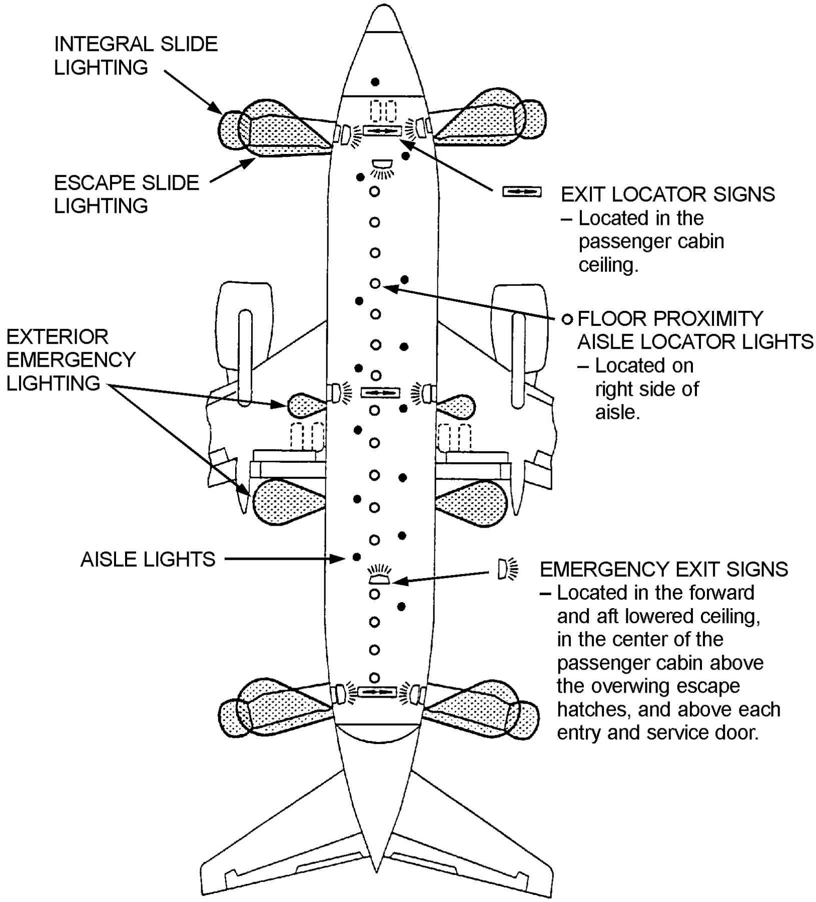


AFT ATTENDANT PANEL

7376-1023

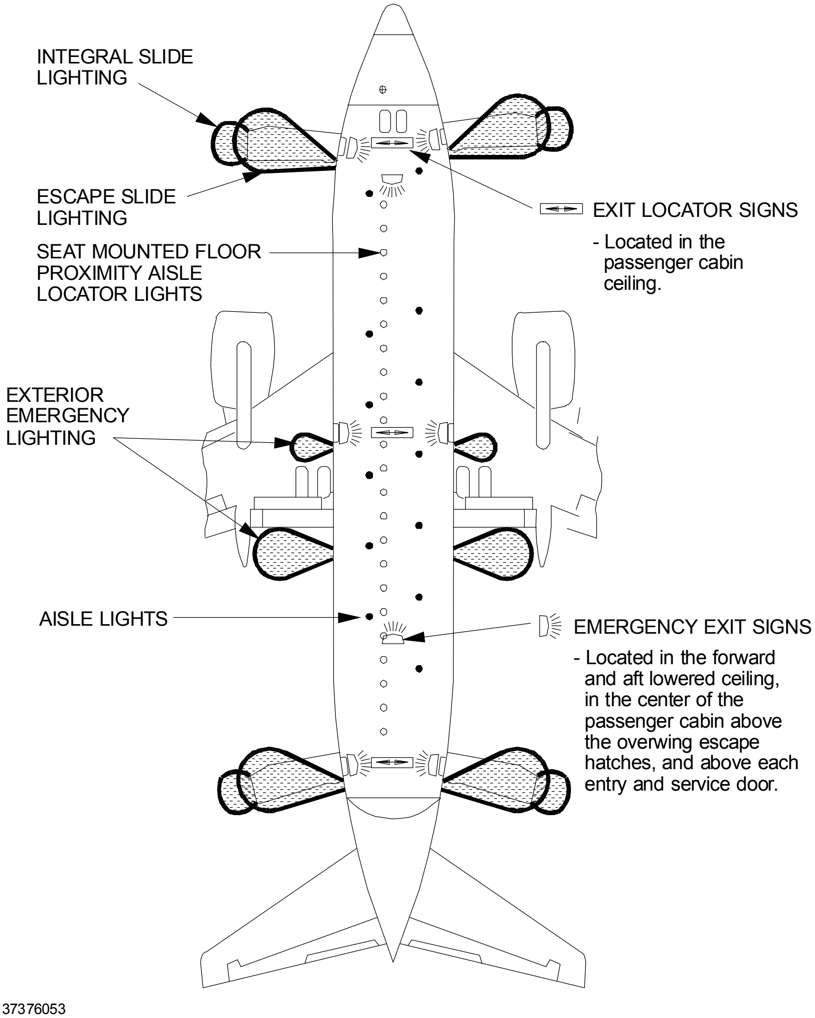
① Passenger Cabin Emergency Lights Switch (guarded)

On – Illuminates all emergency lights and bypasses flight deck control.



EMERGENCY EXIT LIGHT LOCATIONS

③



EMERGENCY EXIT LIGHT LOCATIONS

3 5 7 8 9

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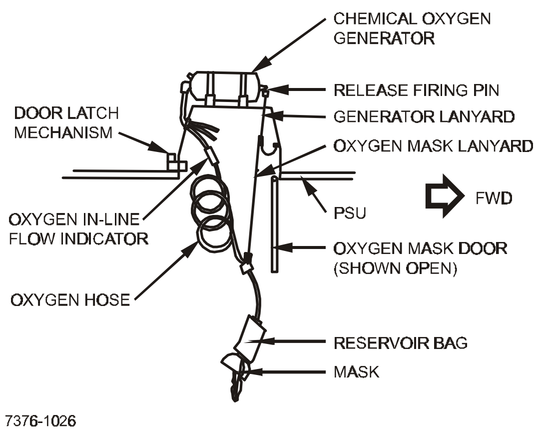
OXYGEN SYSTEM

PASSENGER OXYGEN

The passenger oxygen system is supplied by individual chemical generators located at each Passenger Service Unit (PSU). Four continuous flow masks are connected to each generator. A generator with two masks is located above each attendant station and in each lavatory.

The system is activated automatically by a pressure switch at a cabin altitude of 14,000 feet or when the Passenger Oxygen Switch on the aft overhead panel is positioned to the ON position. When the system is activated, the **PASS OXY ON** light will be illuminated and **OVERHEAD** will be illuminated on the Master Caution System.

Activating the system causes the masks to drop from the stowage compartments. The oxygen generators are activated when any mask in the unit is pulled down. Pulling one mask down causes all masks in that unit to come down and 100% oxygen flows to all masks. A green in-line flow indicator is visible in the transparent oxygen hose whenever oxygen is flowing to the mask. Oxygen flows for approximately 12 minutes and cannot be shut off. If the passenger oxygen is activated, and a PSU oxygen mask compartment does not open, the masks may be dropped manually.



WARNING: WHEN USING PASSENGER OXYGEN, THE "NO SMOKING" SIGN SHOULD BE ON AND STRICTLY OBSERVED. ONCE THE GENERATOR IS ACTIVATED, THE FLOW OF OXYGEN IS CONSTANT, WHETHER OR NOT THE MASK IS BEING WORN.

DO NOT USE PASSENGER OXYGEN WITH CABIN ALTITUDE BELOW 14,000 FEET WHEN SMOKE OR AN ABNORMAL HEAT SOURCE IS PRESENT. THE USE OF PASSENGER OXYGEN WILL NOT PREVENT THE PASSENGERS FROM INHALING SMOKE. AIR INHALED IS A MIXTURE OF OXYGEN AND CABIN AIR.

PSU OXYGEN MASK COMPONENTS

FLIGHT CREW OXYGEN

The flight crew oxygen system is completely separate from the passenger oxygen system. It uses quick-donning diluter demand mask / regulators located at each crew station. Oxygen is supplied by a single cylinder. Pressure is read on the indicator located on the aft overhead panel when the Battery Switch is ON. Oxygen flow is controlled through a pressure-reducing regulator to supply low-pressure oxygen to a shut-off valve located behind the First Officer's seat. Normal pressure is 1850 psi. See Limitations Section 1 for minimum dispatch requirements.

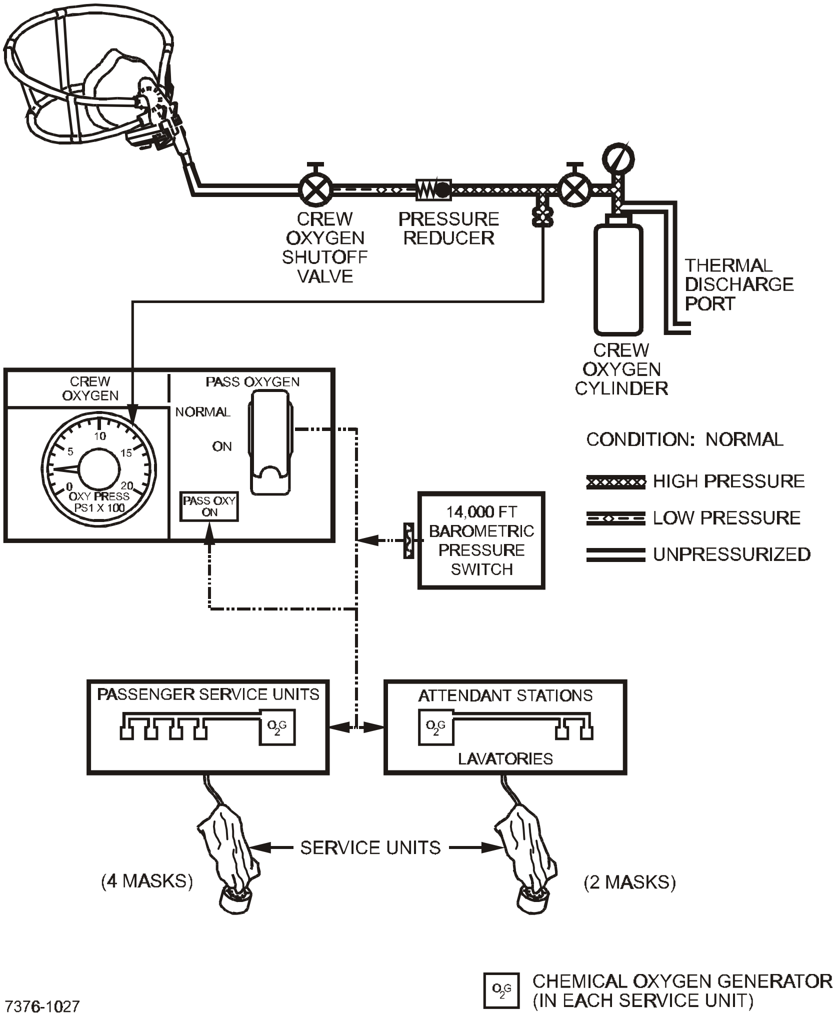
The mask / regulator is stored in a box immediately adjacent to each crew station. To use the mask, squeeze the red release levers with the thumb and forefinger and remove from stowage. Squeezing the release levers inflates the mask harness. The flow indicator will show a yellow cross momentarily as the harness inflates. Place the mask over the head and release the levers. The harness will contract to fit the mask to the head and face.

Oxygen flow is controlled by a regulator that is mounted on the oxygen mask. The regulator may be adjusted to supply 100% oxygen by pushing the NORMAL/100% selector. An emergency control knob labeled EMERGENCY below the chin of the mask, changes the flow from a diluter demand to steady flow if it is rotated to the EMERGENCY position. The emergency knob is also marked PRESS TO TEST. When pressed it allows oxygen to flow into the mask and is used in conjunction with the RESET - TEST lever for mask testing in the box.

The observer oxygen mask, regulator, and harness unit is the same as the pilots'. Oxygen is available to the regulator when the flight deck shut-off valve is open. There is no flow indicator or reset-test lever. The mask, regulator and harness are contained in a stowage cup.

MASK DESCRIPTION

Flight crew stations are provided with combination oxygen mask and regulator that is stored in a special compartment in the sidewall of the aircraft. This location is designed to enable the crew to don the mask quickly with only one hand. All controls for operation of the mask are located at the base of the unit. The harness is pneumatically inflated for quick donning. After the mask has been donned, the elastic of the harness form fits the mask to the face. A microphone is contained in the mask.

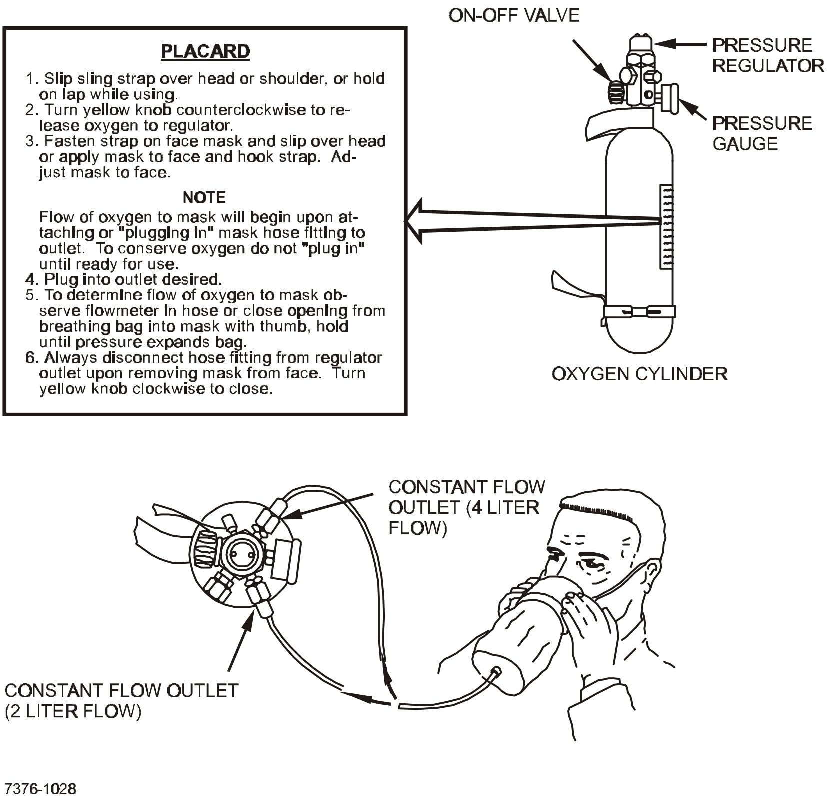


OXYGEN SYSTEM SCHEMATIC

PASSENGER PORTABLE OXYGEN

First aid and sustaining portable oxygen cylinders are installed at suitable locations in the passenger cabin. The cylinders are fitted with a pressure gauge, pressure regulator, and on-off valve. The cylinders are pressurized to 1800 psi. At this pressure, and a temperature of 70ºF (21ºC), the cylinders have a capacity of 4.25 cubic feet (120 liters) of free oxygen. Two continuous flow outlets are provided on each cylinder: one regulates flow at two liters per minute for walk-around; the second outlet provides flow at four liters per minute for first aid.

Duration can be determined by dividing capacity by outflow. (120 liters divided by 4 liters/min = 30 min.)



OXYGEN SYSTEM SCHEMATIC

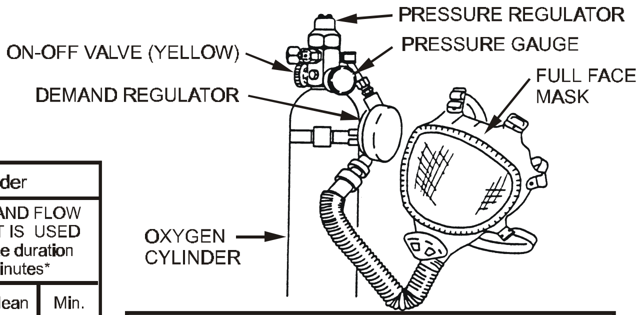
③ FLIGHT CREW PORTABLE OXYGEN

The flight crew portable oxygen unit is a completely self-contained oxygen system, offering both demand and constant flow capabilities. It consists of a portable oxygen cylinder, a pressure regulator (constant flow), an on-off valve, a pressure gauge to show oxygen supply, a demand regulator, and a sling-type carrying strap.

The portable oxygen cylinder is installed behind, and adjacent to, the First Officer's seat. When charged to 1800 psi at 70ºF (21ºC), it contains 11 cubic feet (311 liters) of free oxygen.

The demand regulator has a connection for a demand type, full-face mask, and supplies 100% oxygen. Normally, the full-face mask is attached to the unit and provides portable full-face and respiratory protection from hazardous smoke, fumes, or other emergency situations.

For constant flow oxygen, a bayonet-type fitting accommodates a disposable continuous flow mask. The cylinder provides oxygen for a duration of approximately 103 minutes using the 3 liter constant flow outlet.



11 Cu. Ft. Cylinder			
Alt (Feet) or Cabin Alt. Equiv.	IF DEMAND FLOW OUTLET IS USED Estimate duration in minutes*		
	Max.	Mean	Min.
0	21	12	7
5,000	25	15	9
10,000	31	18	11
15,000	37	22	13
20,000	46	27	16
25,000	57	33	20
30,000	71	41	25

* Estimated duration based on an assumed use rate of 14 LPM-ATPD (sedentary), 24 LPM-ATPD (normal activity), 40 LPM-ATPD (severe activity).

FOR 100% OXYGEN (DEMAND FLOW) USE FULL FACE MASK	1.TURN YELLOW KNOB OPEN 2. ATTACH FULL FACE MASK TO LARGE OUTLET. 3. APPLY MASK TO FACE (TIGHTEN LOWER STRAPS FIRST)
FOR SUPPLEMENTAL OXYGEN (CONSTANT FLOW) USE REBREATHER TYPE MASK	1. TURN YELLOW KNOB OPEN 2. ATTACH MASSK HOSE TO SMALL CONSTANT FLOW OUTLET 3. APPLY REBREATHER TYPE MASK TO FACE

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FLIGHT CREW PORTABLE OXYGEN

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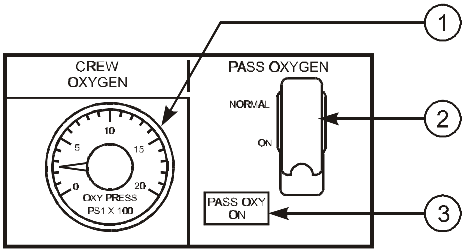
CONTROLS AND INDICATORS

OXYGEN



AFT OVERHEAD PANEL

7376-1030

① Flight Crew Oxygen Pressure Indicator

- Indicates pressure at the crew oxygen cylinder.

② Passenger Oxygen Switch

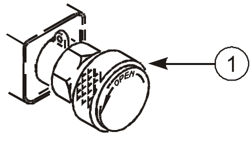
NORMAL – Passenger oxygen will be activated automatically.

- A mask drops in front of each passenger if cabin altitude climbs to 14,000 feet.

ON – Activates the system and drops masks if the automatic function fails to lower masks.

③ Passenger Oxygen On Light (Amber)

- Illuminated – System activated.



RIGHT COCKPIT BULKHEAD
BEHIND F/O SEAT

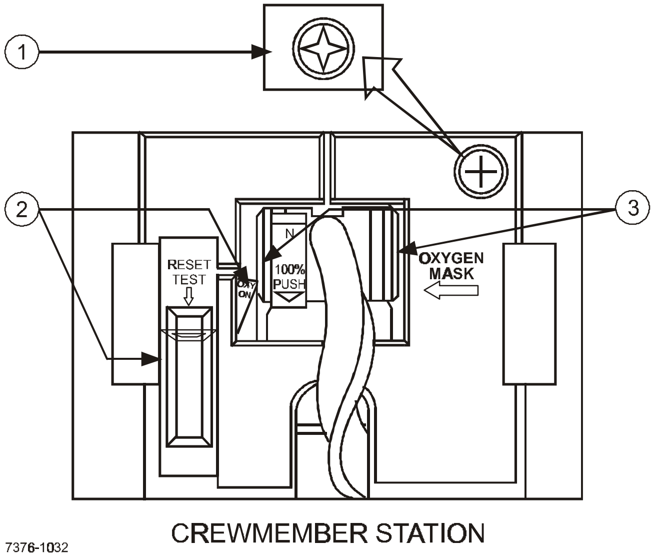
7376-1031

① Flight Crew Oxygen Shutoff Valve

Turns Counterclockwise – Allows oxygen to flow.

Turn Clockwise – Shuts off oxygen flow.

③ 3 5 OXYGEN MASK PANEL



① Oxygen Flow Indicator

Indicates a yellow cross when oxygen is flowing.

② RESET / TEST Slide Lever

Push –

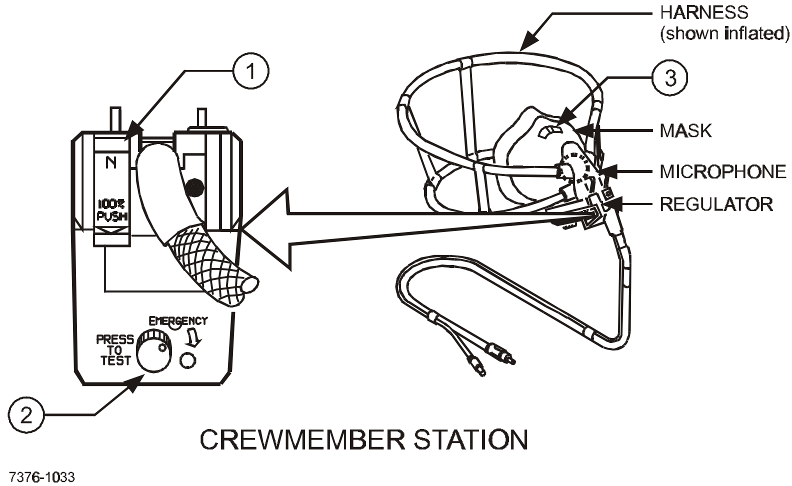
- If mask is stowed, activates oxygen flow momentarily to test regulator.
- If mask is not stowed and stowage box doors are closed, retracts OXY ON flag, shuts off oxygen, and shuts off microphone.

③ Inflation Levers

Squeeze and pull up –

- Releases mask from stowage box
- Releases OXY ON flag when stowage box doors open
- Activates oxygen and microphone
- Inflates mask harness when inflation lever is squeezed
- Flow indicator shows a yellow cross momentarily as harness inflates.

③ 3 5 OXYGEN MASK AND REGULATOR



① NORMAL / 100% Switch

N (normal) – supplies air / oxygen mixture on demand (ratio depends on cabin altitude).

100% – Supplies 100% oxygen on demand.

② Oxygen Mask EMERGENCY / Test Selector (rotary)

Rotate – Supplies 100% oxygen under positive pressure at all cabin altitudes.

PRESS TO TEST – Tests positive pressure supply to regulator.

③ Smoke Vent Valve Selector

Up – Vent valve closed.

Down – Vent valve open, allowing oxygen flow to smoke goggles.

③ 3 5 FLIGHT CREW OXYGEN MASK USAGE

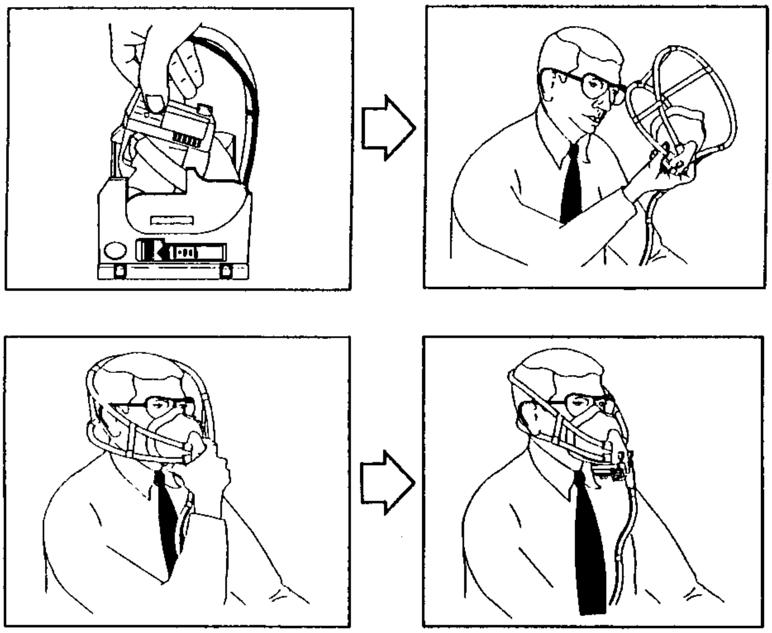
Donning Instructions

To don the mask, grasp the regulator with the thumb and forefinger and remove from stowage. Squeezing the inflation levers and removing from the box:

- Inflates the mask harness
- Momentarily displays a colored oxygen flow indicator.

Place the mask over the head and release the levers. The harness contracts to fit the mask to head and face.

The observer's oxygen mask, regulator, and harness unit is the same as the pilots'.

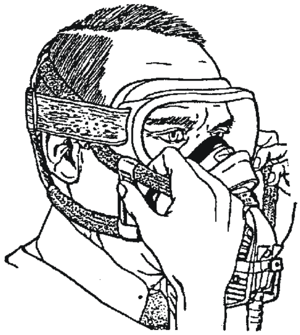


MASK DONNING

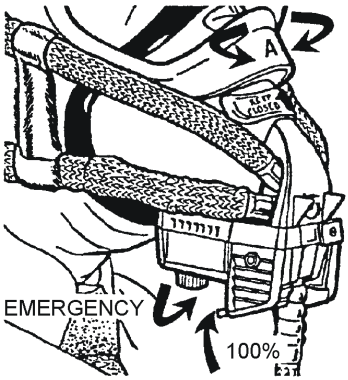
SMOKE GOGGLES

These goggles are provided for use by the flight crew when smoke or fumes are prevalent in the control cabin.

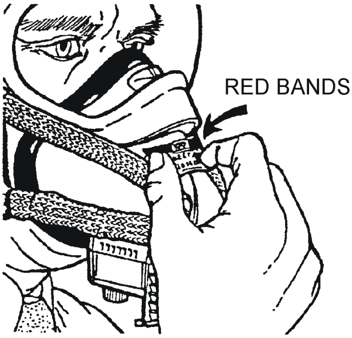
The Captain's and First Officer's goggles are stowed on their respective sidewalls directly below their handsets.



Place smoke goggles on head. Pull upper tube of harness and reposition it over the lower side of goggles frames. Push goggles downward.

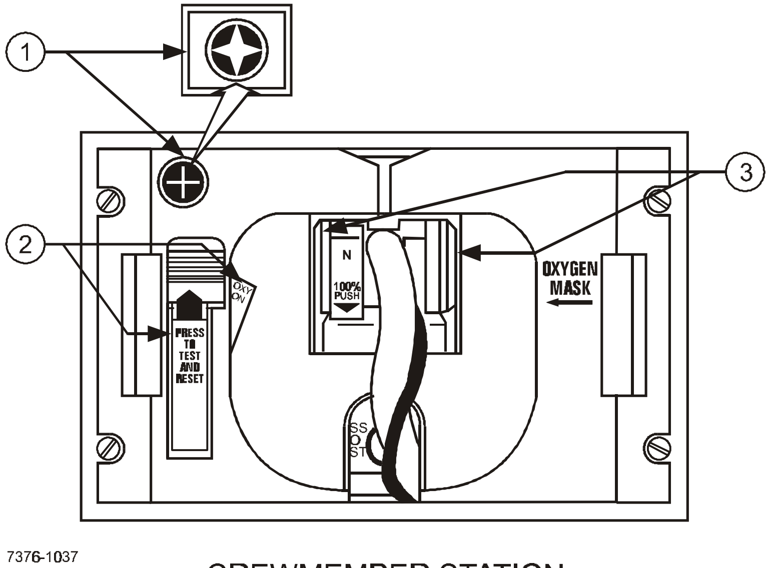


Push the N-100% regulator control into the 100% position and rotate the PRESS TO TEST control knob (counter-clockwise) into EMERGENCY position.



Open vent valve so that red bands are visible. This allows oxygen under positive pressure to clear the goggles and keep them clear.

7 8 9 OXYGEN MASK PANEL



CREWMEMBER STATION

① Oxygen Flow Indicator

Indicates a yellow cross when oxygen is flowing.

② PRESS TO TEST AND RESET Slide Lever

Push –

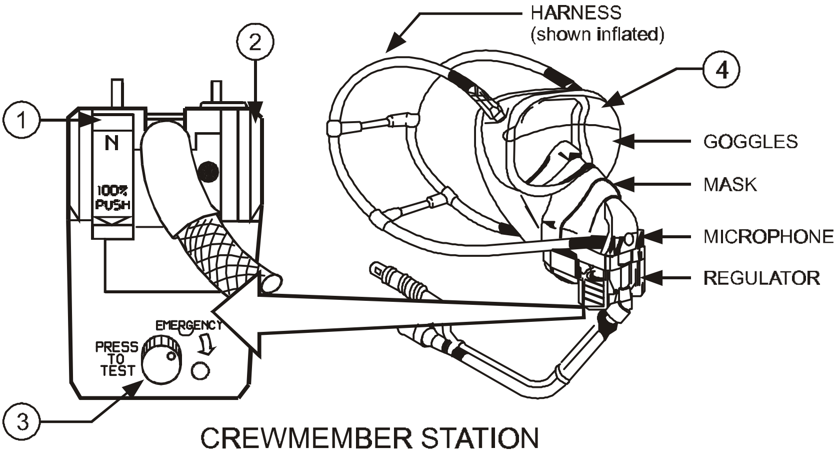
- If mask is stowed, activates oxygen flow momentarily to test regulator
- If mask is not stowed and stowage box doors are closed, retracts OXY ON flag, shuts off oxygen, and shuts off microphone.

③ Inflation Levers

Squeeze and pull up –

- Releases mask from stowage box
- Releases OXY ON flag when stowage box doors open
- Activates oxygen and microphone
- Inflates mask harness when inflation lever is squeezed
- Flow indicator shows a yellow cross momentarily as harness inflates.

7 8 9 OXYGEN MASK AND REGULATOR



7376-1038

① NORMAL / 100% Switch

N (normal) – Supplies air / oxygen mixture on demand (ratio depends on cabin altitude).

100% – Supplies 100% oxygen on demand.

② Inflation Lever

Squeeze –

- Inflates mask harness
- Flow indicator shows a colored cross momentarily as harness inflates.

③ EMERGENCY / PRESS TO TEST Selector

Rotate – Supplies 100% oxygen under positive pressure at all cabin altitudes.

PRESS TO TEST – Tests positive pressure supply to regulator.

④ Protective Strip

There is a protective strip of clear plastic on the top portion of the lens. This strip can be peeled off using the tab on the right side in case of icing caused by a rapid depressurization.

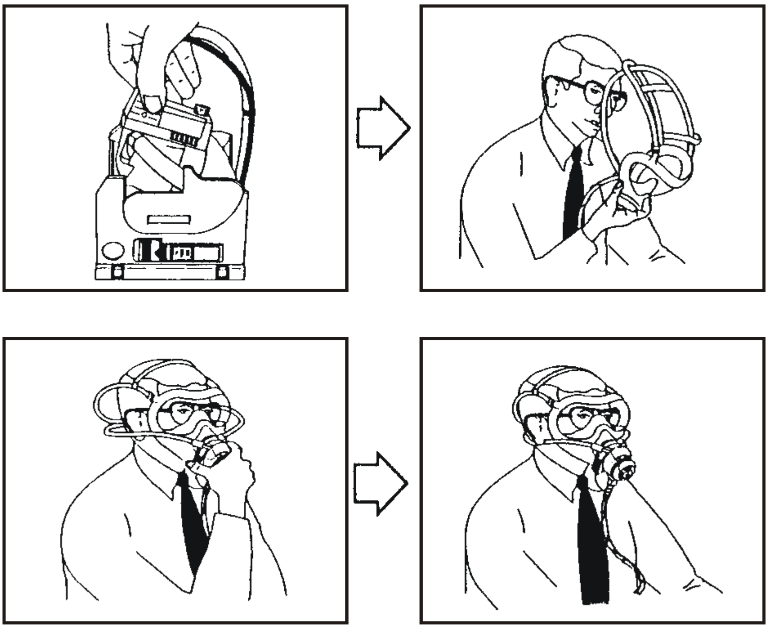
7 8 9 FLIGHT CREW OXYGEN MASK USAGE

Donning Instructions

To don the oxygen mask accomplish the following:

– Grasp the regulator by the red inflation levers with the hand nearest the stowage box.

- Squeeze the inflation levers while pulling the mask from the box.
- Pull the mask across in front of you, toward the center of the aircraft (to ensure ample hose extension) while rolling the mask face-up.
- Lean slightly toward the center of the aircraft and bring the mask toward your face so that the lower portion of the mask contacts your chin first. Roll the top of the mask toward your forehead so the harness goes over and behind your head.
- Release the inflation levers so the harness holds the mask in place.



7376-1039

MASK DONNING

Stowing Instructions

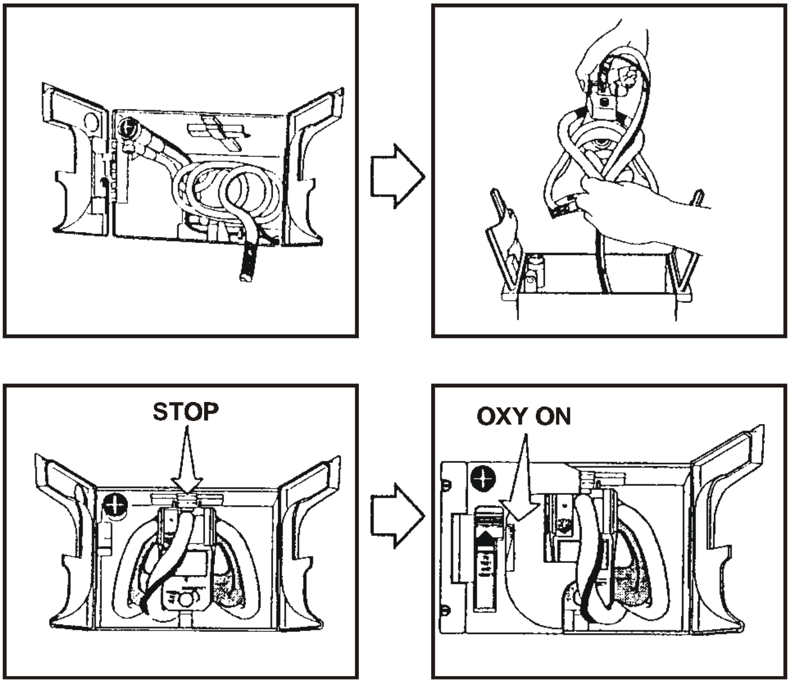
To stow the oxygen mask accomplish the following:

- Set the N / 100% regulator control to 100%.
- Ensure that the EMERGENCY oxygen control knob is off.
- Coil the supply hose into the bottom of the stowage box, making the largest diameter possible.
- Ensure that the harness is completely deflated.
- Hold the mask by the regulator, with the facepiece down and the inside of the mask toward you.
- Grasp the harness and pull it downward so the cross straps are below the facepiece. Allow the excess harness to hang downward.

Caution: Do not push the harness cross straps into or behind the nosepiece. Doing this may cause the cross straps to hang up on the mask during inflation.

- Position the supply hose down the center of the facepiece.
- Insert the mask-regulator assembly into the stowage box, beginning with the harness (regulator up).
- Press down on the assembly until the mask-regulator is fully seated against the stop in the stowage box.
- Close the left-hand door. The OXY ON flag will slide into view at the center of the door.
- Close the right-hand door, ensuring not to pinch the hose.
- Press, then release the TEST AND RESET control lever on the left-hand door. Ensure that the OXY ON flag disappears when the control lever is released.

WARNING: Do not squeeze the red inflation levers during stowing. Doing this will inflate the harness and prevent the correct stowing of the mask.



7376-1040

MASK STOWING

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EMERGENCY EQUIPMENT & EXITS

FIRE EXTINGUISHERS

WARNING: Whenever a fire is encountered on the aircraft, land at the nearest suitable airport unless it can be positively verified that the fire has been extinguished.

Water

Water fire extinguishers contain a solution of water mixed with anti-freeze. The container is pressurized by a $C0_2$ cartridge when the extinguisher handle is rotated fully clockwise. The extinguisher should be used on fabric, paper, or wood fires only.

Caution: Do not use on electrical or grease type fires.

To Use: Remove from stowage. Rotate the handle fully clockwise. Aim at the base of the fire and press the trigger.

The water extinguisher is located in the aft cabin.

Bromochlorodifluoromethane (BCF)

The BCF extinguisher contains a liquefied gas agent (Halon 1211) under pressure. The pressure indicator shows an acceptable pressure range, a RECHARGE range, and an OVERCHARGED range. A safety pin with a pull ring prevents accidental trigger movement. When released, the liquefied gas agent vaporizes and extinguishes the fire. The extinguisher is effective on all types of fires, but primarily on electrical, fuel, and grease fires.

WARNING: If a fire extinguisher is to be discharged on the flight deck, then all crewmembers are to wear oxygen masks and use 100% oxygen with EMERGENCY selected.

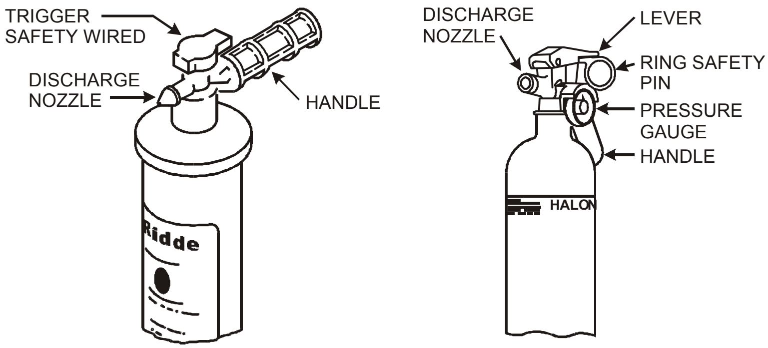
To Use: Remove from stowage. Holding the extinguisher upright, remove the ringed safety pin. Aim the extinguisher at the base of the flames from a distance of six feet and press the top lever. Use a side-to-side motion to suppress the fire.

One BCF extinguisher is located on the aft flight deck wall. A second one is located on the forward bulkhead by the main entry door or at the forward galley. The third is located in the aft cabin.

Each class of fire calls for specialized action. Using the wrong extinguisher may do more harm than good. For your own protection, you should know these basic types, how to use them, and why.

CLASS OF FIRES There are three common classes of fire:		EXTINGUISHER TYPE
CLASS A COMBUSTIBLE MATERIALS	paper, wood, fabric, rubber, certain plastics, etc., where quenching by water is effective.	TYPE A Water (H_2O) saturates material and prevents rekindling.
CLASS B FLAMMABLE LIQUIDS	gasoline, oils, greases, solvents, paints, burning liquids, cooking fats, etc., where smothering action is required.	TYPE B BCF (Halon 1211)
CLASS C LIVE ELECTRICAL	fires started by short circuit or faulty wiring in electrical, electronic equipment, or fires in motors, switches, galley equipment, etc., where a non-conducting extinguisher agent is required. NOTE: Whenever possible, electrical equipment should be de-energized before attacking a Class C fire.	TYPE C BCF (Halon 1211)

WARNING: The wrong extinguisher on a fire could do more harm than good. For example, BC rated extinguisher is not as effective as H_2O on a Class A fire. Water on flammable liquid fires spread the fire. Water on a live electrical fire could cause severe shock or death.



WATER FIRE EXTINGUISHER

BCF FIRE EXTINGUISHER (HALON 1211)

77376064

The flight crew should go on 100% oxygen whenever a portable fire extinguisher is to be discharged on the aircraft. Landing at the nearest suitable airport is recommended.

CREWMEMBER PROTECTIVE BREATHING EQUIPMENT

The PBASCO protective breathing equipment (PBE) is a closed circuit breathing apparatus designed to help protect the wearer's eyes and respiratory tract in an irrespirable atmosphere by isolating the breathing functions from the environment.

The PBE is a hood device, which completely encloses the head of the wearer and seals at the neck with a thin elastic membrane. The chemical air regeneration system is based on the use of potassium superoxide ($K0_2$). It is silently and reliably powered by the exhalation of the wearer into an oronasal mask cone located within the hood.

The hood encloses the head of the wearer and is sealed to the wearer by the neckseal. The enclosed volume of the hood represents approximately 8 liters available rebreathing volume, or counter lung. The oronasal mask serves to direct the exhaled breath containing CO_2 and water vapor back through the KO_2 bead where excess moisture and CO_2 are removed, and drier oxygen is added for return into the hood volume. Inhalation is accomplished directly from the interior of the hood through the inhalation valves located on the oronasal mask. A relief valve located at the back of the hood is used to prevent buildup of excessive pressure within the hood, and to provide emergency pressure relief in the event of a sudden reduction in cabin pressure. The chlorate starter candle mounted on the bottom of the KO_2 canister discharges directly into the canister.

The chlorate starter candle is designed to deliver a fixed volume of approximately 8 liters of oxygen over a short duration of less than 20 seconds. It is contained in a small stainless steel cylinder affixed to the base of the KO_2 canister. The discharge is directed into the interior of the KO_2 canister. The chlorate candle is initiated by a spring loaded plunger striking a small percussion primer when the lanyard attached to the hood adjustment strap is pulled.

Following actuation, the hood will inflate over a 15-20 second period. After this period, the starter candle will cease flowing and the only sound will be slight rustling of the fabric on each inhalation and exhalation. Dependent upon breathing rate, there will be a slight exhalation resistance as the exhaled breath is forced through the KO_2 canister. Heat is produced by both the chemical air regeneration process and transfer of body heat during the rebreathing cycle. Heat buildup within the hood is normal and dependent upon the amount of work performed. There should be no irritation or strong unusual odors within the hood.

The equipment is designed to accommodate the requirements of the most demanding situations. It is optimized to provide a minimum of 15 minutes duration for the heaviest workload (duration is 15 to 30 minutes depending on user's work rate). If the PBE is worn to exhaustion of the chemical regeneration system, this will be evidenced by a gradual reduction in the expanded volume of the hood until the point that the hood is collapsed tightly around the head at the end of a full inhalation. At this point, the wearer should immediately retire to a safe breathing area, clear of flame and toxic fumes and remove the device.

Operation

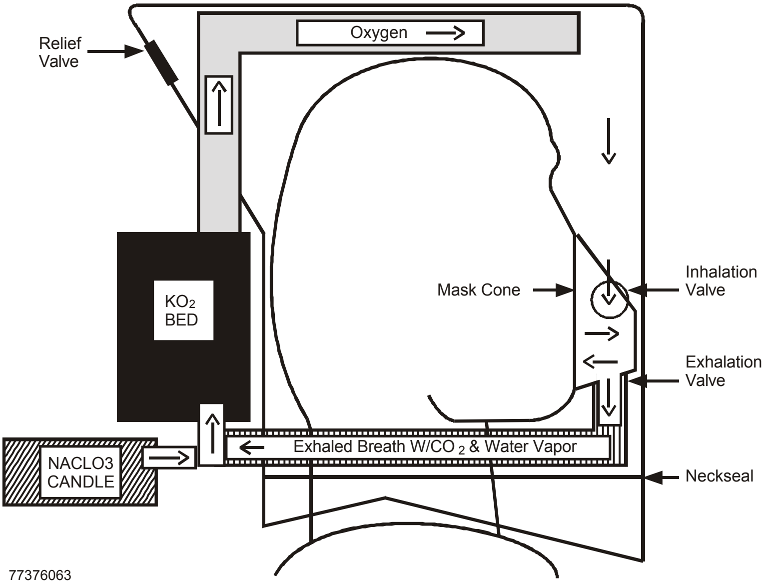
Remove the aluminized vacuum-sealed pouch from the protective canister. Tear open the pouch and don the hood.

Pull the adjustment straps to secure the hood. This motion automatically activates the chemical oxygen system by removing a lanyard pin from the chemical canister located at the back of the hood.

The generated oxygen will inflate the hood, providing the initial breathing atmosphere. Pull the straps again if actuation fails. (The hood will continue to function, although the initial breathing atmosphere is not available. Stick fingers under the neckseal to allow a lung inhalation to enable breathing until the chemical regeneration system begins producing a surplus of oxygen.)

The initial generated oxygen inflates the hood, providing breathable atmosphere. As the wearer begins to breath normally, the exhaled breath is directed through the chemical canister, which removes water vapor, carbon dioxide, and adds oxygen before the gas is returned to the interior of the hood for inhalation.

Excessive leakage of the oral / nasal cone or the neckseal may result in excessive buildup of carbon dioxide. Signs of excessive buildup are: rapid or labored breathing, moisture of fogging on the visor, strong irritating odors, and eye or respiratory tract discomfort. In this instance, move away from immediate contact with the fire, open flame / toxic fumes, and remove the hood. Don an alternate hood if required.


Oxygen
Relief Valve
KO2 BED
Mask Cone
Inhalation Valve
Exhalation Valve
Exhaled Breath W/CO 2 & Water Vapor
NACLO3 CANDLE
Neckseal
77376063

EMERGENCY EVACUATION ROUTES

Emergency evacuation may be accomplished through four entry / service doors and 3 3 5 7 two overwing escape hatches and 8 9 four overwing escape hatches. Flight deck crewmembers may evacuate the aircraft through two sliding flight deck windows.

Flight Deck No. 2 Windows

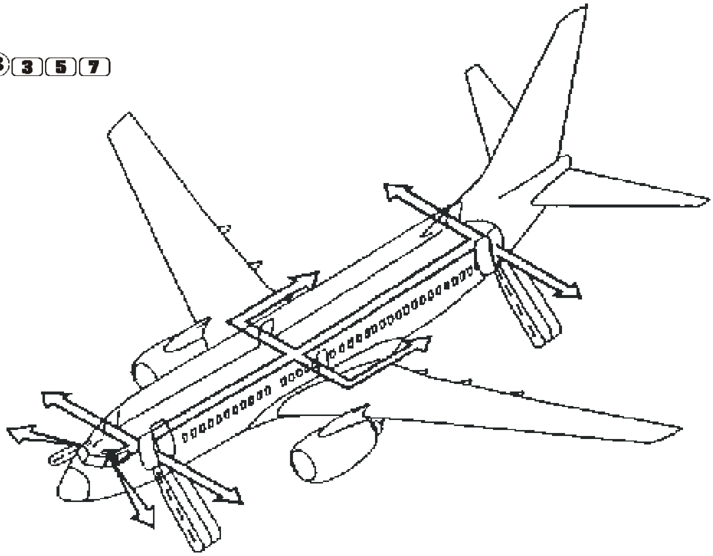
Flight deck sliding windows are opened by squeezing the lock release in the handle, rotating the handle inward and sliding the window aft until it locks. The right hand window has provisions for exterior access as well.

Flight Deck Escape Straps

An escape strap is attached to a compartment above each flight deck sliding window. The straps may be used by a crewmember to lower himself to the ground.

EMERGENCY EVACUATION ROUTES

③ 3 5 7



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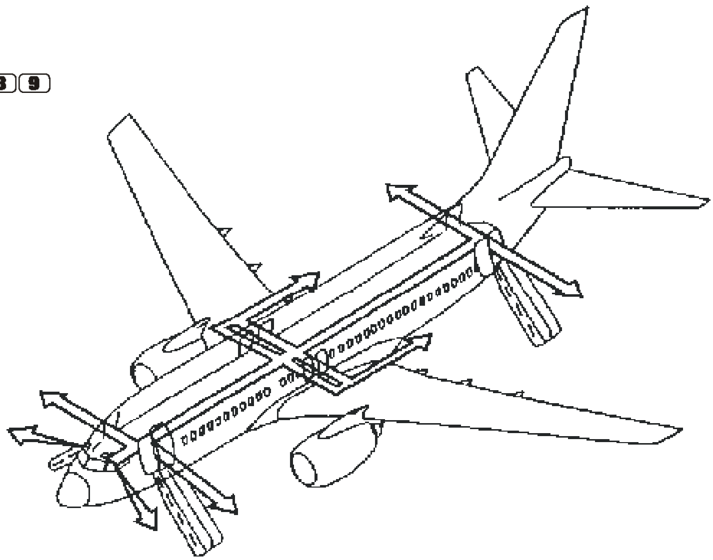

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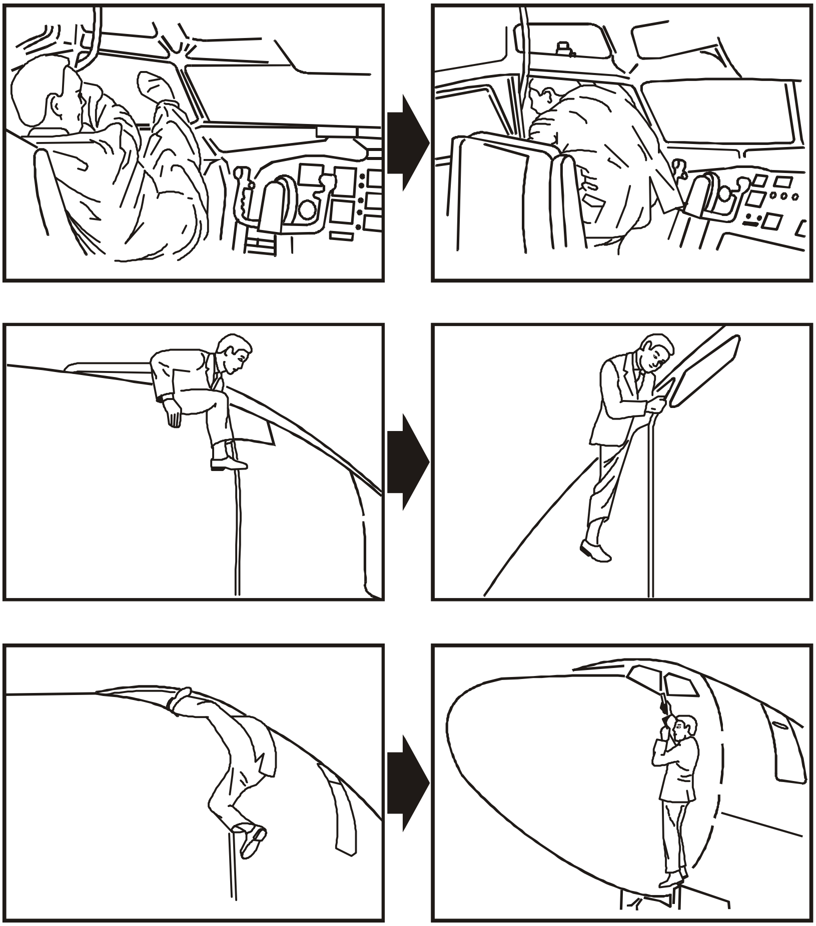

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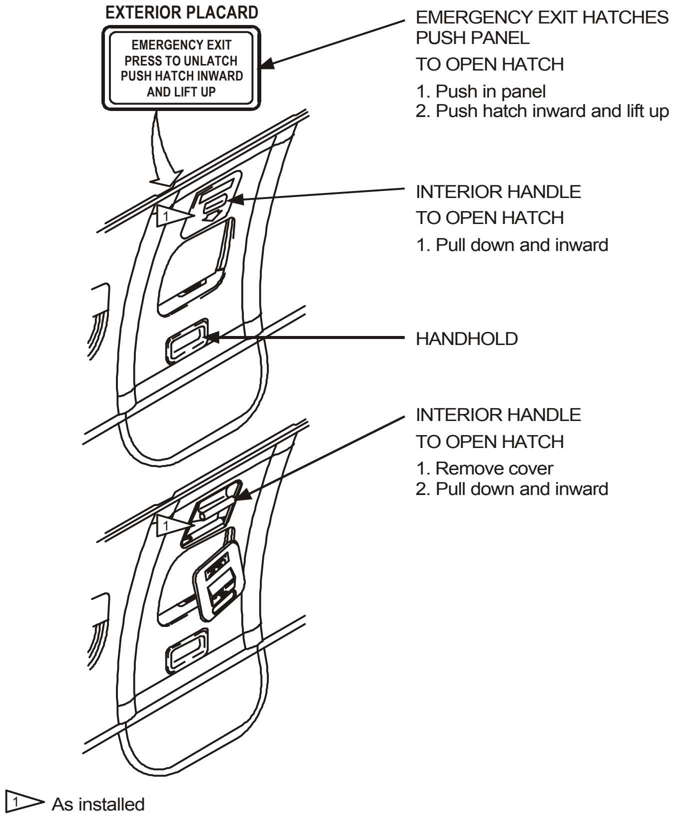
Caution: Check that the strap is anchored to the aircraft structure before dropping it out the window.

The above illustrated method of departure would probably be the easiest for most crewmembers. This technique is difficult and should be used only as extreme emergency.

Overwing Escape Hatches

③❸❺ Two escape hatches are located in the passenger cabin over the wings. These are plug-type hatches and are held in place by mechanical locks and aircraft cabin pressure. The hatches can be opened from the inside or from outside of the aircraft by a spring loaded handle at the top of the hatch.

The outboard armrest of the seat adjacent to the hatch is permanently attached to the hatch. A seat-back blocking an exit may be pushed forward by applying force to the top of the seat-back. For safety reasons, hatches should not be removed in flight.



OVERWING ESCAPE HATCH

Emergency Exit Doors

7 Two Type III emergency exits are located in the passenger cabin over the wings. These are canopy-type doors and are held in place by mechanical locks and aircraft cabin pressure.

8 9 Four Type III emergency exits are located in the passenger cabin over the wings. These are canopy-type doors and are held in place by mechanical locks and aircraft cabin pressure.

The doors can be opened from inside or outside of the aircraft by a spring-loaded handle at the top of the door. The 28 volt DC flight lock system is designed to ensure that the flight lock will automatically lock during takeoff, in-flight, and landing and unlock on the ground to allow for opening of the door in emergency situations. Commands for the flight lock to lock and unlock are dependent upon engine speed, thrust lever position, air / ground mode status, and the open / closed status of the doors.

The overwing emergency exits lock when:

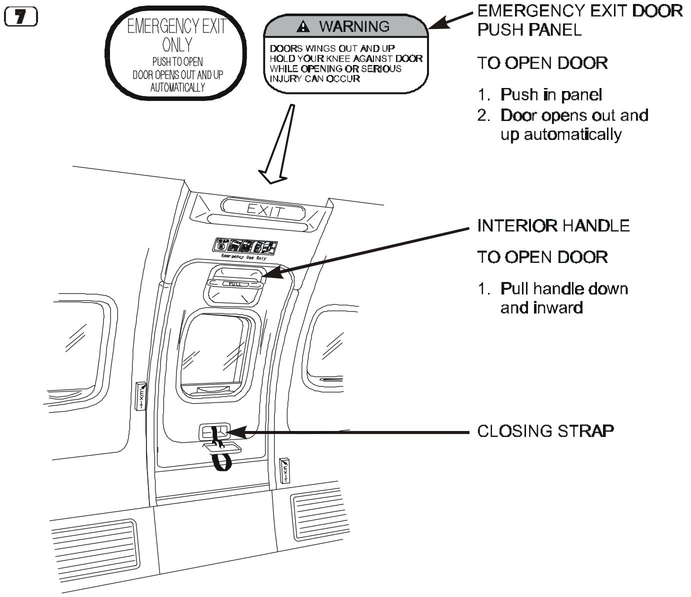
- Three of the four Entry / Service doors are closed and
- Either engine is running and
- The aircraft air / ground logic indicates that the aircraft is in the air or both thrust levers are advanced.

The overwing emergency exits unlock when any one of the above conditions is not met or DC power is lost.

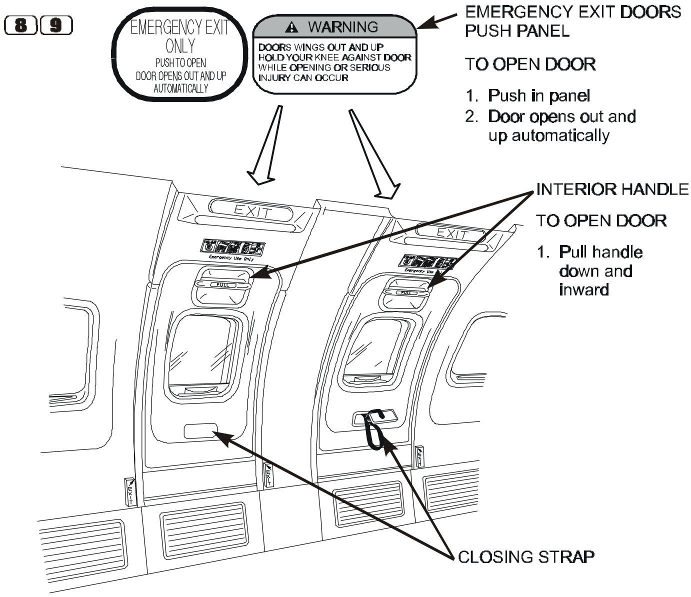
The **LEFT OVERWING** and/or **RIGHT OVERWING** warning lights, **DOORS** annunciator, and **MASTER CAUTION** lights illuminate when an emergency exit door is not fully closed and locked or when the flight lock is not engaged, either during the takeoff roll or in-flight.

If a flight lock has failed locked or a fault is detected, the **PSEU** light, the **OVERHEAD** annunciator, and the **MASTER CAUTION** lights illuminate. These indications are inhibited from takeoff until 30 seconds after the aircraft is in the ground mode. When the doors are latched and locked and the flight lock is operating properly none of these lights will illuminate.

EXTERIOR PLACARDS



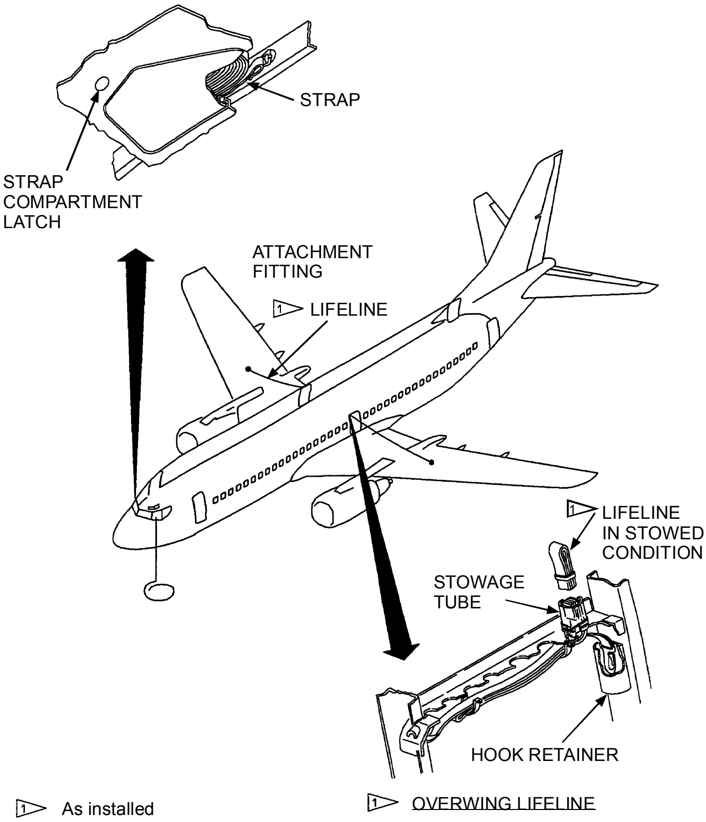
EXTERIOR PLACARDS



7376-1042

Overwing Escape Straps

Escape straps are installed above each emergency escape hatch frame. The overwing escape hatches must be removed to expose the straps. One end of the strap is attached to the hatch frame. The remainder of the strap is stowed in a tube extending into the cabin ceiling. To use, the strap is pulled free from its stowage and attached to a ring on the top surface of the wing. The escape strap can be used as a hand hold in a ditching emergency for passengers to walk out on the wing and step into a life raft.



EMERESCP

EMERGENCY ESCAPE DEVICES

Escape Slides

When an emergency dictates rapid evacuation of the aircraft on the ground, it may be necessary to activate and use the emergency escape slides. The slides are inflatable rubber / nylon units, which are stored in compartments on the bottom inner face of the forward entry, aft entry, and galley service doors.

The slide incorporates a retainer bar, which is normally stowed in special stowage hooks on the compartment cover. Before taxi, this bar is removed from the hooks and fastened to brackets located on the floor of the aircraft. It remains there throughout the flight. When the door is opened, tension on the girt will cause the compartment to open and the slide to deploy outboard of the door opening.

Inflation will begin during slide deployment. Automatic inflation requires approximately 6 seconds. Should the automatic inflation system fail, the manual inflation handle must be pulled completely clear of the slide to effect proper inflation. The manual inflation handle is labeled PULL and is visible when the slide is ejected from its container.

In the event a puncture results in the deflation of a deployed slide, and other slides or overwing exits are not useable, the slide can still be used as a hand held slide. To accomplish this, two or more people must first lower themselves to the ground using the deflated slide as an escape rope. They then use the handholds provided at the bottom of the slide to hold it taut while the remaining passengers, one at a time, use the slide for evacuation.

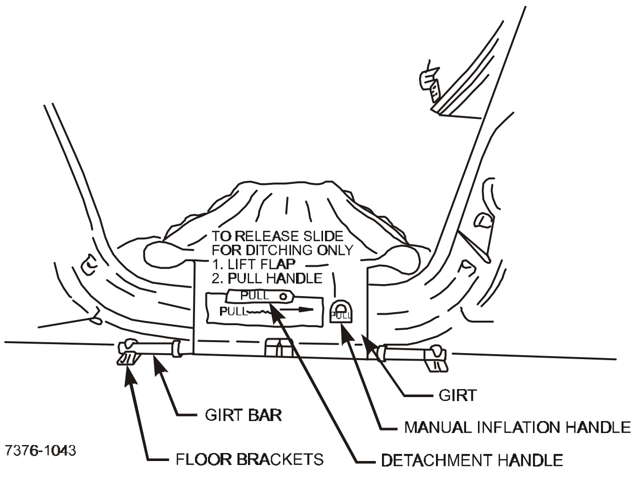
Note: All slides will be armed when passengers are aboard, block departure to block arrival. A designated attendant will accomplish the arming and position a red streamer over the door porthole to alert personnel not to open the doors while the slides are armed. The designated attendant will disarm the slide and stow the red streamer after block arrival time.

Check escape slide air bottle pressure in the green band.

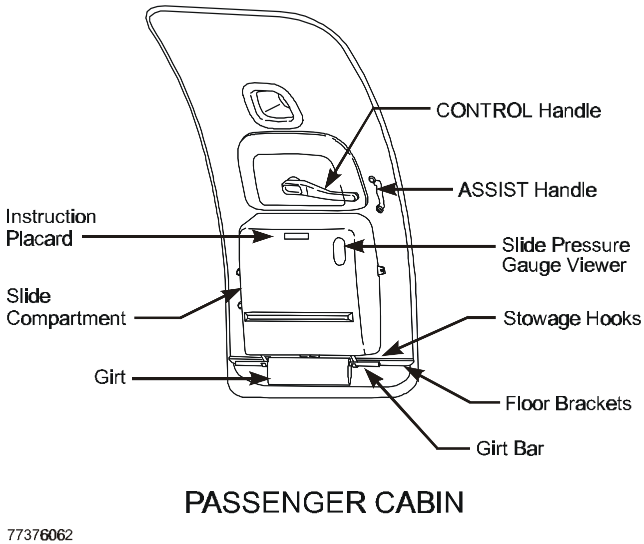
If the aircraft is ditched in water, the escape slides can be used as life rafts.

Escape Slide Detachment Handle

The slide has not been certified to be part of the water landing emergency equipment. In a water environment, the slide may not properly inflate when deployed. If the deployed slide is recognized to be a potential obstruction to egress, a detachment handle is provided near the top of the slide. This handle is protected by a cover and is placarded. The escape slide is detached from the aircraft by pulling the detachment handle. Once detached from the door sill, the slide is tethered to the door sill by a lanyard. A properly inflated slide could be buoyant, and useful as a flotation device for passengers in the water. Hand grips are positioned along the sides of the slide.



Passenger Entry / Galley Service Doors



ESCAPE SLIDE

Megaphone

Two megaphones are installed, one at each end of the cabin, in the left stowage bins.

Portable Oxygen Cylinders

Cabin

There are storage spaces for five or six portable cylinders in the cabin. Each is a 4.25 cubic-foot bottle with two and four liter outlets. A continuous flow mask is attached to the four liter outlet.

Crew

③ An 11 cubic-foot cylinder is installed on the aft bulkhead of the flight deck. The bottle has provisions for a three liter continuous flow mask, or a connection for the crewmember's oronasal mask (for use when 100% oxygen is required).

Crash Axe

One crash axe is provided and is installed on the left side of flight deck entry.

Emergency Flashlight

The emergency flashlight is a self-powered, high intensity flashlight. The lens is impact-resistant and the flashlight has waterproof integrity. A magnetic switch closes when the light is removed from its mounting bracket, which turns the flashlight on automatically. The light does not have an external control switch. There is an internal disconnect at the end cap of the light, should it become necessary to turn the light off.

A monitoring circuit in the light employs a LED (Light Emitting Diode) for continuous, visual indication of battery condition. The LED will flash intermittently indicating satisfactory battery power for flashlight operation.

The light and monitoring circuit are powered by the battery pack using alkaline / manganese dioxide cells.

A nylon cord lanyard is coiled in the exterior recess at the end cap of the light.

The mounting bracket is designed so that the light, when properly installed, is fully seated in the bracket clip and the flashlight LED is visible. The flashlight is deactivated when properly installed.

The plastic shield is installed with the bracket, which is designed to discourage indiscriminate use and to reduce loss due to pilferage. In case of emergency, the shield is removed by pulling the strap, thus breaking the perforated tabs, allowing the user access to the light.

The emergency flashlights are mounted forward of the main entry door and aft of the left rear door.

Emergency Radio Beacon (If Installed)

The emergency radio beacon contains all solid state circuits, which are sealed in a water tight can, protected by buoyant foam material within an outer aluminum case. Its dimensions are 3¼ X 30 inches with antenna folded and increased to 46 inches in height with antenna erected.

Performance Specifications

Transmitting Frequencies:	121.5 MHz & 243.0 MHz ± 0.005%.
Range:	(Typical at or above line-of-sight altitude) 121.5 MHz - 225 nautical miles 243.0 MHz - 100 nautical miles
Operating Life:	50 hours minimum.

Battery Type:	Reserve cell activated by sea water, fresh water, or other non-fatty, non-oily water-base liquids.
Battery Life Aboard Aircraft:	5 years minimum.
Weight (NET):	5.8 lbs. including battery and tow line.
Flotation:	Base of antenna approx. 5 inches above water line.
Color:	Gray body with fire-orange fluorescent cap at base of antenna.
Location:	Just inside the main cabin door opposite of the forward flight attendant jumpseat.

Operation

The beacon transmits signals that radiate simultaneously on emergency frequencies 121.5 and 243.0 MHz. The beacon transmits on both frequencies for at least 50 hours.

The frequency 121.5 MHz is monitored primarily by civilian aircraft, while most of the world's military and search-and-rescue services guard 243.0 MHz.

It will be necessary to unwind the nylon cord, which will allow the antenna to erect. Activate by dropping into the water. Buoyed up by foam plastic, the beacon floats with the base of the antenna about five inches above the water.

The beacon may be used for land rescue by placing the beacon case into a container of any available aqueous liquid except acid. Fresh water, salt water, coffee, tea, and urine are all excellent battery activators.

Emergency Radio Beacon (Dolphin) (If Installed)

General Description

The emergency radio beacon is compact, battery powered, with transmitting capabilities of up to 200 miles.

Performance Specifications

Transmitting frequencies:	121.5 MHz and 243.0 MHz simultaneously
Operating life:	100 hours
Battery life aboard aircraft:	2 years
Weight:	3.5 lbs.
Color:	Red
Location:	Just inside the main cabin door opposite of the forward flight attendant jumpseat.

Operation - Water

- Attach lanyard to raft.
- Submerge transmitter in water.
- Antenna is released when water soluble tape dissolves.

Operation - Land

- Break tape, release antenna.
- Unscrew guard cover located adjacent to antenna.
- Turn the switch right from the OFF to the ON position.

Note: The two types of Emergency Radio Beacons described are interchangeable.

Life Raft (If Installed)

Cabin:

③ 3 5 (Overwater Equipped) Three life rafts are in the cabin. Two are in overhead compartments located near the overwing emergency exits (one on each side). One is in the right-hand overhead compartment, behind first class divider.

7 8 9 (Overwater Equipped) The life rafts are stowed in overhead ceiling compartments.

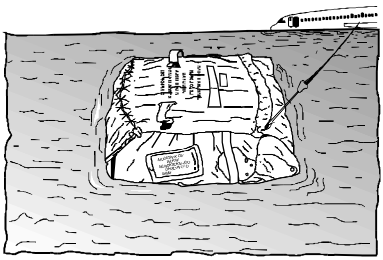
A lanyard is folded in a flap at one corner of the raft pack. The lanyard serves two purposes. It prevents the raft from floating away and when pulled, releases the “D” ring inflating the raft. The lanyard is designed to breakaway at a force less than the raft's buoyancy. Therefore, the aircraft's escape lines should be used to secure the raft to the aircraft.

To Inflate The Raft

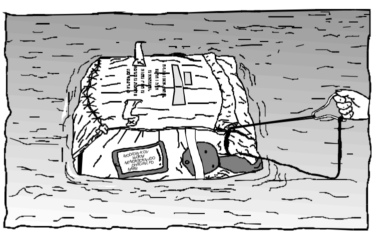
1. Move the life raft pack to the emergency exit. Do not pull the lanyard or “D” ring.

   Note: Do not allow either mechanism to catch on some projection and inflate the raft. If this should happen inside the aircraft, immediately puncture the raft.

2. The free end of the lanyard should be attached to the door-mounted tie down lug (when exiting through the main door) or tied to the escape rope (when exiting through a window emergency exit).
3. Push the life raft into the water in an area clear of debris that might damage the raft.
4. Jerk sharply on the lanyard (or “D” ring) to inflate.



RAFT1



RAFT2

Life Raft Operating Notes

Changing temperatures will cause the raft's main flotation tubes to become over or under inflated, requiring air to be released or pumped in. The valve for the submerged flotation tube is accessible through marked sleeves in the deck. The hand pump is used to add air to the tubes. The hand pump would also be used to inflate the center floor emergency equipment container.

Keep all items securely tied to the raft. Always keep the emergency equipment container zippered closed.

Erect canopy to protect survivors from exposure. It is generally desirable to keep the sides of the canopy pulled up over the supporting rods onto the roof to prevent survivors from developing motion sickness. If water is splashing in, the canopy sides may be pulled down and the elastic band pushed out over the top flotation tube.

Rainwater or dew can be caught by removing the center support from the canopy. The canopy roof will form a reservoir, which will drain water into the raft through the hole in the canopy.

A bailing bucket and a sponge are provided to remove the water accumulated in the raft during boarding. The plastic bags used to package the life vest should be saved by each person and can be used to bail water, store rain water, or to protect personal items.

The signal flares are the hand-held type, with a night flare at one end and a day signal (orange smoke) at the other. The night end has a ring of raised bumps around it. To ignite either signal, fracture seal by folding the ring back over the edge and levering with a twisting movement with the thumb under the near side of the ring and forefinger on top far side of ring. When seal snaps, remove the seal with a quick pull directly away from the end of the container. When igniting and using the flare, hold it out over the water on the downwind side of the raft. After use of one end, dowse in water and save for use of opposite end. Do not ignite signals until rescue plane or ship is close enough to see the signal (approximately seven (7) miles).

WARNING: When igniting the signal flare, hold well away from the body, out over the water, to prevent serious burns to the user or damage to the raft from the hot chemical that may drip out as the flare burns.

Life Vest

Life vests for the flight crew are stowed in pockets on the back of the seats.

Cabin attendant's life vests are stowed at each attendant seat.

Individual passenger life vests are located under each passenger seat.

Instructions for donning the vests are printed on the back of the vest.

Vests are filled automatically with CO_2 by pulling on the tagged cable ends.

Oral tubes near the mouth permit inflating the vest if the CO_2 bottle fails.

Emergency Medical Kit

The emergency medical kit contains equipment for use in the diagnosis and treatment of medical emergencies that might occur during flight. The contents of this kit are of a clinical nature and are to be used only by a medical practitioner.

The kit is located on the flight deck, on the lower side wall, behind the Captain or in a bracket just inside of the flight deck coat closet. The latch on the metal case will be secured with a lead seal. If the seal is broken, the kit must be checked to ensure that it is complete or replaced with a fresh kit and the case resealed. The case will also have the expiration date of the kit attached. This should be checked to ensure that the kit is current.

The emergency medical kits will be supplied with dual quantities of depletable items. This permits the aircraft to continue to a station where the kit can be replaced in the event that it has been necessary to use it.

New greatly expanded kits are replacing this model of kit and are stored and locked in the aft left overhead bin.

The kit contains a form to be completed by the medical practitioner who used the emergency medical kit.

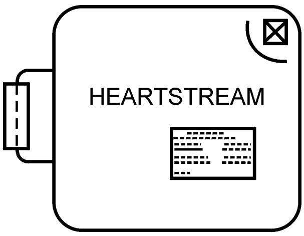
7376-1050

ENHANCED EMERGENCY MEDICAL KIT

Automatic External Defibrillators (AED)

An AED is used to resuscitate a victim experiencing sudden cardiac arrest, which is caused by an abnormal heart rhythm. It is about the size of a laptop computer and delivers an electrical shock to restore normal heartbeat. The device is used in conjunction with basic CPR procedures. If the AED deems it necessary to deliver a shock to the victim, it prompts the rescuer to simply push a button that sends the shock. Simple instructions are written clearly on the front of the unit that will guide the user through the process.

The container can be opened with the old flight deck key.



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* TOC-4	11/15/02	* 32	11/15/02	* 65	11/15/02
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AIR SYSTEMS

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BLEED AIR SYSTEM DESCRIPTION

INTRODUCTION

Air for the bleed air system can be supplied by the engines, APU, or an external air cart / source. The APU or external cart supplies air to the bleed air duct prior to engine start. After engine start, air for the bleed air system is normally supplied by the engines.

The following systems rely on the bleed air system for operation:

- Air conditioning / pressurization
- Wing and engine thermal anti-icing
- Engine starting
- Hydraulic reservoirs pressurization
- Water tank pressurization

Switches on the pneumatic panel operate the APU and engine bleed air supply system.

ENGINE BLEED SYSTEM SUPPLY

Bleed air is obtained from the 5th and 9th stages of the compressor section of the engine. When 5th low-stage pressure is insufficient, the 9th high-stage valve modulates open to maintain proper pressure. During takeoff, climb, and most cruise conditions, the pressure available from the low-stage port is adequate. The high-stage valve remains closed when 5th stage pressure is adequate.

Engine Bleed Air Valves

The engine bleed valve acts as a pressure regulator, shutoff valve. With the engine bleed air switch ON, it is normal DC activated and pneumatically operated. The valve acts as a pressure regulator, maintaining system pressure below the preset outflow pressure.

The bleed valve also reduces pneumatic outflow in response to a signal of high bleed air temperature downstream of the precooler.

Bleed Trip Sensors

Bleed trip sensors illuminate the respective **BLEED TRIP OFF** light when engine bleed air temperature or pressure exceeds a predetermined limit. The respective engine bleed air valve closes automatically.

Precooler And Precooler Control Valve

A precooler, or heat exchanger, precools engine bleed air. Engine fan air is ducted through the precooler at a rate determined by a thermostatic precooler valve. If the temperature of the engine bleed air leaving the precooler increases, the precooler control valve modulates open. The fan air from the precooler control valve extracts heat from the crossflow heat exchanger, then is discharged into the engine core cavity and then eventually overboard.

Starter Valve

The starter valve opens when the engine start switch is placed to GRD. The APU, ground air cart, or engine bleed air is then used to start the engine. The engine start valve is DC (battery bus) activated and pneumatically operated.

Duct Pressure Transmitters

Duct pressure transmitters provide pneumatic duct pressure indications to the respective (L and R) pointers on the pneumatic duct pressure indicator. The indicator is AC operated.

Thermal Anti-Icing (TAI)

Engine bleed air is used for both wing and engine cowl lip anti-icing.

Isolation Valve

The isolation valve isolates the left and right sides of the bleed air duct during normal operations. The isolation valve is AC operated.

With the isolation valve switch in AUTO, both engine bleed air switches ON, and both air conditioning pack switches AUTO or HIGH, the isolation valve is closed. The isolation valve opens if either engine bleed air switch or air conditioning pack switch is positioned OFF. Isolation valve position is not affected by the APU bleed air switch.

External Air Connection

An external air cart / source provides an alternate air source for engine start or air conditioning.

APU Bleed Air Valve

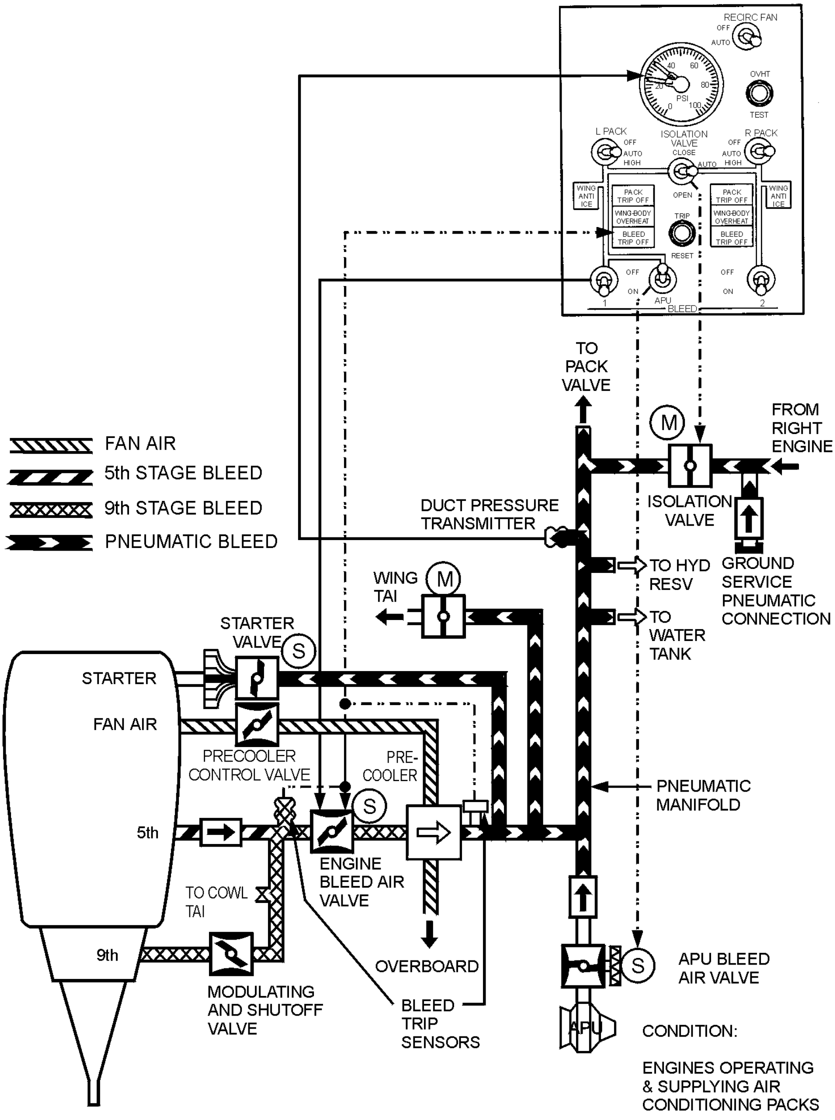
The APU bleed valve furnishes APU bleed air to the pneumatic manifold and may be used on the ground or in the air. The valve closes automatically when the APU is shut down. The APU bleed valve is DC (battery bus) activated and pneumatically operated.

With the APU bleed air valve open and the engines operating at idle thrust, there is a possibility of APU bleed air backpressuring the 9^{th} stage modulating and shutoff valve. This would cause the 9^{th} stage valve to close. Therefore, the APU bleed air valve must be closed during ground use of engine anti-ice to ensure that sufficient engine bleed air is available for cowl anti-icing.

Dual Bleed Light

The **DUAL BLEED** light illuminates whenever the APU bleed air valve is open and the position of the engine bleed air switches and isolation valve would permit possible backpressure of the APU. Therefore, thrust must be limited to idle with the **DUAL BLEED** light illuminated.

③③⑤ BLEED AIR SYSTEM SCHEMATIC



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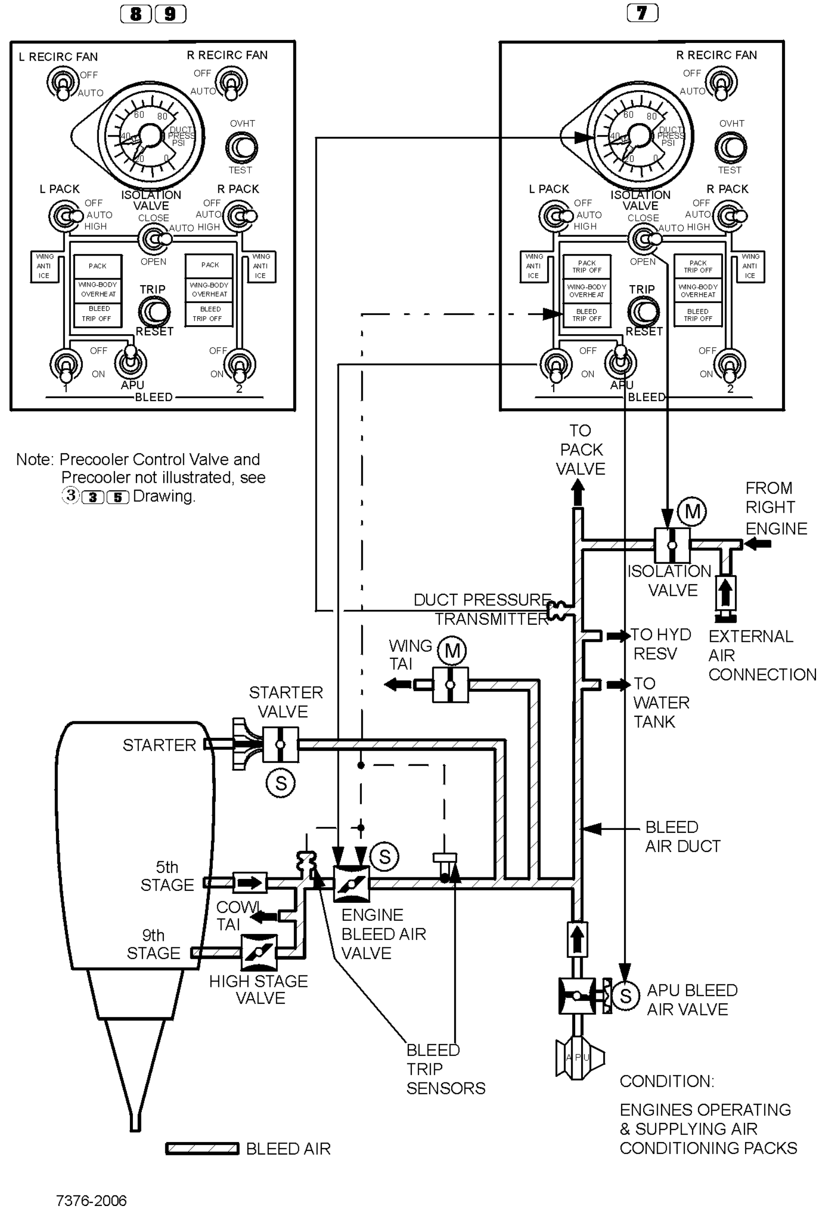
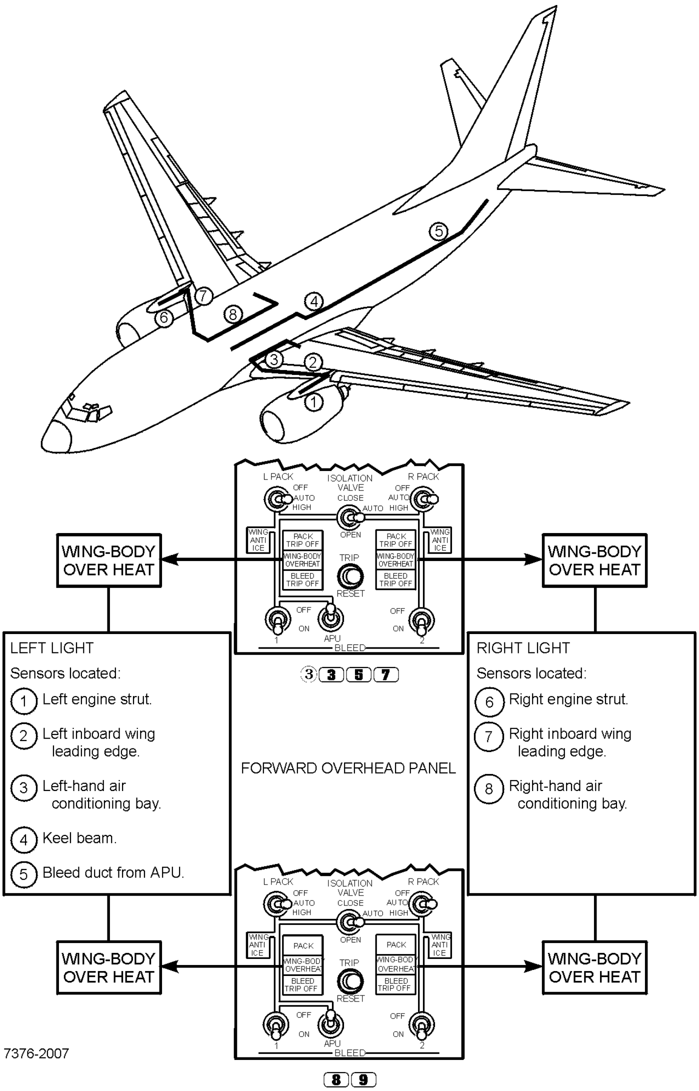
7 8 9 BLEED AIR SYSTEM SCHEMATIC



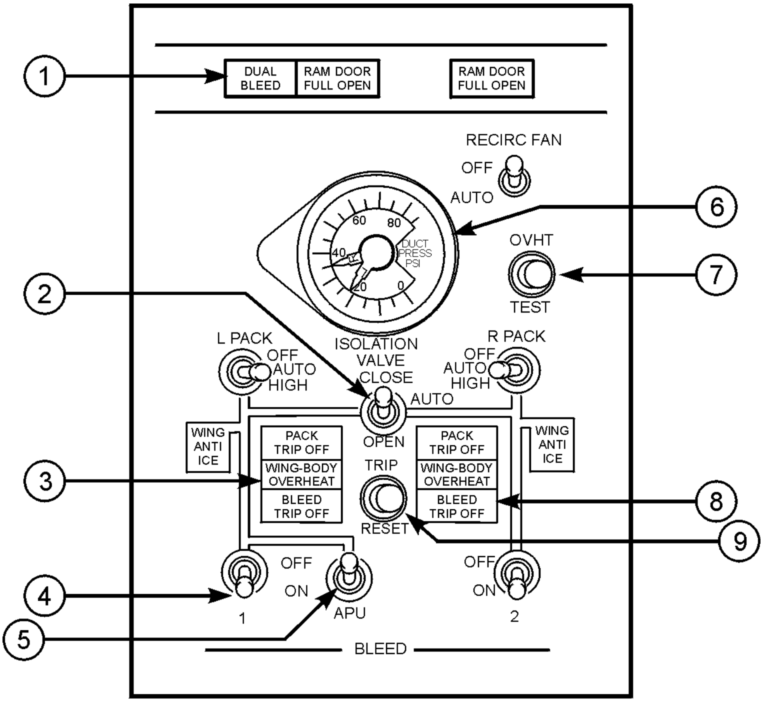
Wing-Body Overheat

A wing-body overheat condition is caused by a bleed air duct leak. It is sensed by the overheat sensors located as shown.

Wing-Body Overheat Ducts And Lights



③ 3 5 7 Bleed Air Controls And Indicators



FORWARD OVERHEAD PANEL

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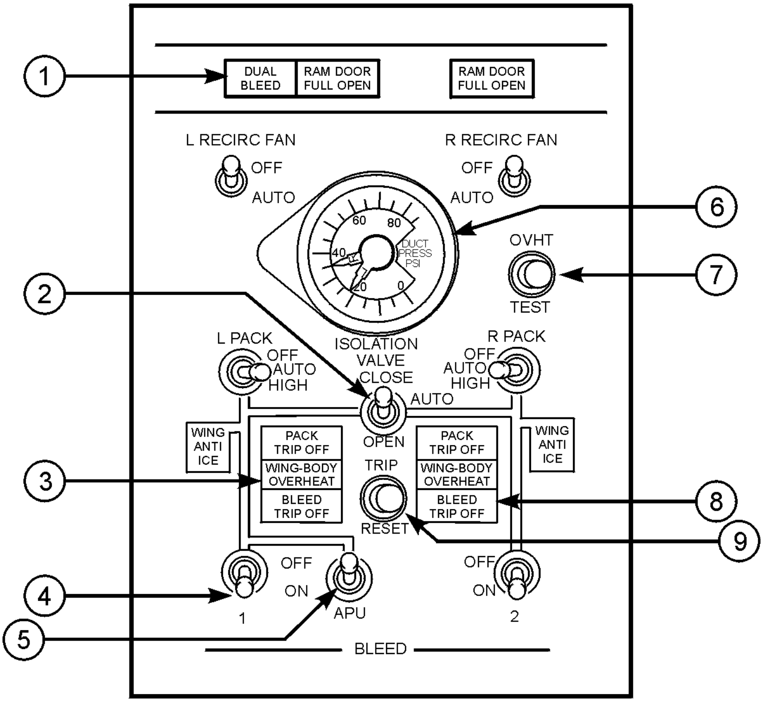
8 9 Bleed Air Controls And Indicators



FORWARD OVERHEAD PANEL

7376-2009

① **DUAL BLEED** Light

Illuminated (amber) – APU bleed air valve open and engine No. 1 BLEED air switch ON, or engine No. 2 BLEED air switch ON, APU bleed air valve and isolation valve open.

② ISOLATION VALVE Switch

CLOSE – Closes isolation valve.

AUTO –

- Closes isolation valve if both engine BLEED air switches are ON and both air conditioning PACK switches are AUTO or HIGH.
- Opens isolation valve automatically if either engine BLEED air or air conditioning PACK switch positioned OFF.

OPEN – Opens isolation valve.

③ **WING-BODY OVERHEAT** Light

Illuminated (amber) –

- Left light indicates overheat from bleed air duct leak in left engine strut, left inboard wing leading edge, left air conditioning bay, keel beam or APU bleed air duct.
- Right light indicates overheat from bleed air duct leak in right engine strut, right inboard wing leading edge or right air conditioning bay.

④ Engine BLEED Air Switches

OFF – Closes engine bleed air valve.

ON – Opens engine bleed air valve when engines are operating.

⑤ APU BLEED Air Switch

OFF – Closes APU bleed air valve.

ON – Opens APU bleed air valve when APU is operating.

⑥ Bleed Air DUCT PRESSURE Indicator

Indicates pressure in L and R (left and right) bleed air ducts.

⑦ Wing-Body Overheat (OVHT) TEST Switch

Push –

- Tests wing–body overheat detector circuits.
- Illuminates both **WING-BODY OVERHEAT** lights.

⑧ **BLEED TRIP OFF** Light

Illuminated (amber) – Excessive engine bleed air temperature or pressure.

- Related engine bleed air valve closes automatically.
- Requires reset.

③ 3 5 7

⑨ TRIP RESET Switch

Push (if fault condition is corrected) –

- Resets **BLEED TRIP OFF**, **PACK TRIP OFF** and **DUCT OVERHEAT** lights.
- Lights remain illuminated until reset.

8 9

⑨ TRIP RESET Switch

Push (if fault condition is corrected) –

- Resets **BLEED TRIP OFF**, **PACK** and **ZONE TEMP** lights.
- Related engine bleed valve opens, or related pack valve opens, or related air mix valve opens.
- Lights remain illuminated until reset.

AIR CONDITIONING SYSTEM DESCRIPTION

INTRODUCTION

Conditioned air for the cabin comes from either the aircraft air conditioning system or a preconditioned ground source. Air from the preconditioned ground source enters the air conditioning system through the mix manifold.

The air conditioning system provides temperature controlled air by processing bleed air from the engines, APU, or a ground air source in air conditioning packs. Conditioned air from the left pack, upstream of the mix manifold, flows directly to the flight deck. Excess air from the left pack, air from the right pack, and air from the recirculation system is combined in the mix manifold. The mixed air is then distributed through the left and right sidewall risers to the passenger cabin.

AIR CONDITIONING PACK

The flow of bleed air from the bleed air duct through each air conditioning pack is controlled by the respective pack valve. The left and right packs are completely independent. Normally the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2. Cabin altitude can be maintained at or below 8,000 feet when the aircraft is at maximum certified ceiling with only one system operating.

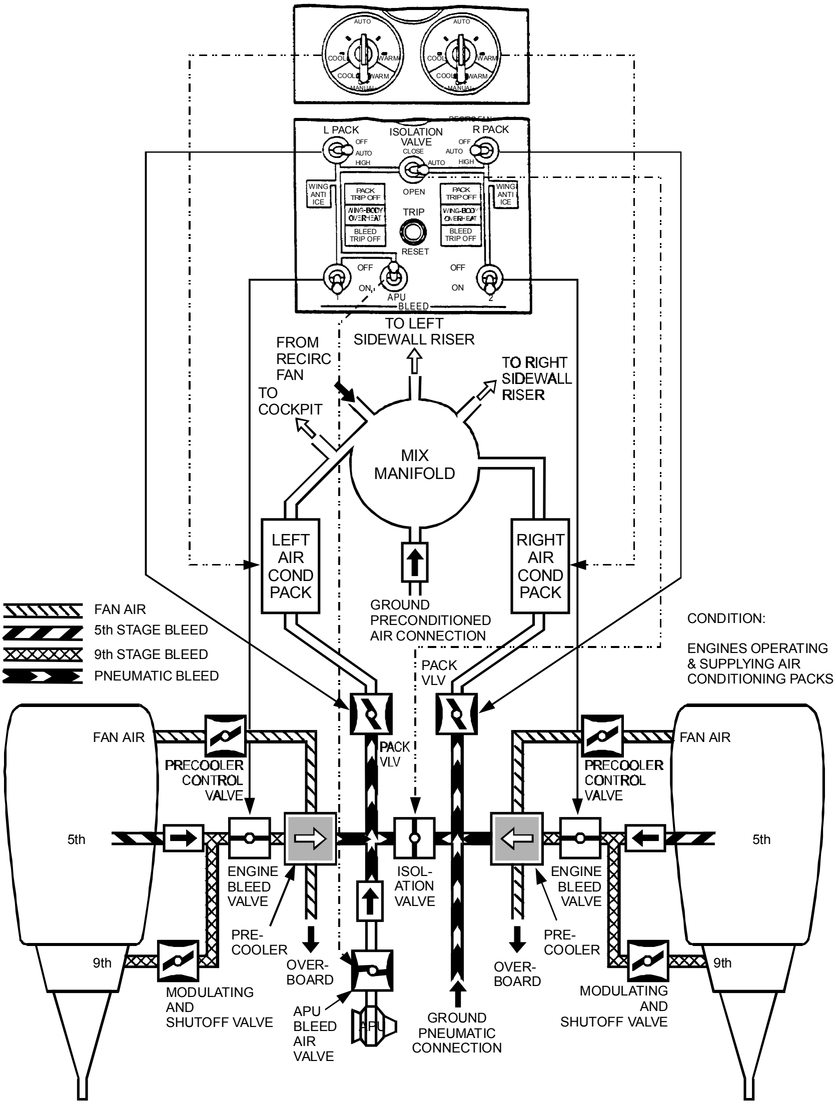
③ [3] [5] The APU is capable of supplying bleed air for two packs on the ground only for rapid heating of the cabin, or one pack in flight.

[7] [8] [9] The APU can supply two packs on the ground for all operations.

Most external air carts are capable of supplying adequate bleed air for two pack operation.

③ [3] [5] Two pack operation from a single bleed air source is not recommended due to excessive bleed requirements. Pack temperature control is automatic with manual control as a backup.

AIR CONDITIONING SCHEMATIC



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AIRFLOW CONTROL

With both air conditioning pack switches in AUTO and both packs operating, the packs provide "normal air flow." However, with one pack not operating, the other pack automatically switches to "high air flow" to maintain the necessary ventilation rate. This automatic switching is inhibited when the aircraft is on the ground, or inflight with the flaps extended, to insure adequate engine power for single engine operation. Automatic switching to "high air flow" occurs if both engine bleed air switches are OFF and the APU bleed air switch is ON, regardless of flap position, air / ground status or number of packs operating.

With the air conditioning pack switch in HIGH, the pack provides "high air flow." Additionally, an "APU high air flow" rate is available when the aircraft is on the ground, the APU bleed air switch is ON and either or both pack switches are positioned to HIGH. This mode is designed to provide the maximum airflow when the APU is the only source of bleed air.

AIR MIX VALVES

The two air mix valves for each pack control hot and cold air according to the setting of the CONT CABIN or PASS CABIN temperature selector. Air that flows through the cold air mix valve is processed through a cooling cycle and then combined with hot air flowing from the hot air mix valve.

In the automatic temperature mode, the air mix valves are operated by the automatic temperature controller. The automatic temperature controller uses inputs from the respective temperature selector and cabin temperature sensor. The automatic temperature controller is bypassed when the temperature selector is positioned to MANUAL.

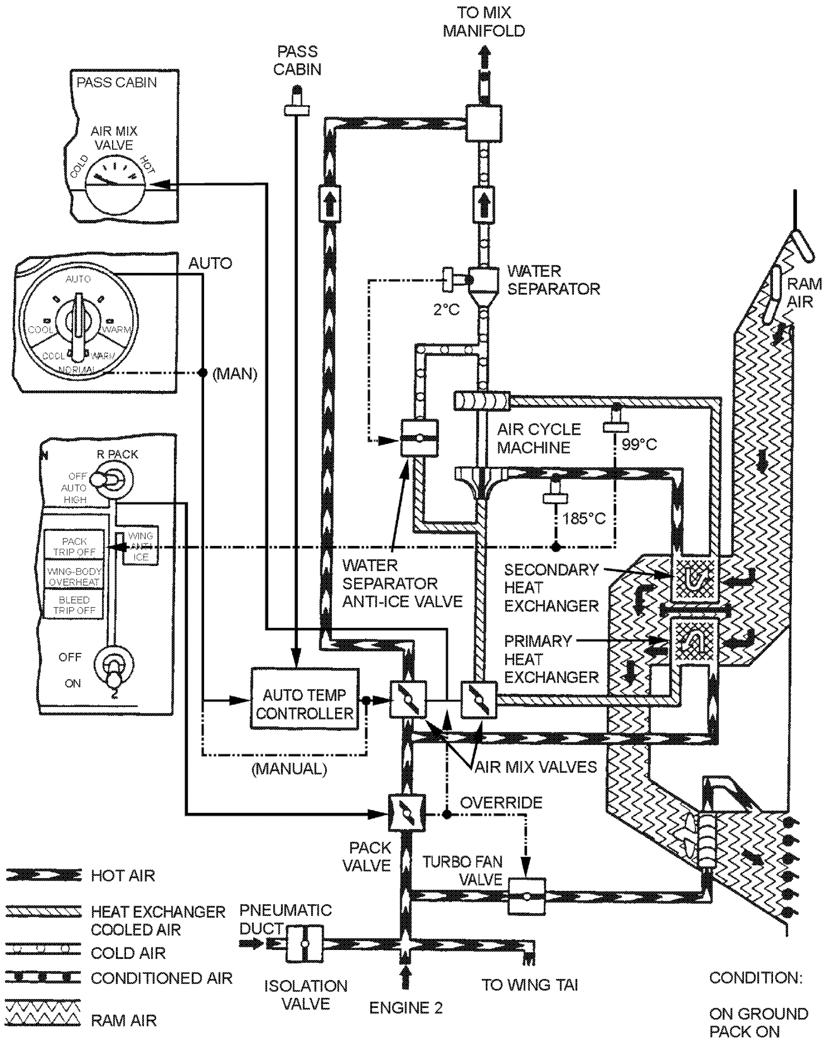
Anytime the pack valve closes, the air mix valves are driven to the full cold position automatically. This aids startup of the cooling cycle and prevents nuisance hot air trips when the pack is turned on.

COOLING CYCLE

The flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration and to a water separator which removes moisture. The processed cold air is then combined with hot air. The conditioned air flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the **PACK TRIP OFF** light to illuminate.

③③⑤ AIR CONDITIONING PACK SCHEMATIC



3737704

RAM AIR SYSTEM

The ram air system is used to provide cooling for the heat exchangers in the air conditioning system. Operation of the system is automatic.

During flight, the ram air modulating system automatically regulates airflow through the system. A temperature sensor in the air cycle machine (ACM) compressor discharge duct controls airflow through the system. The sensor modulates the mechanically linked ram door and exhaust louvers to maintain the required cooling airflow across the heat exchangers. 7 8 9 Louvers are not installed. In normal cruise, the ram door will modulate between a normal open and normal closed position.

When on the ground or during slow flight with the flaps not fully retracted, the ram door moves to the full open position for maximum cooling. The **RAM DOOR FULL OPEN** light illuminates whenever the ram door is fully open.

DEFLECTOR DOOR

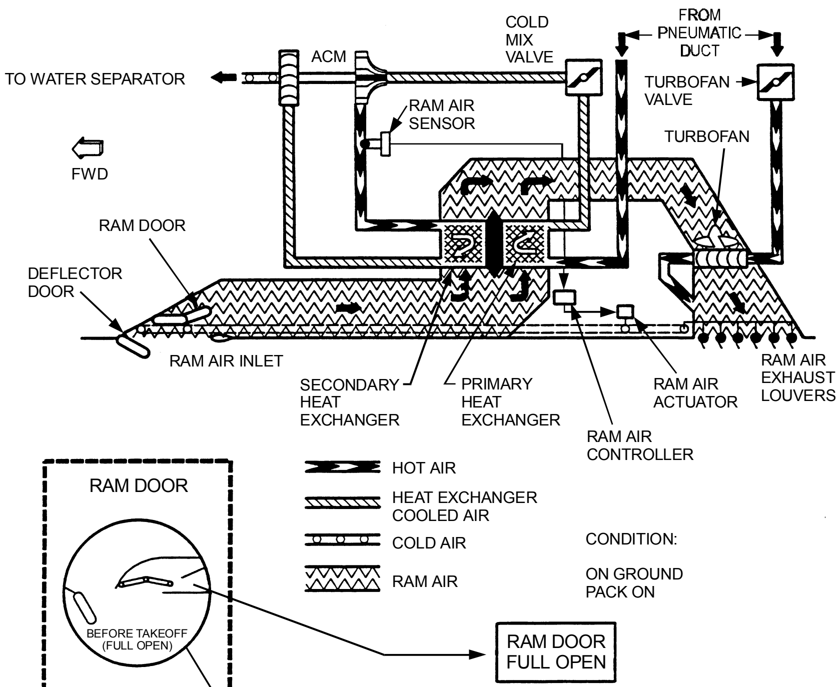
A deflector door is installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector door extends when activated electrically by the air-ground safety sensor.

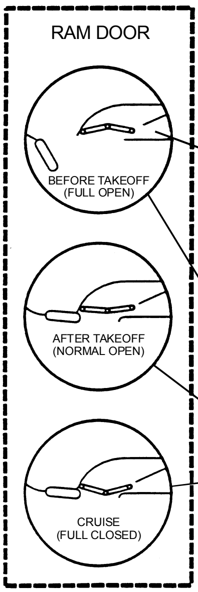
TURBOFAN

③ 3 5

A turbofan is located in each ram air exit duct just upstream of the exit louvers. It augments the ram airflow on the ground, or during slow flight with the flaps not fully retracted. The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

③ 3 5 RAM AIR SYSTEM SCHEMATIC





AIRPLANE ATTITUDE	FLAP POSITION	TURBO FAN VALVE POSITION	FLAP POSITION	RAM DOOR FULL OPEN LIGHT
BEFORE TAKEOFF	UP OR DOWN	OPEN	EXTENDED	ILLUMINATED
TAKEOFF/ CLIMB	DOWN	OPEN	RETRACTED	ILLUMINATED
CLIMB	UP	CLOSES	RETRACTED	EITHER
CRUISE	UP	CLOSES	RETRACTED	EXTINGUISHED
BEFORE LANDING	DOWN	OPENS	RETRACTED	ILLUMINATED
TOUCH DOWN	DOWN	OPEN	EXTENDED	ILLUMINATED

3737705

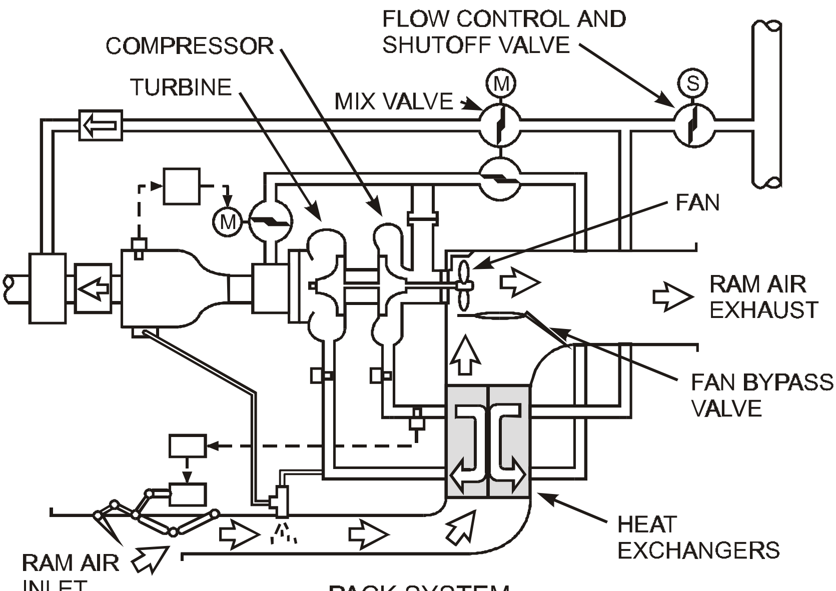
7 8 9 AIR CYCLE MACHINE FAN

7 8 9 Adequate air flow across the heat exchangers is assured when the aircraft is on the ground or in flight by a fan attached to the ACM.

A spring loaded fan bypass valve opens when ram air pressure is more than fan air pressure. This valve serves as a check valve when the ACM fan air pressure exceeds ram air pressure.

FWD

AIR CONDITIONING COMPARTMENTS



PACK SYSTEM

7376-2010

AIR CONDITIONING DISTRIBUTION

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the CONT CABIN and PASS CABIN temperature selectors.

Overheat detection is provided by temperature sensors located downstream of the packs. An overheat condition causes the appropriate mix valves to drive full cold and the **DUCT OVERHEAT** light to illuminate. A temperature higher than the duct overheat causes the appropriate pack valve to close and the **PACK TRIP OFF** light to illuminate.

FLIGHT DECK

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack air output is mixed with the right pack supply and routed to the passenger cabin.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling, and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

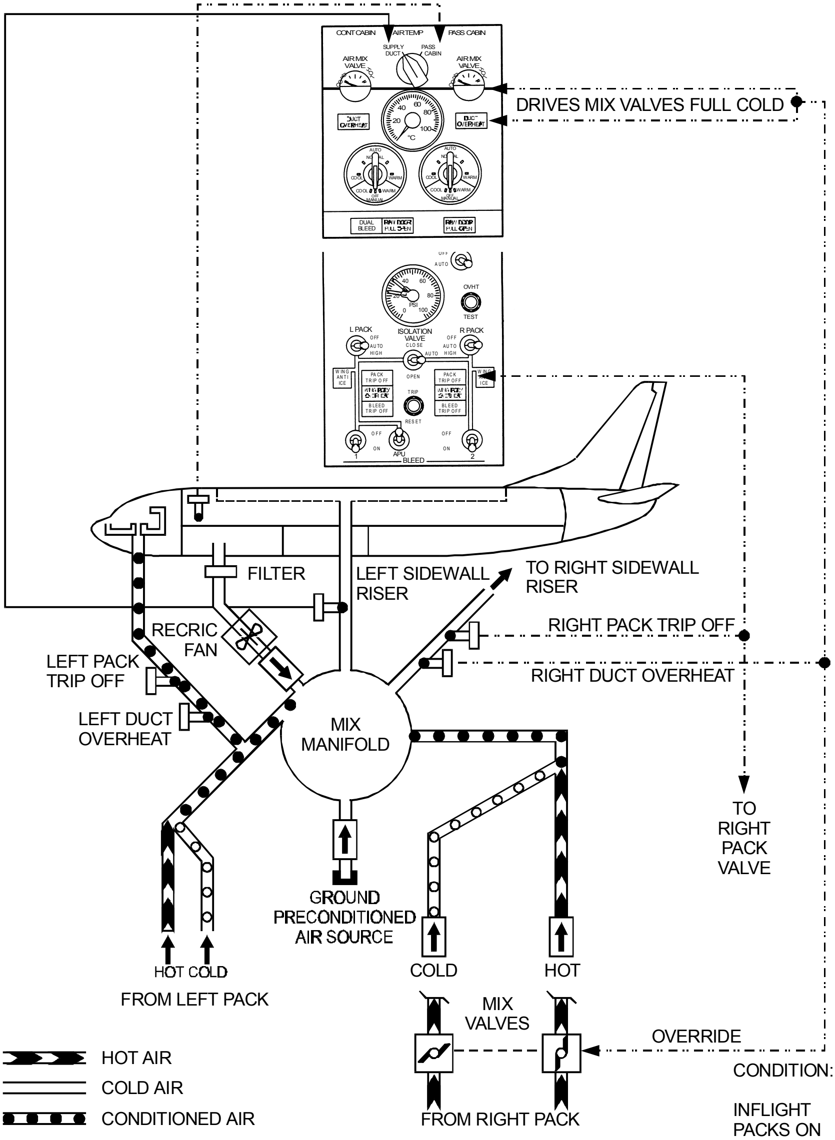
There is also a dual purpose valve behind the rudder pedals of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panel, respectively.

PASSENGER CABIN

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left wall of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the aircraft centerline and also supplies the sidewall diffusers.

③ 3 5 7 AIR CONDITIONING DISTRIBUTION SCHEMATIC



3737706

(8)(9) TRIM AIR SYSTEM OPERATION

Due to the length of the aircraft, the air conditioning system is divided into three zones. These include the CONT CAB (flight deck), FWD CAB, and AFT CAB. Adjusting the individual selector sets desired zone temperature. With the desired temperatures selected, the packs produce an air temperature that will satisfy the zone that requires the most cooling. In order to prevent the remaining two zones from receiving conditioned air that is too cool for the selected temperatures, trim air (bleed air) is mixed with the air from the manifold to regulate it to the desired temperature.

With the TRIM AIR switch in the ON position, the trim air pressure regulator and shutoff valve are open. This allows bleed air ducted from upstream of the packs to be directed to three trim air modulating valves, one for each zone. Two separate electronic controllers control the modulating valves. The right controller provides for the modulation of the forward cabin and acts as the primary controller for the flight deck. The left controller modulates the valve for the aft cabin and acts as backup controller for the flight deck. The controllers will allow the valves to open when necessary to provide bleed air for mixing with the conditioned air to maintain desired zone temperatures.

When the TRIM AIR switch is OFF, the left pack controller provides air at the temperature selected for the flight deck zone and the right pack supplies air at the temperature requested by the passenger cabin zone demanding the coolest air. If all temperature selectors are positioned OFF, the left pack will maintain a fixed temperature of 75°F and the right pack will be controlled to maintain a fixed temperature of 65°F, measured at pack discharge.

The system also incorporates zone supply duct overheat protection. If a supply duct overheats, the associated amber **ZONE TEMP** and **MASTER CAUTION** lights will illuminate, and the trim air modulating valve closes.

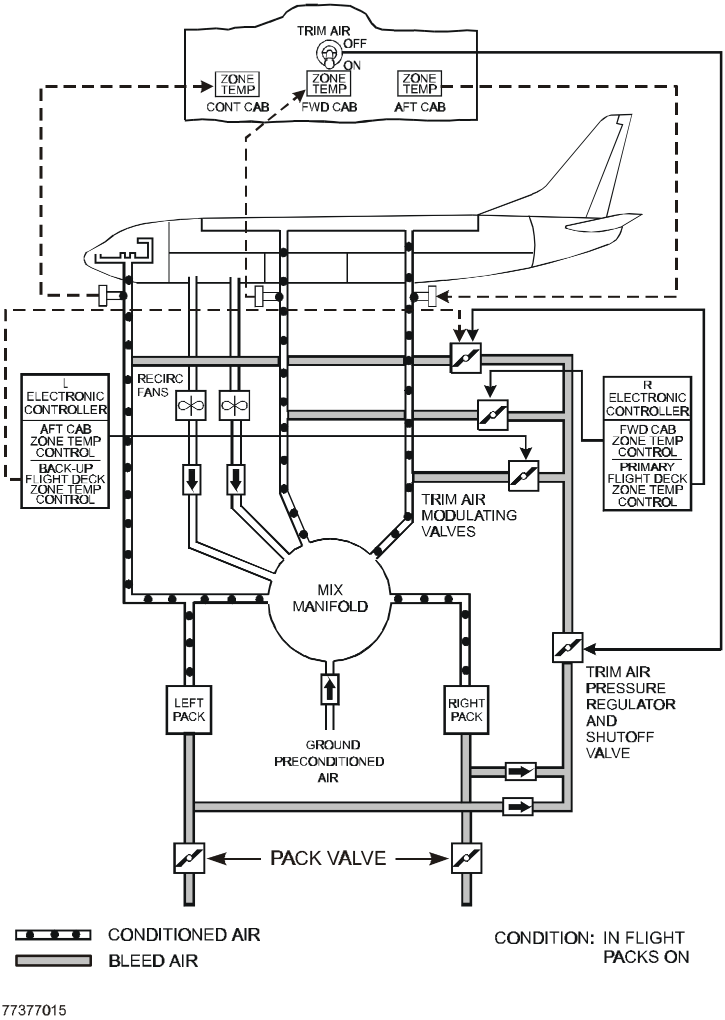
If the **CONT CAB ZONE TEMP** light illuminates after master caution **RECALL**, a failure of the Electronic Controllers is indicated. If a passenger zone temperature controller fails, the associated trim air modulating valve closes. The temperature selectors are still operable but the temperature output will be an average of the FWD CAB and AFT CAB temperature selectors.

Any failure of the Trim Air system will cause the packs to revert to independent operation. If the CONT CAB (flight deck) trim air is lost, the left pack will be controlled by the CONT CAB temperature selector and right pack will be controlled to provide air at a temperature to satisfy the demand of the passenger cabin zone requiring the coolest air.

If the Trim Air for a passenger cabin zone is lost, the right pack will supply air at an averaged temperature for the FWD CAB and AFT CAB temperature selectors.

The Electronic Controllers will ignore the setting of any Temperature Selector which has been switched OFF. If all three selectors are switched OFF, the Left Pack will output air to maintain 75°F (24°C) and the Right Pack will output air to maintain 65°F (18°C) as measured at the pack temperature sensors.

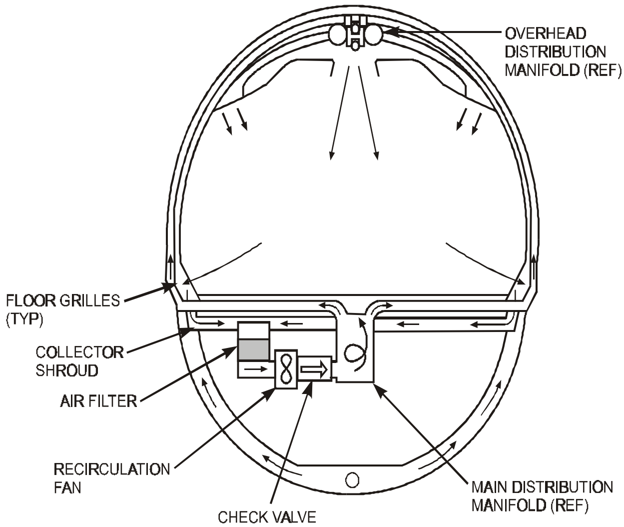
8 9 AIR CONDITIONING DISTRIBUTION SCHEMATIC



RECIRCULATION FAN

③ [3] [5] [7] The recirculation fan system reduces the air conditioning pack load and the engine bleed air demand. The air for the recirculation fan is exhaust air from the main cabin and electrical equipment bay collected in a shroud located above the forward cargo compartment. This air is filtered and recirculated to the mix manifold. The fan is driven by an AC motor. Fan operates with switch in AUTO except when both packs are on and one or both are in HIGH.

When the fan shuts down as a result of this action, the forward outflow valve ③ [3] [5], motorized overboard exhaust valve [7], will open to assure continued air flow around the forward cargo compartment.

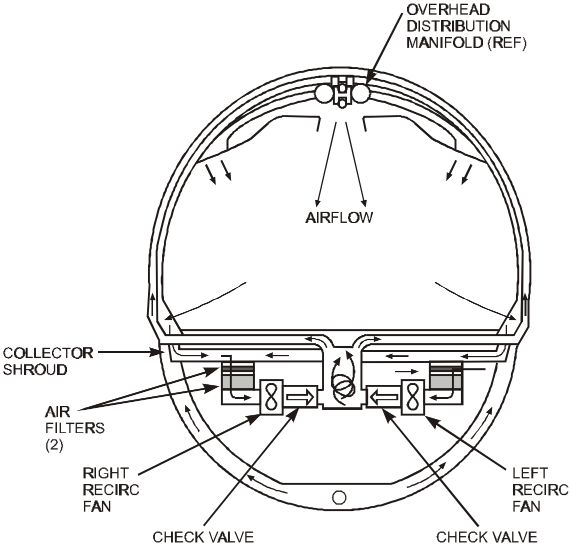


RECIRCULATION SCHEMATIC

7376-2012

[8] [9] The dual recirculation fan system reduces the air conditioning pack load and the engine bleed air demand. The air for the right recirculation fan is exhaust air from the main cabin and electrical equipment bay collected in a shroud located above the forward cargo compartment. The left recirculation fan draws air from the air distribution compartment where the mix manifold is located. This compartment is connected to the area under the floor aft of the wheel well via a tunnel system, which enables the fan to receive adequate air supply. The air for the fans is filtered and recirculated to the mix manifold. The fans are driven by AC motors. The fans normally operate with the switches in AUTO. Fan(s) operation is subject to the conditions listed in the following table.

7 8 9 OVERBOARD EXHAUST VALVE



RECIRCULATION SCHEMATIC

7376-2013

8 9

RECIRC FAN SW POSITION	PACK OPERATION		LEFT RECIRC FAN	RIGHT RECIRC FAN
OFF	ANY		OFF	OFF
AUTO	GROUND	LEFT PACK LOW FLOW RIGHT PACK LOW FLOW	ON	ON
		LEFT PACK HIGH FLOW RIGHT PACK LOW FLOW	ON	ON
		LEFT PACK LOW FLOW RIGHT PACK HIGH FLOW	ON	ON
		LEFT PACK HIGH FLOW RIGHT PACK HIGH FLOW	OFF	ON
	AIR	LEFT PACK LOW FLOW RIGHT PACK LOW FLOW	ON	ON
		LEFT PACK HIGH FLOW RIGHT PACK LOW FLOW	OFF	ON
		LEFT PACK LOW FLOW RIGHT PACK HIGH FLOW	OFF	ON
		LEFT PACK HIGH FLOW RIGHT PACK HIGH FLOW	OFF	OFF

7 8 9 Motorized Overboard Exhaust Valve

Low cabin pressure – Open
High cabin pressure – Closed
Both packs on High – Open

③③⑤ FORWARD CARGO COMPARTMENT

The forward cargo compartment is warmed in flight when more than 2.5 psi pressure differential exists. Air from the E & E compartment flows up and around the forward cargo compartment lining. The recirculation fan maintains this warming air flow. When the recirculation fan is off, the forward outflow valve opens to ensure this warm air flow (except when closed in order to maintain pressurization).

⑦⑧⑨ FORWARD CARGO COMPARTMENT

The forward cargo compartment utilizes a motorized overboard exhaust valve in place of the flow control valve, while eliminating the forward outflow valve. When the overboard exhaust valve is closed, exhaust air from the equipment cooling system is also diffused to the lining of the forward cargo compartment for additional inflight heating.

When the right recirculation fan shuts down, according to the above operation table, the overboard exhaust valve opens venting the E & E compartment overboard. The forward cargo compartment continues to stay warm by air from the forward cabin. This air flows through the floor registers, down the sides of the forward cargo compartment and backwards to the overboard exhaust valve.

CONDITIONED AIR SOURCE CONNECTION

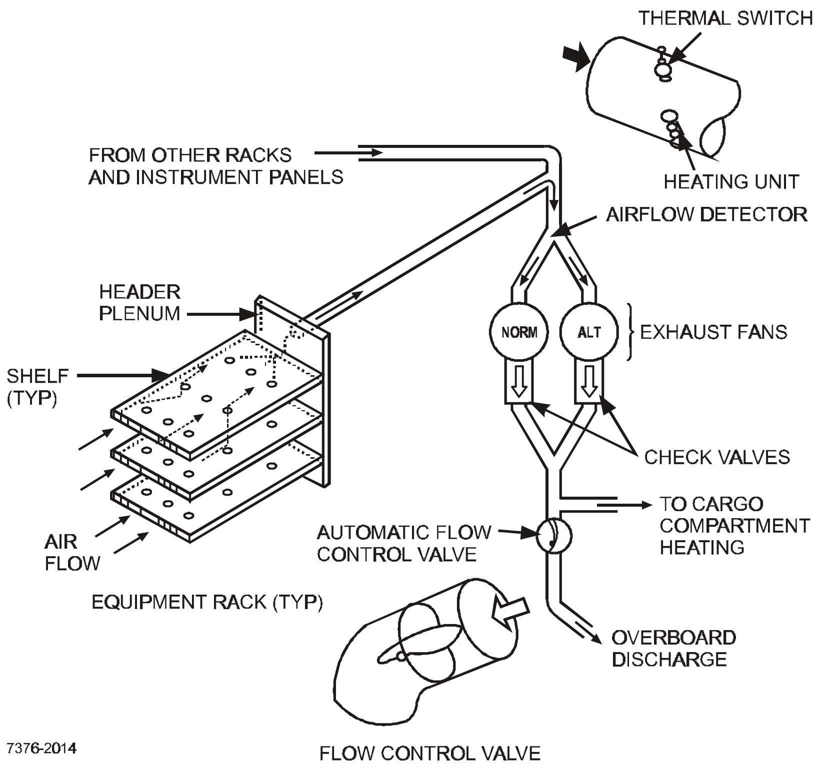
A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the aircraft.

EQUIPMENT COOLING – EXHAUST FAN

EFIS equipment, if installed, circuit breaker and instrument panels in the flight deck and electronic equipment in the E & E compartment are cooled by the equipment cooling system. Warm air, from the equipment, is ducted away by the selected AC powered exhaust fan. On the ground, or with the cabin differential pressure less than 2.5 psi, the exhaust fan air is blown through a flow control valve / overboard exhaust valve and out the bottom of the aircraft.

With increasing airflow at greater cabin differential pressures, the flow control valve / overboard exhaust valve closes. Warm air from the electronic equipment is then diffused around the forward cargo compartment.

EQUIPMENT COOLING SCHEMATIC



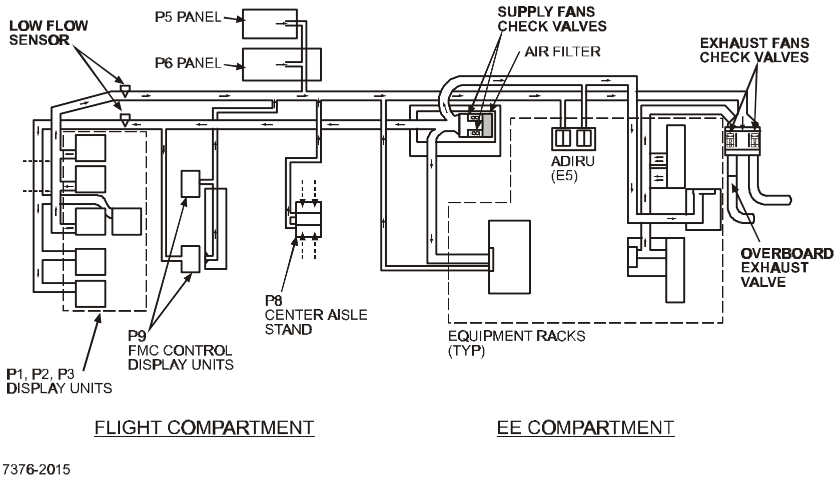
3 5 7 8 9 EQUIPMENT COOLING – SUPPLY FAN

On EFIS equipped aircraft, the supply fan draws cool air from the passenger cabin and furnishes it to the instrument panels.

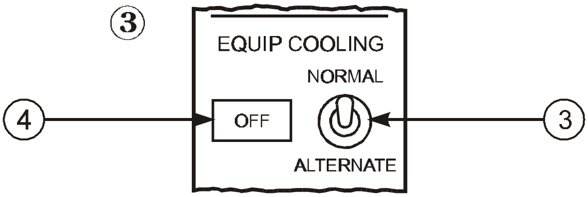
Additional thermal switches are located in the E & E compartment.

Loss of air flow due to failure of an equipment cooling fan results in illumination of the related equipment cooling **OFF** light. Selecting the alternate fan should restore air flow and extinguish the **OFF** light within approximately 5 seconds.

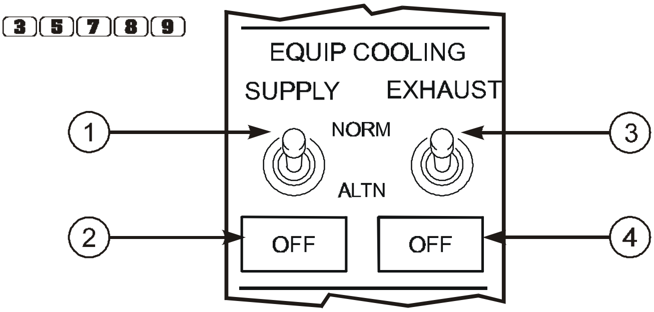
If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.



EQUIPMENT COOLING PANEL



FORWARD OVERHEAD PANEL



FORWARD OVERHEAD PANEL

7376-2016

① Equipment (EQUIP) COOLING SUPPLY Switch

NORM – Normal cooling supply fan activated.

ALTN – Alternate cooling supply fan activated.

② Equipment Cooling Supply **OFF** Light

Illuminated (amber) – No airflow from selected cooling supply fan.

③ Equipment (EQUIP) COOLING EXHAUST Switch

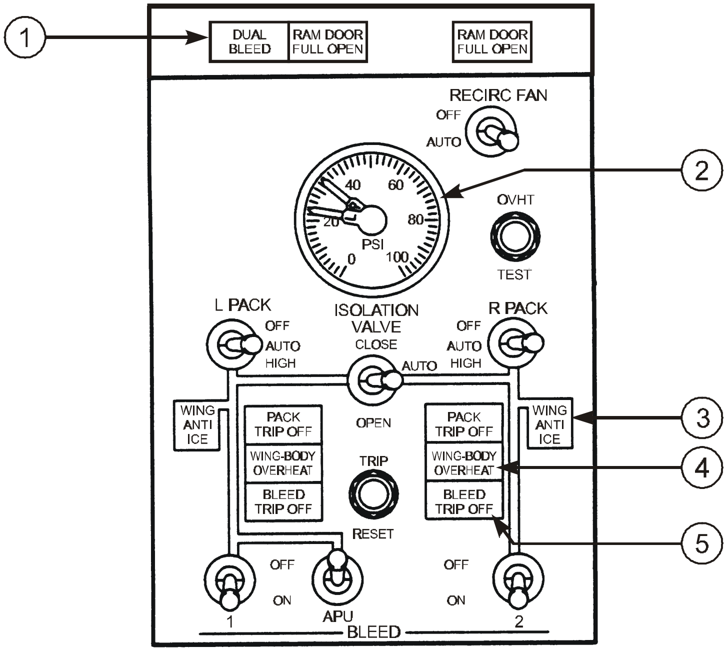
NORM – Normal cooling exhaust fan activated.

ALTN – Alternate cooling exhaust fan activated.

④ Equipment Cooling Exhaust **OFF** Light

Illuminated (amber) – No airflow from selected cooling exhaust fan.

③③⑤⑦ BLEED AIR INDICATORS



FORWARD OVERHEAD PANEL

7376-2017

① **DUAL BLEED** Light (amber)

Illuminated – APU bleed air valve OPEN and No. 1 engine bleed switch ON, or No. 2 engine bleed switch ON, APU bleed air valve and isolation valve OPEN.

② Pneumatic Duct Pressure Indicator

- Indicates pressure in the L and R (left and right) pneumatic ducts.

③ WING ANTI-ICE Schematic Decal

- Depicts the relationship of bleed air for wing anti-ice to the pneumatic system.

④ WING-BODY OVERHEAT Light (amber)

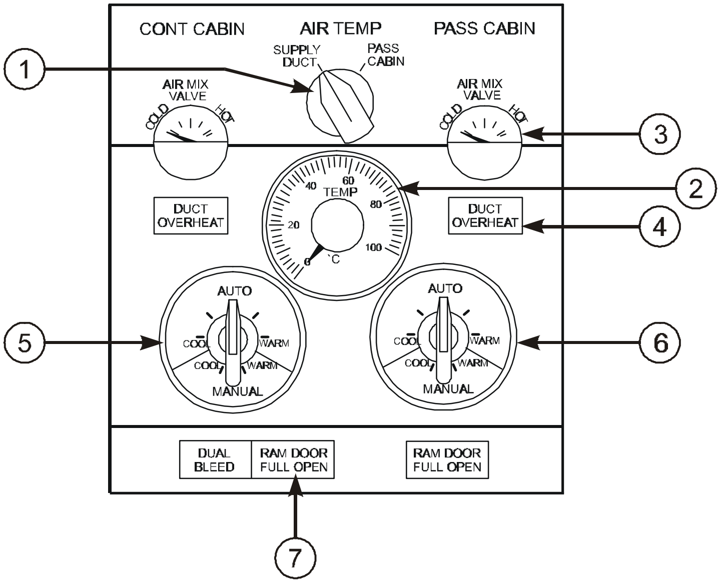
- Left Light Illuminated – Indicates overheat from a bleed air duct leak in the left engine strut, left wing leading edge, left air conditioning bay, keel beam or APU bleed air duct.
- Right Light Illuminated – Indicates overheat from a bleed air duct leak in the right engine strut, right wing leading edge or right air conditioning bay.

⑤ BLEED TRIP OFF Light (amber)

Illuminated – Indicates excessive engine bleed air temperature or pressure. Associated engine bleed air valve closes automatically and requires reset.

Note: Lights remain illuminated until the TRIP RESET switch is pushed.

③ 3 5 7 TEMPERATURE CONTROLS



FORWARD OVERHEAD PANEL

7376-2018

① Air Temperature Source Selector

SUPPLY DUCT – Selects main distribution supply duct sensor for Temperature Indicator.

PASS CABIN – Selects passenger cabin.

② Temperature Indicator

- Indicates temperature at location selected with Air Temperature Source Selector.

③ Passenger Cabin AIR MIX VALVE Indicator

- Indicates position of air mix valves.
- Controlled automatically with Passenger Cabin Temperature Selector in AUTO.
- Controlled manually with Passenger Cabin Temperature Selector in MANUAL.

④ **DUCT OVERHEAT** Light (amber)

Illuminated – Indicates passenger cabin duct overheat.

- Air mix valves drive full cold.
- Requires reset.

⑤ Flight Deck Temperature Selector

⑥ Passenger Cabin Temperature Selector

AUTO – Automatic temperature controller controls passenger cabin temperature as selected.

- Controlled through temperature sensor located in cabin ceiling and controller located in electronic equipment bay.

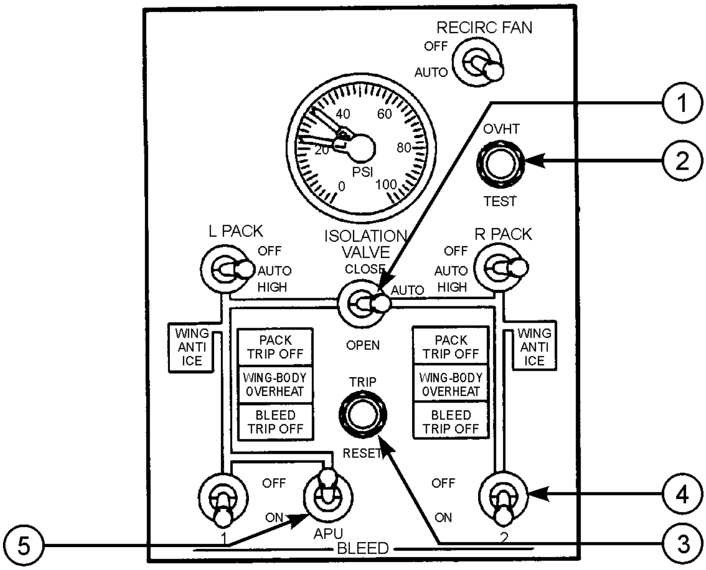
MANUAL – Air mix valves controlled manually.

- Automatic temperature controller bypassed.

⑦ **RAM DOOR FULL OPEN** Light (blue)

Illuminated – Indicates ram door in full open position.

③ 3 5 7 BLEED AIR CONTROLS



FORWARD OVERHEAD PANEL

7376-2019

① ISOLATION VALVE Switch

CLOSE – Closes the isolation valve.

AUTO – Closes the isolation valve if all engine bleed air and air conditioning pack switches are ON.

- Opens the isolation valve automatically if either engine bleed air or air conditioning pack switch is positioned OFF.

OPEN – Opens the isolation valve.

② Wing-Body Overheat Test Switch

PRESS – Tests the wing-body overheat detector circuits.

- Both **WING-BODY OVERHEAT** lights illuminate.

③ TRIP RESET Switch

PRESS – If the fault condition has been corrected, resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT. Lights remain illuminated until reset.

④ Engine Bleed Air Switch

OFF – Closes the engine bleed air valve.

ON – Opens the engine bleed air valves when the engine is operating.

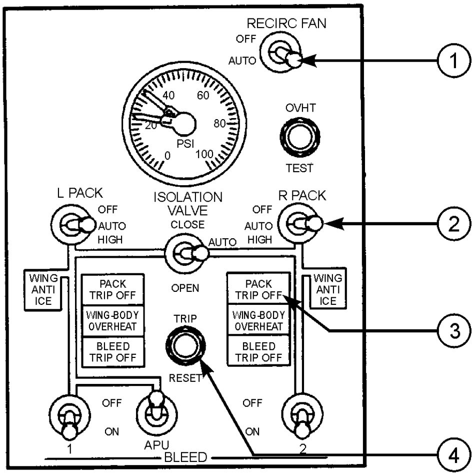
⑤ APU BLEED Air Switch

OFF – Closes the APU bleed air valve.

ON – Opens the APU bleed air valve if the APU is operating.

AIR CONDITIONING CONTROLS

③ 3 5 7 Forward Overhead Panels



FORWARD OVERHEAD PANEL

7376-2020

① Recirculation Fan Switch

AUTO – Fan is signaled on except when both packs are operating with either pack switch in HIGH.

② Air Conditioning Pack Switch

AUTO – With both packs operating, each pack regulates to low flow rate.

- With only one pack operating, regulates to high flow rate when inflight with flaps up.

HIGH – Pack regulates to high flow.

- Recirc fan signaled off when both packs are operating.
- Provides maximum flow rate on ground with APU bleed air switch ON.

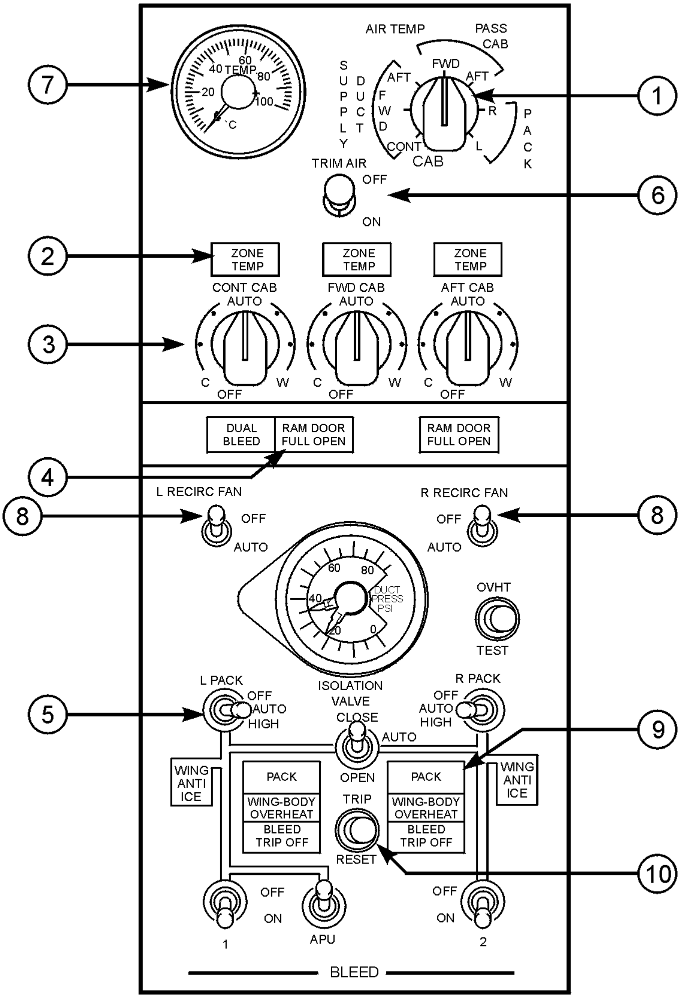
③ **PACK TRIP OFF** Light (amber)

Illuminated – Indicates pack trip off. Pack valve automatically closes and mix valves drive full cold. Trips are caused by pack temperatures exceeding limits.

④ TRIP RESET Switch

PRESS – If the fault condition has been corrected, reset **BLEED TRIP OFF**, **PACK TRIP OFF** and **DUCT OVERHEAT** lights. Lights remain illuminated until reset.

8 9 Forward Overhead Panel



FORWARD OVERHEAD PANEL

7376-2021

① AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – Selects appropriate zone supply duct temperature.

PASS CAB – Selects forward or aft passenger cabin temperature.

PACK – Selects left or right pack temperature.

② ZONE TEMP Lights

Illuminated (amber):

- CONT CAB indicates a duct temperature overheat or failure of the flight deck primary and standby temperature control.
- FWD CAB or AFT CAB indicates duct temperature overheat.

During Master Caution light recall:

- CONT CAB indicates failure of the flight deck primary or standby temperature control.
- Either FWD CAB or AFT CAB indicates failure of the associated zone temperature control.
- Lights will extinguish when Master Caution is reset.

③ Temperature Selector

AUTO – Provides automatic temperature control for the associated zones. Rotating the control toward C (cool) or W (warm) manually sets the desired temperature.

OFF – Closes the associated trim air-modulating valve.

④ RAM DOOR FULL OPEN Light

Illuminated (blue) – Indicates ram door in full open position.

⑤ Air Conditioning PACK Switch

OFF – Pack signaled OFF.

AUTO –

- With both packs operating, each pack regulates to low flow.
- With one pack operating, operating pack regulates to high flow in flight with flaps up.
- When operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- Pack regulates to high flow.
- Provides maximum flow rate on ground with APU BLEED air switch ON.

⑥ TRIM AIR Switch

ON – Trim air pressure regulating and shutoff valve signaled open.

OFF – Trim air pressure regulating and shutoff valve signaled closed.

⑦ Air Temperature (TEMP) Indicator

- Indicates temperature at location selected with AIR TEMP source selector.

⑧ Recirculation (RECIRC) FAN Switches

OFF – Fan signaled OFF.

AUTO – Fan signaled on except when both packs operating with either pack switch in HIGH.

⑨ **PACK** Light

Illuminated (amber):

- Indicates pack trip off or failure of both primary and standby pack controls.
- During Master Caution recall, indicates failure of either primary or standby pack control. Extinguishes when Master Caution is reset.

⑩ TRIP RESET Switch

PUSH (if fault condition is corrected):

- Resets **BLEED TRIP OFF**, **PACK** and **ZONE TEMP** lights.
- Lights remain illuminated until reset.

INTENTIONALLY LEFT BLANK

PRESSURIZATION SYSTEM DESCRIPTION

GENERAL

The aircraft is pressurized by bleed air supplied to, and distributed by, the air conditioning system. Pressurization and ventilation are controlled by varying the opening of outflow valves. A proportional relationship is maintained between ambient and cabin pressure in climb or descent, and a maximum differential is normally maintained in cruise.

There are two type of pressure control systems. The earlier Cabin Pressure Control System (CPCS) and later Digital Cabin Pressure Control System (DCPCS).

③ 3 5 PRESSURIZATION OUTFLOW

Cabin air outflow is controlled by the main outflow valve, the forward outflow valve, and the flow control valve. During pressurized flight the flow control valve is closed, and the majority of the overboard exhaust is through the main outflow valve. A small amount is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by seal leakage.

7 8 9 PRESSURIZATION OUTFLOW

Cabin air outflow is controlled by the outflow valve and the overboard exhaust valve. The outflow valve is the exhaust exit for the majority of the air circulated through the passenger cabin.

The forward outflow valve found in prior models has been removed. The flow control valve has been replaced with a motorized overboard exhaust valve.

③ 3 5 FLOW CONTROL VALVE

The flow control valve opens to exhaust the cooling air from the E & E compartment overboard during ground operation, unpressurized flight, and pressurized flight below a cabin differential pressure of approximately 2.5 psi.

When the flow control valve closes, air is directed around the forward cargo compartment liner for inflight heating.

7 8 9 OVERBOARD EXHAUST VALVE

The motorized overboard exhaust valve combines the functions of the flow control valve and the forward outflow valve.

On the ground and in flight with low differential presure, the overboard exhaust valve is open and warm air from the E & E bay is discharged overboard. In flight, at higher cabin differential pressures, the overboard exhaust valve is normally closed and exhaust air is diffused to the lining of the forward cargo compartment.

7 However, the overboard exhaust valve is driven open if either PACK switch is in HIGH and the recirculation fan is off. This allows for increased ventilation in the smoke removal configuration.

8 9 However, the overboard exhaust valve is driven open if either PACK switch is in HIGH and the right recirculation fan is off. This allows for increased ventilation in the smoke removal configuration.

3 3 5 FORWARD OUTFLOW VALVE

The forward outflow valve is the overboard discharge exit for air circulated around the forward cargo compartment. The valve closes whenever the recirculation fan is operating.

7 8 9 FORWARD OUTFLOW VALVE

The forward outflow valve has been removed leaving the main outflow valve as the exit for the majority of the air.

7 8 9 MAIN OUTFLOW VALVE

The main outflow valve is the overboard exhaust exit for the majority of the air circulated through the passenger cabin. Passenger cabin air is drawn through foot level grills, down around the aft cargo compartment, where it provides heating, and is discharged overboard through the main outflow valve.

PRESSURE RELIEF VALVES

A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

③ [3] [5] Two pressure relief valves provide maximum safety pressure relief by limiting the differential pressure to a maximum of 8.65 psi (max certified ceiling 37,000).

[7] [8] [9] Two pressure relief valves provide maximum safety pressure relief by limiting the differential pressure to a maximum of 9.1 psi (max certified ceiling 41,000).

CABIN PRESSURE CONTROL SYSTEM (AIRCRAFT WITH CPCS)

③ [5] Outflow Valves

The main outflow valve can be actuated by either an AC or a DC motor. The AC motor is used during AUTO and MAN AC operation. The DC motor is used during STANDBY and MAN DC operation.

The forward outflow valve closes automatically to assist in maintaining cabin pressure when the main outflow valve is almost closed or when the recirculation fan is operating.

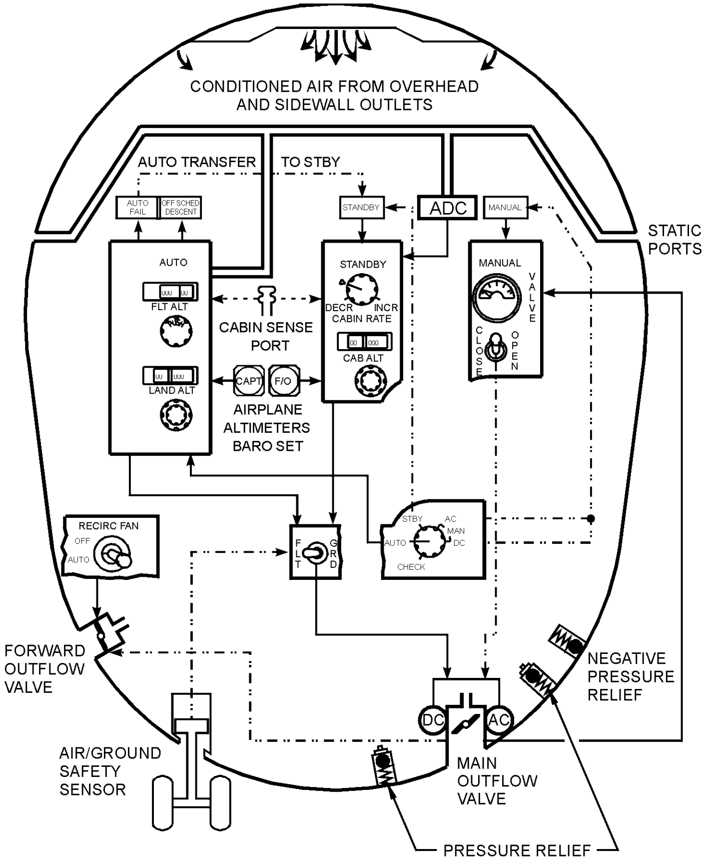
Electronic Cabin Pressure Controller

The pressurization system controls cabin altitude in any one of four modes as selected by the pilot:

AUTO	-	Automatic, the normal mode of operation. Uses AC motor.
STBY	-	Semi-automatic; a standby system in the event of AUTO failure. Uses DC motor.
MAN AC	-	Manual control of the system using AC motor.
MAN DC	-	Manual control of the system using DC motor.

In the automatic mode of operation, aircraft altitude is sensed directly from the static ports. In the standby mode, aircraft altitude is sensed electrically from the Air Data Computer (ADC). Barometric corrections to these pressures come from the Captain's altimeter in AUTO and the First Officer's altimeter in STBY. The controller receives additional information from the air / ground safety sensor and cabin pressure altitude sense port.

③⑤ CABIN PRESSURE CONTROL SYSTEM (CPCS) SCHEMATIC

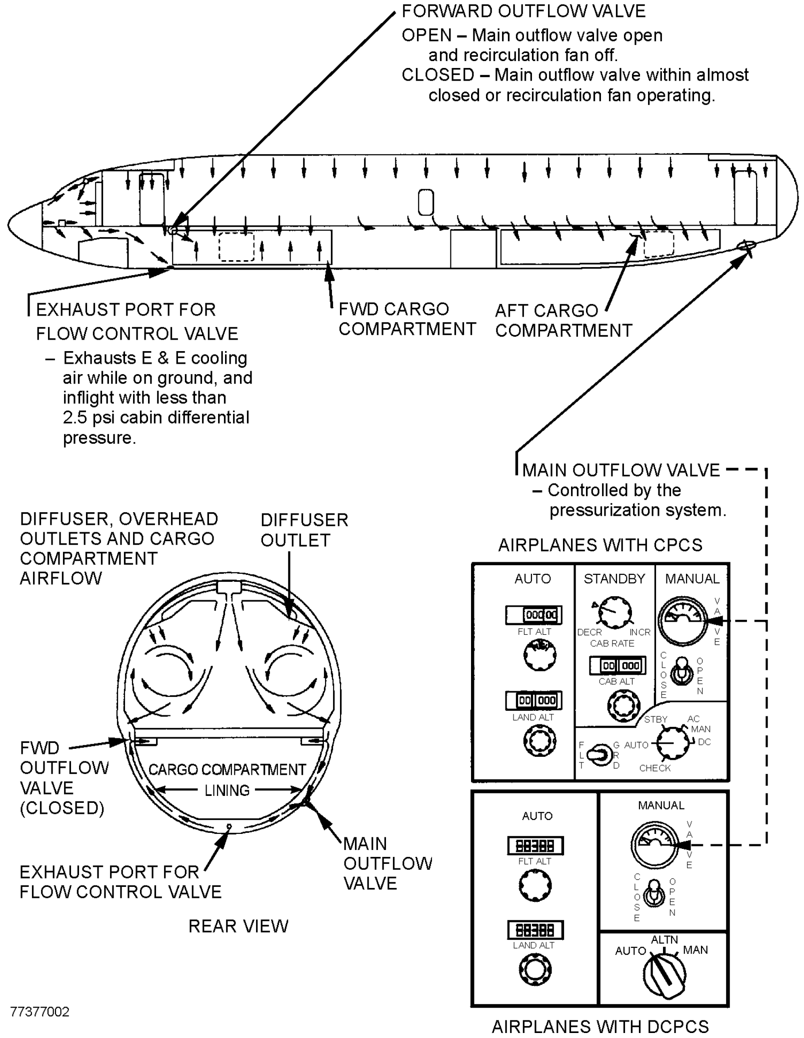


CONDITION:

IN FLIGHT
NORMAL OPERATION

77377006

③③⑤ PRESSURIZATION OUTFLOW SCHEMETIC



AUTO MODE OPERATION (AIRCRAFT WITH CPCS ③5)

In AUTO, the pressurization control panel is used to preset two altitudes into the pressure controller:

- FLT ALT (flight or cruise altitude)
- LAND ALT (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is fed into the pressurization controller at all times when on the ground.

The air / ground safety sensor signals whether the aircraft is on the ground or in the air. On the ground, the FLT/GRD switch is used to keep the cabin depressurized by driving the main outflow valve full open when the switch is in the GRD position. With the switch in the FLT position, the controller modulates the main outflow valve towards close, slightly pressurizing the cabin. This ground pressurization of the cabin makes the transition to pressurized flight more gradual for the passengers and crew, and also gives the system better response to ground effect pressure changes during takeoff.

In the air, the pressure controller maintains a proportional pressure differential between aircraft and cabin altitude. By climbing the cabin altitude “proportional” to aircraft climb rate, cabin altitude change is held to the minimum rate required.

Approximately 1000 feet below flight altitude a cruise relay trips. The controller schedules a constant cabin altitude during cruise using a 7.45 psi differential (7.80 psi differential with Flt Alt >28,000 ft.) between flight and cabin altitudes.

An amber **OFF SCHED DESCENT** light illuminates if the aircraft begins to descend without having tripped the cruise relay; for example, a flight aborted in climb and returning to the takeoff airport. The controller programs the cabin to land at the takeoff field elevation without further pilot inputs. If the Flight Altitude Indicator is changed or the Flight Altitude Selector is depressed during climb, the automatic cabin abort capability to the original takeoff field elevation will be lost.

During isobaric cruise, minor aircraft excursions from flight altitude may cause the pressure differential to go as high as 7.90 psid to maintain a constant cabin altitude.

The controller programs the cabin altitude at cruise to slightly below the selected LAND ALT if the differential (between the corresponding ambient pressures for the selected LAND ALT and FLT ALT) is less than or equal to 7.8 psid (7.45 psid with FLT ALT less than 28,000 ft).

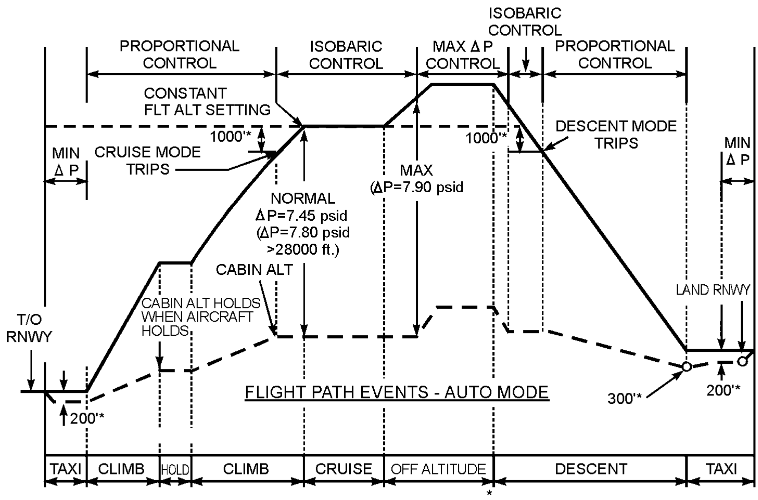
Beginning descent, approximately 1,000 feet below cruise altitude, a descent relay trips, scheduling the cabin to begin a proportional descent to the selected LAND ALT. The controller programs the cabin to land slightly pressurized, so that rapid changes in altitude during approach result in minimum cabin pressure changes.

Taxiing in, the controller drives the main outflow valve slowly to full open when the FLT/GRD switch is positioned to GRD, thereby depressurizing the cabin. Having the main outflow valve full open also prevents the equipment cooling fan from depressurizing the aircraft to a negative pressure.

An amber **AUTO FAIL** light illuminates if any one of three conditions occurs:

- Loss of AUTO AC power.
- Excessive rate of cabin pressure change (± 1800 sea level feet / minutes).
- High cabin altitude (13,875 feet).

With illumination of the **AUTO FAIL** light, the pressure controller automatically trips to STANDBY mode, which illuminates the green **STANDBY** light; however, the pressurization mode selector remains in AUTO. Positioning the mode selector to STBY extinguishes the **AUTO FAIL** light.



CABIN ALTITUDE VS. AIRPLANE ALTITUDE

* The controller senses only psi. References to altitudes are approximations and vary according to density altitude. As the density of the air decreases, the greater the change in altitude is for a given psi.

STANDBY MODE OPERATION (AIRCRAFT WITH CPCS)

A green **STANDBY** light will be illuminated when the pressure controller is in the STANDBY mode.

On the ground, the GRD position of the FLT/GRD switch drives the main outflow valve full open. The FLT position drives the main outflow valve to attempt to pressurize the cabin to the selected CAB ALT. CAB ALT should be set 200 feet below the takeoff airport altitude to pressurize the cabin properly when the FLT/GRD switch is placed to FLT prior to takeoff.

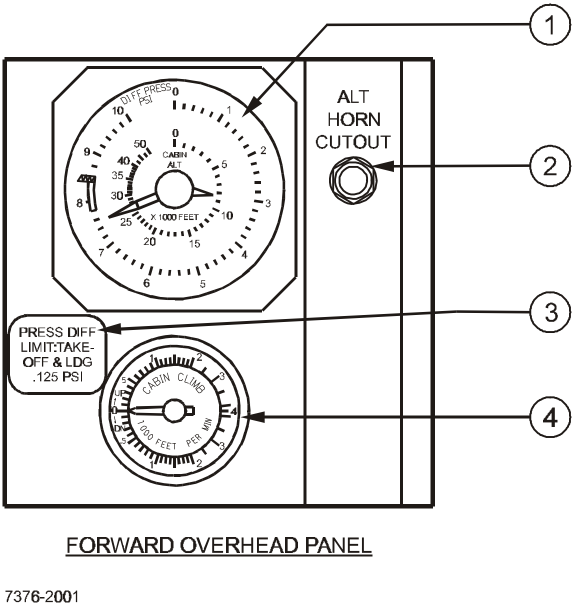
In the air, by referring to a placard below the pressurization control panel, the cabin altitude indicator is set to the isobaric cabin altitude, based on the proposed flight altitude and pressure differential. Cabin rate of climb or descent is controlled by the cabin rate selector. In descent, the cabin altitude indicator is set 200 feet below landing field altitude to ensure a pressurized cabin during landing.

MANUAL MODE OPERATION (AIRCRAFT WITH CPCS ③5)

A green **MANUAL** light illuminates with the pressurization mode selector in MAN AC or MAN DC.

Operation in the MAN modes assumes failure of the AUTO and STANDBY modes. Manual mode allows the pilot, by using the outflow valve switch, to modulate the main outflow valve while monitoring the outflow valve position indicator. MAN AC mode uses the AC motor to control the main outflow valve; MAN DC uses the DC motor. The rate of operation in MAN AC is faster than that in MAN DC.

CABIN ALTITUDE PANEL



① Cabin Altimeter / Differential Pressure Indicator

INNER SCALE – Indicates cabin altitude in feet.

OUTER SCALE – Indicates differential pressure between cabin and ambient in psi.

② Altitude Horn Cutout Switch

PRESS – Cuts out intermittent cabin altitude warning horn.

- Altitude warning horn sounds when cabin reaches 10,000 feet altitude.

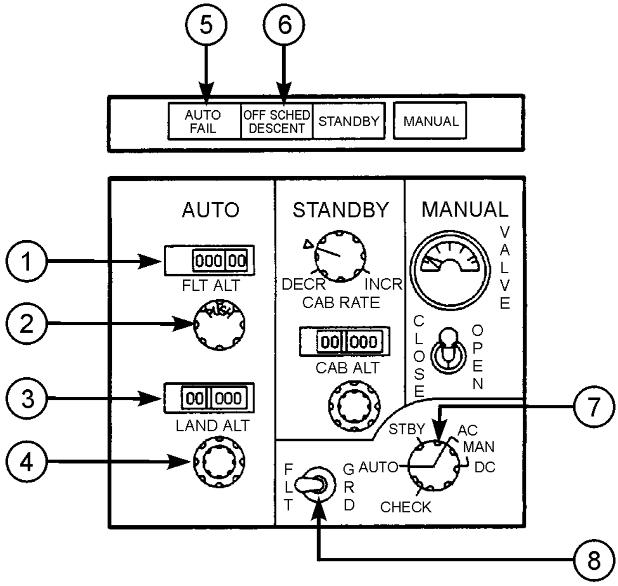
③ Pressurization Limit Placard

- Maximum cabin differential pressure for takeoff and landing is .125 psi.

④ Cabin Rate Of Climb Indicator

- Indicates cabin rate of climb or descent in feet per minute.

CABIN PRESSURE CONTROL SYSTEM (CPCS) CONTROLS AND INDICATORS – AUTOMATIC OPERATIONS ③5



FORWARD OVERHEAD PANEL

7376-2002

① Flight Altitude Indicator

- Indicates selected cruise flight altitude.
- Set before takeoff.

② Flight Altitude Selector

PUSH / ROTATE – To set planned cruise flight altitude.

③ Landing Altitude Indicator

- Indicates altitude of intended landing field.
- Set before takeoff.

④ Landing Altitude Selector

ROTATE – To select planned landing field altitude.

- Large diameter control sets to the nearest 1000 feet.
- Small diameter control sets to the nearest 10 feet.

⑤ **AUTO FAIL** Light (amber)

Illuminated – Automatic pressurization control failure.

- Control automatically transfers to standby mode.

⑥ Off Schedule Descent Light (amber)

Illuminated – Aircraft descends before reaching the planned cruise flight altitude set in the flight altitude indicator.

⑦ Pressurization Mode Selector

AUTO – Aircraft pressurization system controlled automatically.

CHECK – Tests auto failure function of AUTO system.

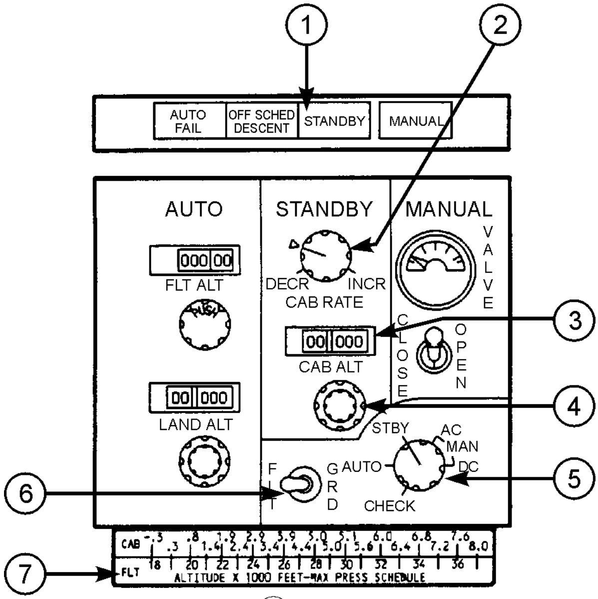
⑧ Flight / Ground Switch

GRD – Drives pressurization outflow valve full open at controlled rate and depressurizes the aircraft when on the ground.

FLT – On the ground, pressurizes the cabin to .1 psid (approximately 200 feet below airport elevation).

- After takeoff, cabin pressure automatically controlled in climb and descent as function of aircraft altitude.
- In cruise, cabin pressure held constant.

CABIN PRESSURE CONTROL SYSTEM (CPCS) CONTROLS AND INDICATORS – STANDBY OPERATION ③ 5



③ 5

FORWARD OVERHEAD PANEL

7376-2003

① **STANDBY** Light (green)

Illuminated – Pressurization system operating in standby mode.

② Cabin Rate Selector

DECR – Cabin altitude rate of change equals 50 ft/min.

INCR – Cabin altitude rate of change equals 2000 ft/min.

△ (Index) – Cabin altitude rate of change equals 300 ft/min.

③ Cabin Altitude Indicator

- Indicates selected cabin altitude.

④ Cabin Altitude Selector

ROTATE – To select desired cabin altitude.

- Large diameter control sets nearest 1000 feet.
- Small diameter control sets nearest 10 feet.

⑤ Pressurization Mode Selector

STBY – Aircraft pressurization system controlled through the standby mode.

- Requires cabin altitude rate of change and cabin altitude selections.
- Automatic mode bypassed.

⑥ Flight / Ground Switch

GRD – Drives outflow valve open at rate selected by Cabin Rate Selector.

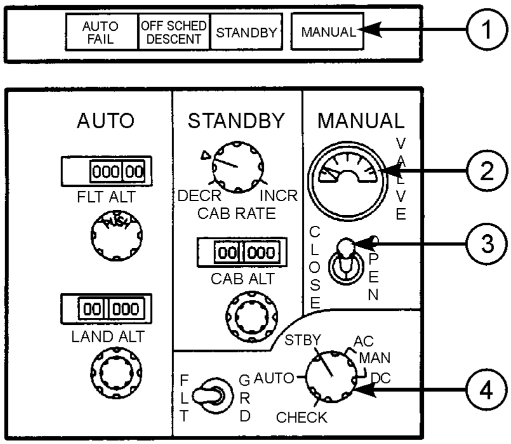
FLT – Pressurizes aircraft at rate selected by Cabin Rate Selector to cabin altitude selected on Cabin Altitude Indicator (normally 200 feet below takeoff field elevation).

⑦ Cabin / Flt Altitude Placard

Used to determine the setting for cabin altitude.

Example: In the event automatic pressurization mode is inoperative, and a flight is planned at 22,000 feet using the standby mode, set 1900 feet in the Cabin Altitude Indicator after takeoff.

CABIN PRESSURE CONTROL SYSTEM (CPCS) CONTROLS AND INDICATORS – MANUAL OPERATIONS ③ 5



FORWARD OVERHEAD
PANEL

7376-2004

① MANUAL Light (green)

Illuminated – Pressurization system operating in manual mode.

② Outflow Valve Position Indicator

- Indicates position of main cabin outflow valve.
- Operates in all modes.

③ Outflow Valve Switch (spring-loaded to center)

OPEN – Opens main cabin outflow valve electrically.

CLOSE – Closes main cabin outflow valve electrically.

④ Pressurization Mode Selector

MAN – Aircraft pressurization controlled manually by Outflow Valve Switch.

AC – Outflow valve operates from AC power.

DC – Outflow valve operates from DC power.

- All auto and standby circuits bypassed.

DIGITAL CABIN PRESSURE CONTROL SYSTEM (AIRCRAFT WITH DCPCS)

Outflow Valves

[3][5] The main outflow valve is actuated by DC motors in any operating mode. The forward outflow valve closes automatically to assist in maintaining cabin pressure when the main outflow valve is almost closed or when the recirculation fan is operating.

[7][8][9] The forward outflow valve found in prior models has been removed. The flow control valve has been replaced with a motorized overboard exhaust valve which combines the functions of the flow control valve and forward outflow valve.

Digital Cabin Pressure Controller

Controls cabin altitude in the following modes:

AUTO - Automatic pressurization control; the normal mode of operation. Uses brushless DC motor.

ALTN - Automatic pressurization control; the alternate mode of operation. Uses brushless DC motor.

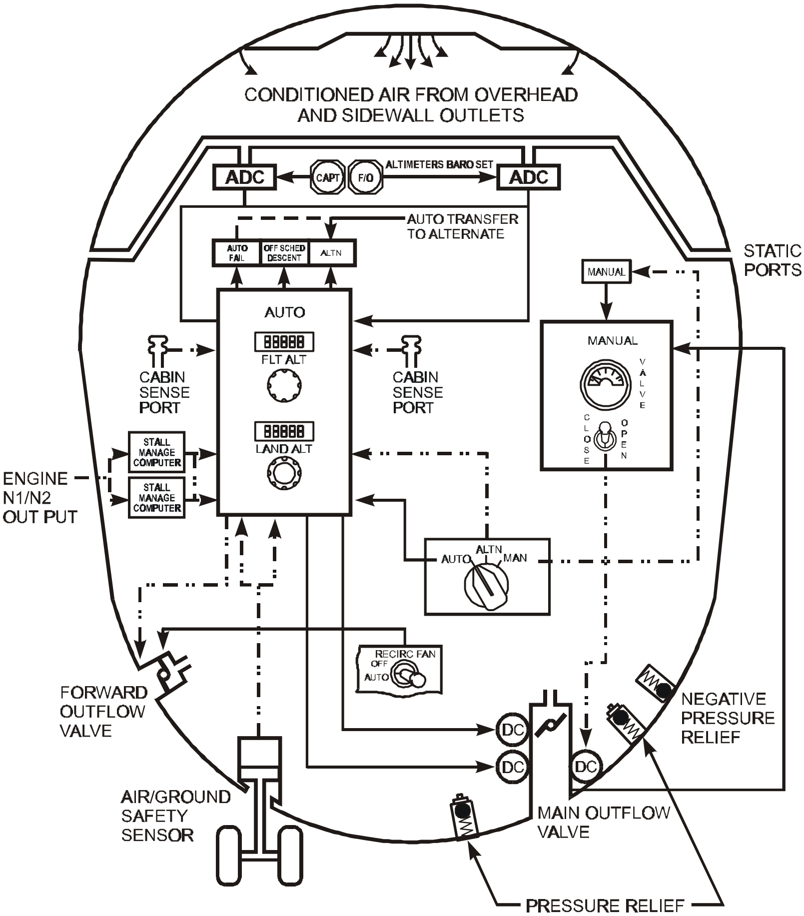
MAN - Manual control of the system using DC motor.

[3][5] In the automatic and alternate modes of operation, aircraft altitude is provided by the Air Data Computers (ADCs). The ADCs receive barometric corrections from the Captain’s and First Officer’s altimeters.

[7][8][9] The air data computer in earlier B737 models has been replaced by Air Data Inertial Reference Units (ADIRUs). The ADIRUs provide ambient static pressure, baro corrected altitude, non-corrected altitude and calibrated airspeed to both automatic controllers. The ADIRUs receive barometric corrections from the Captain’s and First Officer’s Barometric Reference Selectors.

The controllers receive additional information from the air / ground safety sensor, cabin pressure altitude sensing ports and the stall management computers.

3 5 DIGITAL CABIN PRESSURE CONTROL SYSTEM (DCPCS) SCHEMATIC

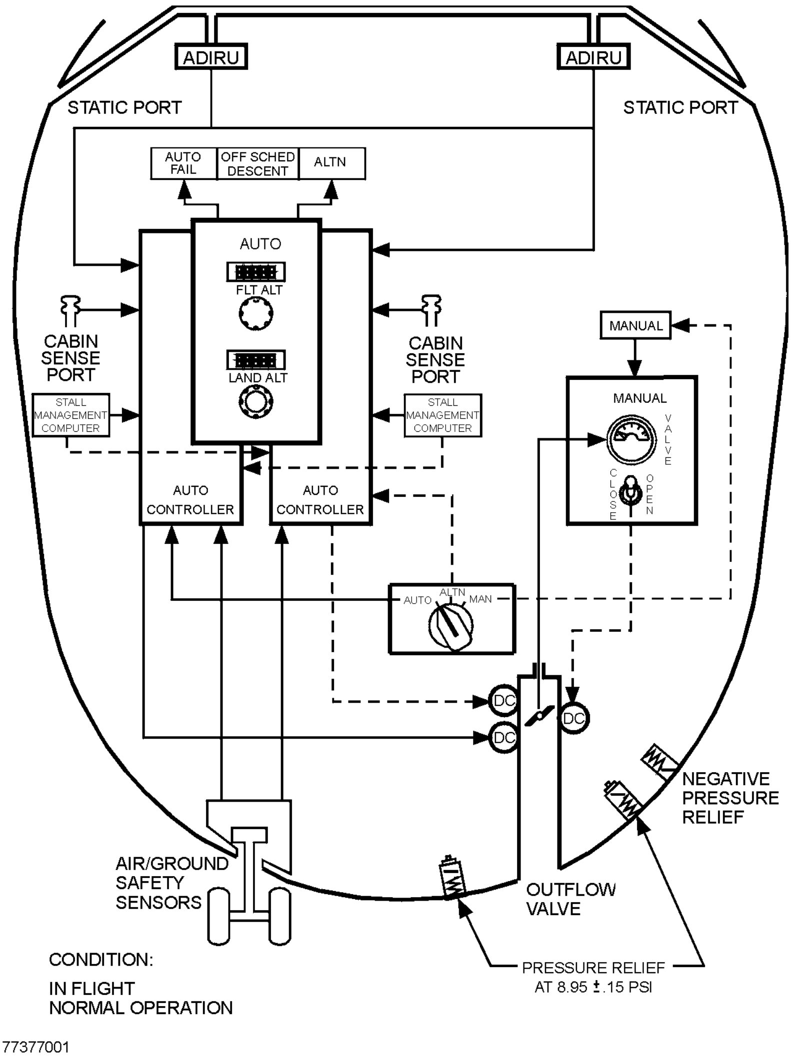


CONDITION:

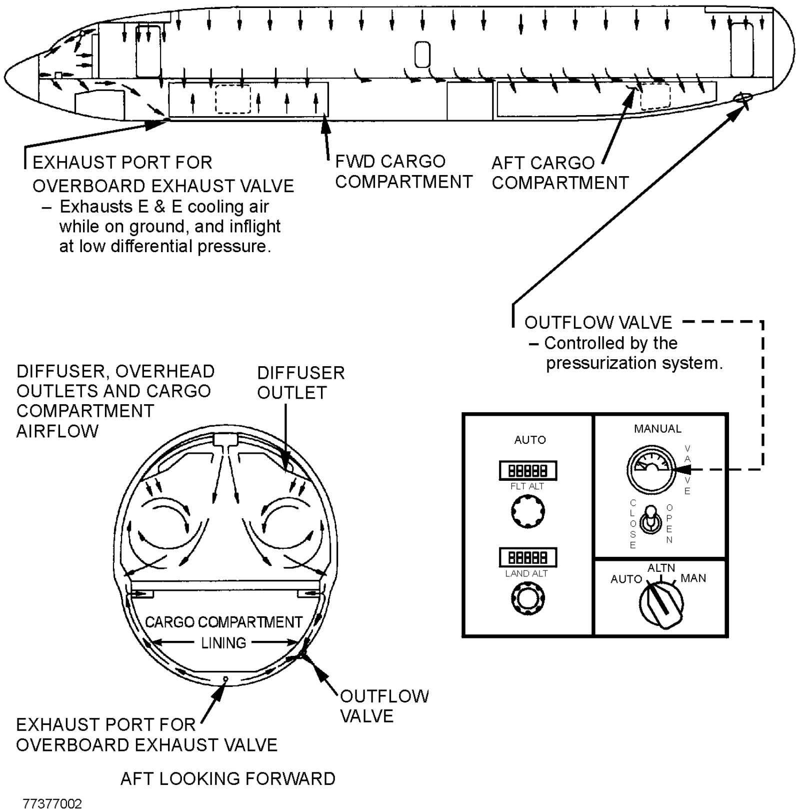
IN FLIGHT
NORMAL OPERATION

7376-2022

7 8 9 DIGITAL CABIN PRESSURE CONTROL SYSTEM (DCPCS) SCHEMATIC



7 8 9 PRESSURIZATION OUTFLOW SCHEMATIC



AUTO MODE OPERATION (AIRCRAFT WITH DCPCS ③⑤⑦⑧⑨)

In the AUTO or ALTN mode, the pressurization control panel is used to preset two altitudes into the pressure controller:

- FLT ALT (flight or cruise altitude).
- LAND ALT (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is fed into the pressurization controller at all times when on the ground.

The air / ground safety sensor signals whether the aircraft is on the ground or in the air. On the ground and at lower power settings, the cabin is depressurized by driving the main outflow valve to the full open position. The cabin begins to pressurize on the ground when N_1 is greater than 60%, N_2 is greater than 89% and after a delay of 1.5 seconds. The controller modulates the main outflow valve toward close, slightly pressurizing the cabin. This ground pressurization of the cabin makes the transition to pressurized flight more gradual for the passengers and crew, and also gives the system better response to ground effect pressure changes during takeoff.

In the air, the pressure controller maintains a proportional pressure differential between aircraft and cabin altitude. By climbing the cabin altitude at a rate proportional to the aircraft climb rate, cabin altitude change is held to the minimum rate required.

Approximately 1,000 feet below flight altitude (when outside air pressure is within .25 psi of the pressure that will exist when the aircraft is at selected FLT ALT) the cruise mode is activated. The controller schedules a constant cabin altitude differential between flight and cabin altitudes during cruise as follows:

- ≤ 28,000 ft. - 7.45 psid (③⑤⑦⑧⑨)
- > 28,000 ft. - 7.80 psid (③⑤)
- 28,000 ft. to 37,000 ft. - 7.80 psid (⑦⑧⑨)
- > 37,000 ft. - 8.35 psid (⑦⑧⑨).

An amber **OFF SCHED DESCENT** light illuminates if the aircraft begins to descend without having reached the planned cruise altitude, for example, a flight aborted in climb and returning to the takeoff airport. The controller programs the cabin to land at the takeoff field elevation without further pilot inputs. If the Flight Altitude Indicator is changed, the automatic cabin abort capability to the original takeoff field elevation will be lost.

During isobaric cruise mode, minor aircraft excursions from flight altitude may cause the pressure differential to go as high as 7.90 psid (3 5) or 8.45 psid (7 8 9) to maintain a constant cabin altitude.

Beginning descent, approximately 1,000 feet below aircraft cruise altitude, the cabin begins a proportional descent to 300 feet below the selected LAND ALT. The controller programs the cabin to land slightly pressurized, so that rapid changes in altitude during approach result in minimum cabin pressure changes.

While taxiing in, the controller drives the main outflow valve slowly to full open position depressurizing the cabin when N_1 is less than 50%. Having the main outflow valve full open also prevents the equipment cooling fan from depressurizing the aircraft to a negative pressure.

An amber **AUTO FAIL** light illuminates if any of the following conditions occur:

- Loss of DC power
- Controller fault
- Excessive rate of cabin pressure change ($\pm$ 2,000 sea level feet / minute)
- High cabin altitude (15,800 feet)

With illumination of the **AUTO FAIL** light, the pressure controller automatically transfers to the ALTN mode.

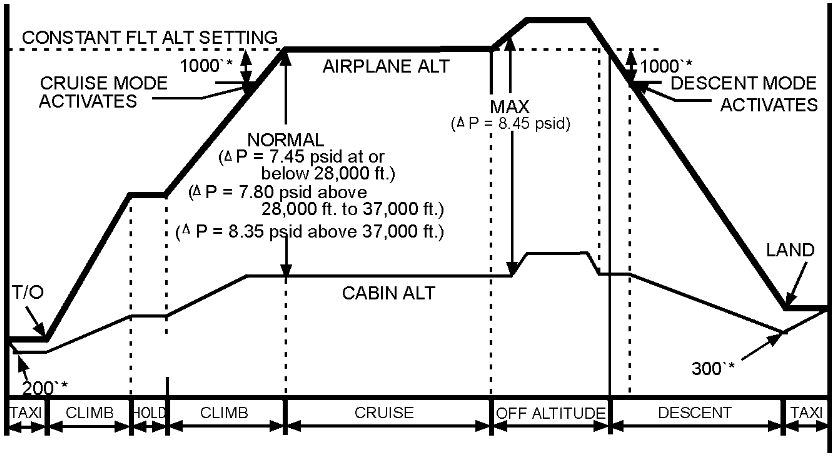
Moving the pressurization mode selector to the ALTN position extinguishes the **AUTO FAIL** light and the **ALTN** light remains illuminated to indicate single channel automatic operation.

MANUAL MODE OPERATION (AIRCRAFT WITH DCPCS)

A green **MANUAL** light illuminates with the pressurization mode selector in MAN position.

Manual control of the cabin altitude is available if the AUTO and ALTN modes are inoperative. In the MAN mode the outflow valve switch is used to modulate the main outflow valve by monitoring the cabin altitude panel and valve position on the outflow valve position indicator. The main outflow valve is driven by a separate DC motor at a slower rate than the automatic modes. Outflow valve full range of motion takes approximately 20 seconds.

7 8 9 AIRCRAFT WITH DCPCS



CABIN ALTITUDE VS. AIRPLANE ALTITUDE

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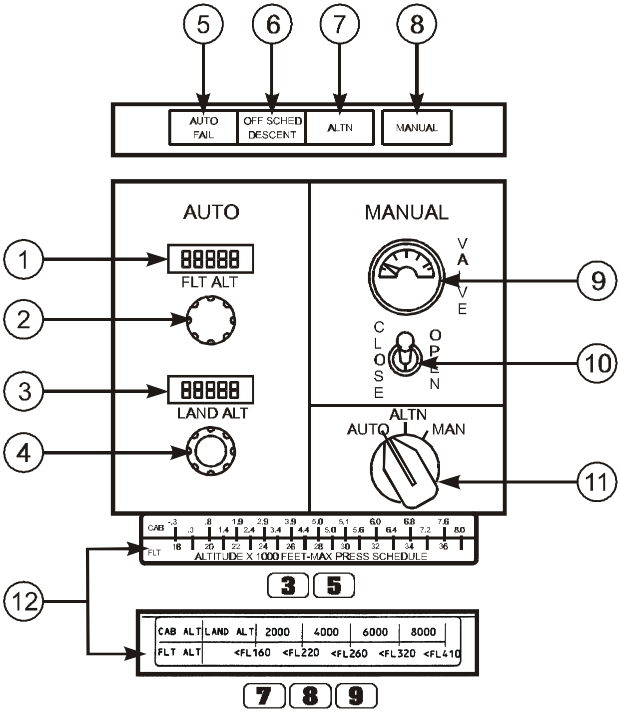
* The controller senses only psi. References to altitudes are approximations and vary according to density altitude. As the density of the air decreases, the greater the change in altitude is for a given psi.

3 5 7 8 9 DIGITAL CABIN PRESSURE CONTROL SYSTEM (DCPCS) CONTROLS AND INDICATORS



FORWARD OVERHEAD PANEL

7376-2005

① Flight Altitude Indicator

- Indicates selected cruise flight altitude.
- Set before takeoff.

② Flight Altitude Selector

ROTATE – To set planned cruise flight altitude.

③ Landing Altitude Indicator

- Indicates altitude of intended landing field.
- Set before takeoff.

④ Landing Altitude Selector

ROTATE – To select planned landing field altitude.

⑤ **AUTO FAIL** (amber)

Illuminated – Automatic pressurization system failure detected.

- Indicates a single channel controller failure when **ALTN** light is also illuminated.
- Indicates a dual channel controller failure when illuminated alone.

⑥ Off Schedule Descent Light (amber)

Illuminated – Aircraft descends before reaching the planned cruise flight altitude set in the Flight Altitude Indicator.

⑦ Alternate Light (green)

Illuminated – Pressurization system operating in alternate automatic mode.

- With the Pressurization Mode Selector in the AUTO position, illumination of both **ALTN** and **AUTO FAIL** lights indicate a single channel controller failure and automatic transfer to the ALTN mode.
- Pressurization Mode Selector in the ALTN position.

⑧ **MANUAL** Light (green)

Illuminated – Pressurization system operating in manual mode.

⑨ Outflow Valve Position Indicator

- Indicates position of main outflow valve.
- Operates in all modes.

⑩ Outflow Valve Switch (spring-loaded to center)

OPEN – Opens main outflow valve electrically with the Pressurization Mode Selector in MAN position.

CLOSE – Closes main outflow valve electrically with the Pressurization Mode Selector in MAN position.

⑪ Pressurization Mode Selector

AUTO – Aircraft pressurization system controlled automatically.

ALTN – Aircraft pressurization system controlled automatically in the ALTN mode.

MAN – Aircraft pressurization controlled manually by Outflow Valve Switch.

- Both auto system control circuits are bypassed.

⑫ Cabin / Flight Altitude Placard

- Used in the manual mode to determine cabin altitude.

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ANTI-ICE & RAIN

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SYSTEM DESCRIPTION

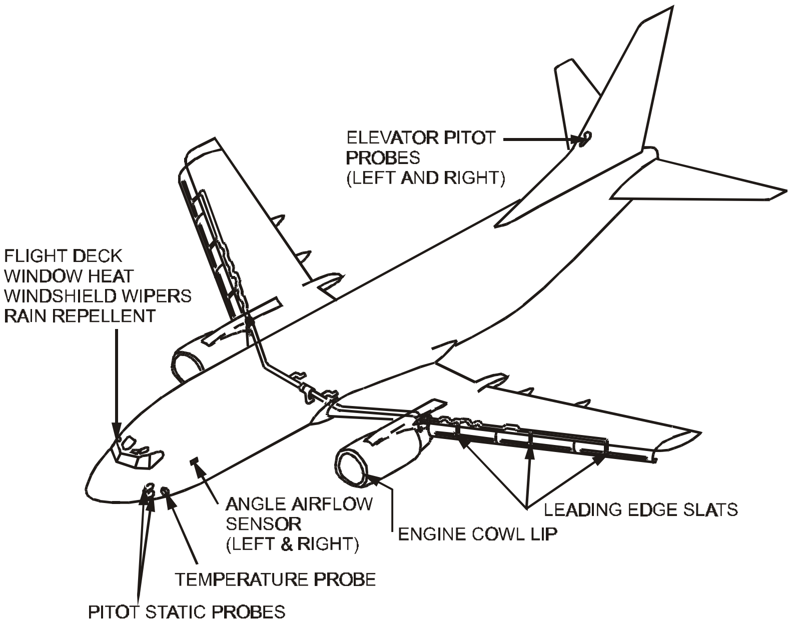
INTRODUCTION

Thermal anti-icing (TAI), electrical anti-icing, and windshield wipers are the systems provided for ice and rain protection.

The anti-ice and rain systems include:

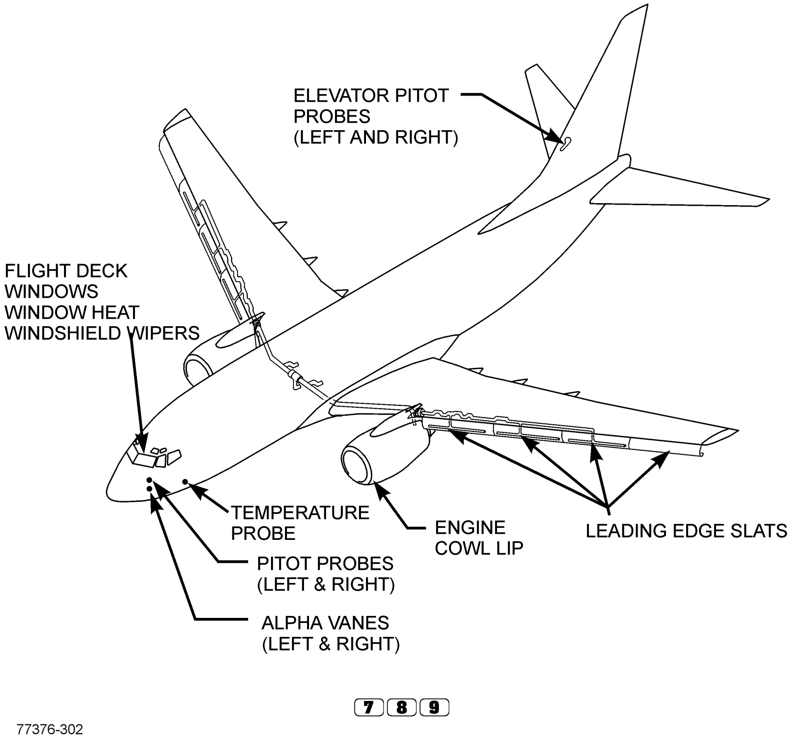
- Flight Deck Window Heat
- Windshield Wipers
- Probe and Sensor Heat
- Engine Anti-Ice System
- Wing Anti-Ice System

③③⑤ ANTI-ICE COMPONENTS DIAGRAM



77376-301 ③③⑤

7 8 9 ANTI-ICE COMPONENTS DIAGRAM



Note: The outboard slats are not heated.

Note: Static ports (4) on the fuselage are not heated.

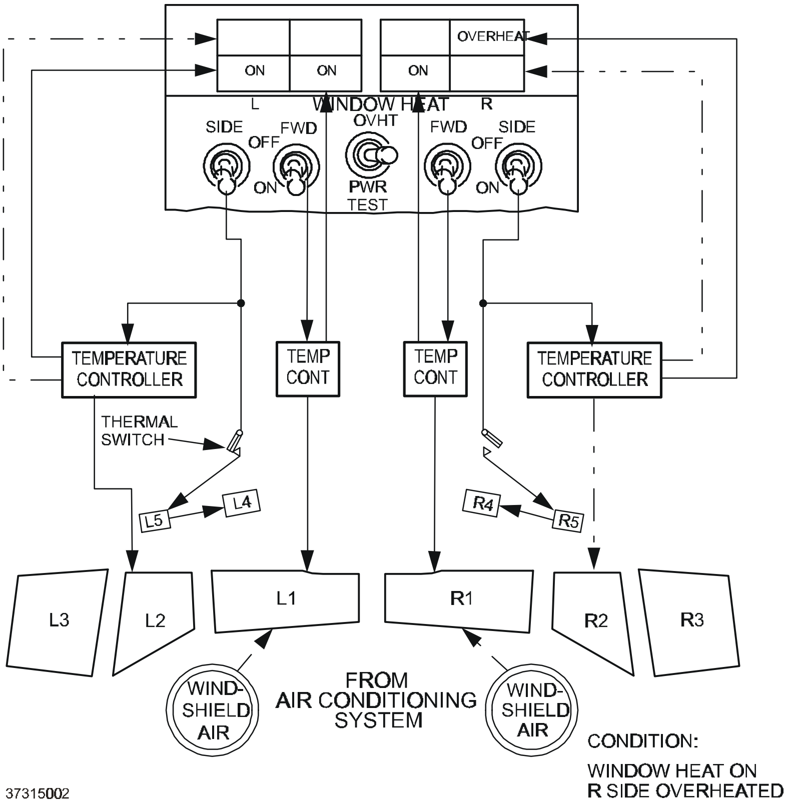
Note: All of the Ice & Rain systems operate on normal electrical power. If operating on battery power none of these systems will operate.

FLIGHT DECK WINDOW HEAT

Flight deck window Nos. 1, 2, 4 and 5 consist of glass panes laminated to each side of a vinyl core. Flight deck window No. 4 has an additional vinyl layer and acrylic sheet laminated to the inside surface. Flight deck window No. 3 consists of two acrylic panes separated by an air space.

A conductive coating on the outer glass pane of window Nos. 1 and 2 permits electrical heating to prevent ice build-up and fogging. A conductive coating on the inner glass pane of window Nos. 4 and 5 permits electrical heating to prevent fogging. Window No. 3 is not electrically heated.

Flight Deck Window Heat Schematic

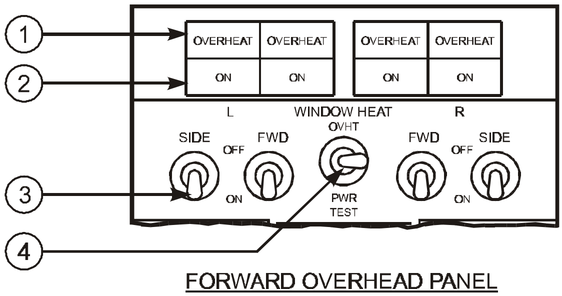


Flight Deck Window Heat Operation

The FWD WINDOW HEAT switches control heat to window No. 1. The SIDE WINDOW HEAT switches control heat to window Nos. 2, 4 and 5.

Temperature controllers maintain window Nos. 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact. Power to window Nos. 1 and 2 is automatically removed if an overheat condition is detected. A thermal switch located on window 5 opens and closes to maintain the correct temperature of window Nos. 4 and 5.

Window Heat Panel



737610-04

① Window **OVERHEAT** Lights

Illuminated (amber) – Overheat condition is detected, power removed from window. **ON** light extinguishes.

OVERHEAT lights illuminate if electrical power to window(s) is interrupted.

② Window Heat **ON** Lights

Illuminated (green) – window heat is being applied to selected window(s).

Extinguished –

- switch is OFF,
- overheat is detected,
- system failure.

③ WINDOW HEAT Switches

ON –

- Signals the window heat controller to apply heat to the associated window.
- The SIDE switch supplies power to windows Nos. 2, 4, 5.

OFF –

- Window heat not in use.
- Resets the **OVERHEAT** light circuit.

④ WINDOW HEAT Test Switch (spring-loaded to neutral)

OVHT – Simulates an overheat condition. All **OVERHEAT** lights illuminate.

- **ON** lights may extinguish immediately, or remain illuminated for as long as 70 seconds.
- Reset by momentarily positioning the window heat switch to OFF.

PWR TEST – Provides a confidence test (window heat switches must be ON).

- Controller is forced to full power, bypassing normal temperature control.
- Overheat protection is still available.

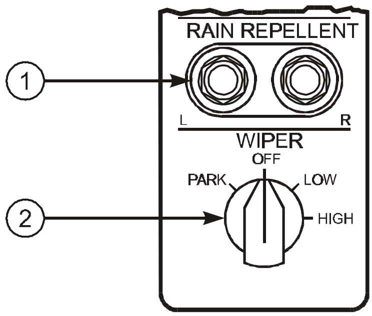
WINDSHIELD WIPERS

③ [3] [5] The rain removal system for the forward windows consists of windshield wipers. The forward window wipers are controlled by one switch.

[7] [8] [9] A permanent rain repellent has been applied to the window at the factory. Each window wiper has its own switch.

Windshield scratching will occur if the windshield wipers are operated on a dry windshield.

③ [3] [5] Rain Removal Controls



FORWARD OVERHEAD PANEL

737610-05

① RAIN REPELLENT Switch (INOP)

System deactivated.

② Windshield WIPER Selector

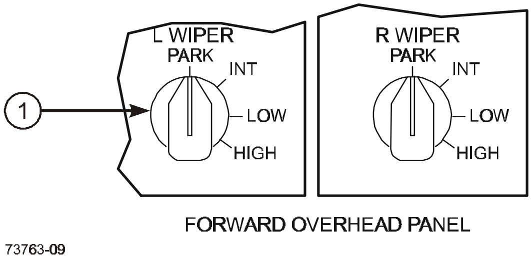
PARK – Momentary position used to stow both wiper blades.

OFF – Spring loaded to OFF from PARK position.

LOW – Low speed operation both blades.

HIGH – High speed operation both blades.

7 8 9 Windshield Wiper Selector Panel



① Windshield WIPER Selectors

PARK – turns off wiper motors and stows wiper blades.

INT – seven second intermittent operation.

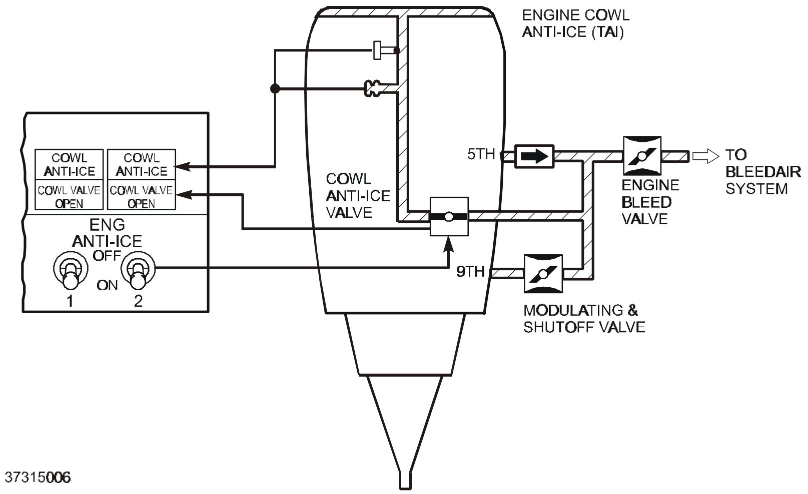
LOW – low speed operation.

HIGH – high speed operation.

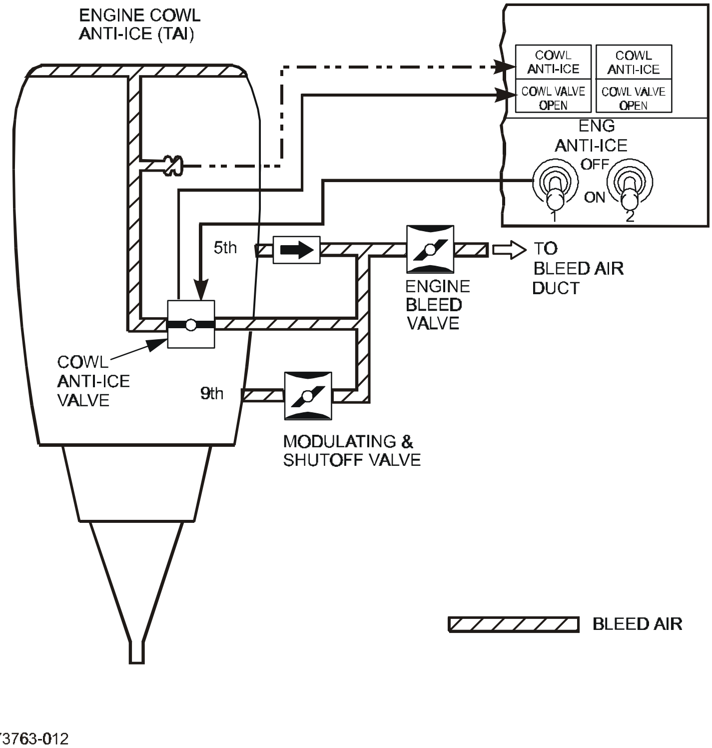
ENGINE ANTI-ICE SYSTEM

Engine bleed air thermal anti-icing prevents the formation of ice on the engine cowl lip. Engine anti-ice operation is controlled by individual ENG ANTI-ICE switches. The engine anti-ice system is operated on the ground and in fight.

③ 3 5 Engine Anti-Ice System Schematic



7 8 9 Engine Anti-Ice System Schematic



③ 3 5 Engine Anti-Ice System Operation

Each cowl anti-ice valve is electrically controlled and pressure actuated. Positioning the ENG ANTI-ICE switches to ON allows engine bleed air to flow through the cowl anti-ice valve for cowl lip anti-icing.

If the cowl anti-ice valve fails to move to the position indicated by the ENG ANTI-ICE switch, the **COWL VALVE OPEN** light remains illuminated bright blue. The amber **COWL ANTI-ICE** light illuminates due to excessive pressure or temperature in the duct leading from the cowl anti-ice valve to the cowl lip.

7 8 9 Engine Anti-Ice System Operation

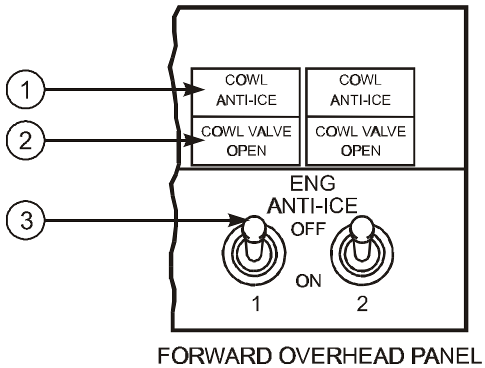
Each cowl anti-ice valve is electrically controlled and pressure actuated. Positioning the ENG ANTI-ICE switches to ON:

- Allows engine bleed air to flow through the cowl anti-ice valve for cowl lip anti-icing.
- Sets stick shaker logic for icing conditions.
- Adjusts stick shaker and minimum maneuver speed bars on airspeed indications. FMC displayed V_{REF} is not adjusted automatically.
- Stick shaker logic and airspeed indications return to normal when engine anti-ice is positioned OFF if wing anti-ice has not been used in flight.

If the cowl anti-ice valve fails to move to the position indicated by the ENG ANTI-ICE switch, the **COWL VALVE OPEN** light remains illuminated bright blue and an amber TAI indication illuminates on the CDS after a short delay.

The amber **COWL ANTI-ICE** light illuminates due to excessive pressure in the duct leading from the cowl anti-ice valve to the cowl lip.

Engine Anti-Ice Panel



737610-03

① **COWL ANTI-ICE** Light

③ 3 5

Illuminated (amber) – An overpressure or overtemperature condition in the duct downstream of the engine cowl anti-ice valve.

7 8 9

Illuminated (amber) – Indicates an overpressure condition in duct downstream of engine cowl anti-ice valve.

② **COWL VALVE OPEN** Lights

Illuminated (blue) –

- Bright – Related cowl anti-ice valve is in transit, or, cowl anti-ice valve position disagrees with related ENGINE ANTI-ICE switch position.
- Dim – Related cowl anti-ice valve is open (switch ON).
- Extinguished – Related cowl anti-ice valve is closed (switch OFF).

③ ENG ANTI-ICE Switches

ON –

- Related engine anti-ice valve is open

7 8 9

- Stick shaker logic is set for icing conditions.

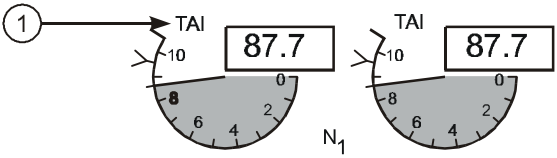
OFF –

- Related engine anti-ice valve is closed.

7 8 9

- Stick shaker logic returns to normal if wing anti-ice has not beed used in flight.

7 8 9 Thermal Anti-Ice Indication



73763-010

UPPER DISPLAY UNIT

① Thermal Anti-Ice Indications

Illuminated –

- Green – cowl anti-ice valve(s) open
- Amber – cowl anti-ice valve is not in position indicated by related engine anti-ice switch.

WING ANTI-ICE SYSTEM

③ 3 5

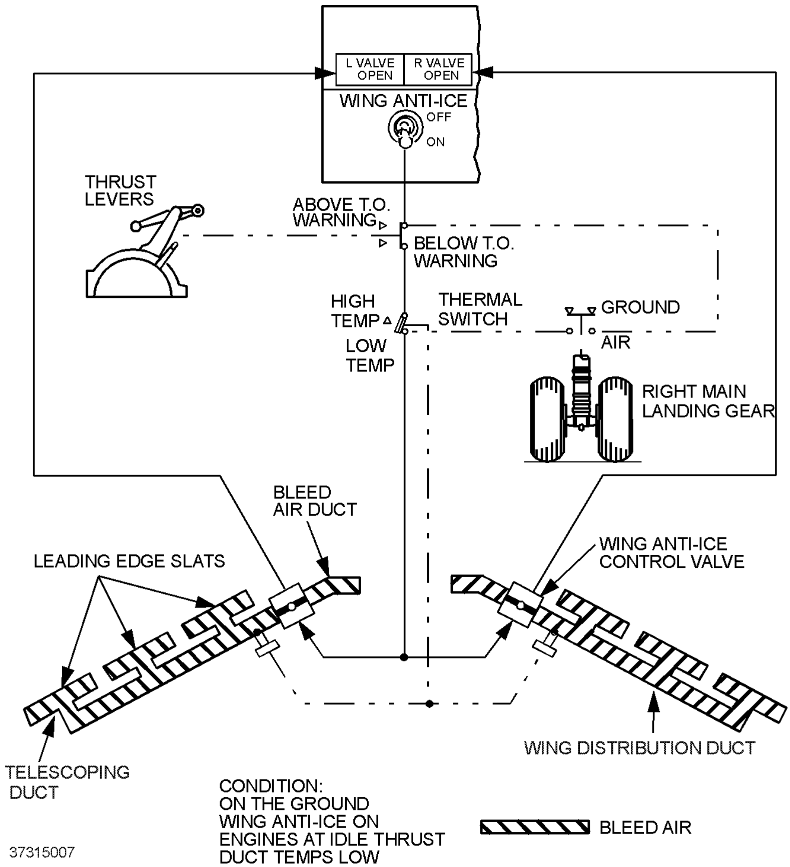
The wing anti-ice system provides protection for the three leading edge slats by using bleed air. The wing anti-ice system does not include the leading edge flaps.

7 8 9

The wing anti-ice system provides protection for the three inboard leading edge slats by using bleed air. The wing anti-ice system does not include the leading edge flaps or the outboard leading edge slats.

The wing anti-ice control valves are AC motor-operated and will remain in position with loss of electrical power. With a valve open, bleed air flows to the three leading edge inboard slats, and then exhausts overboard. The wing anti-ice system is effective with the slats in any position.

Wing Anti-Ice Schematic



Wing Anti-Ice System Operation

Placing the WING ANTI-ICE switch ON when on the ground, opens both control valves if thrust on both engines is below the setting for takeoff warning activation and the temperature inside both wing distribution ducts is less than the thermal switch activation temperature.

Both valves close if either engine thrust is above the takeoff warning setting or either temperature sensor senses a duct overtemperature. The valves automatically open if thrust on both engines is reduced and both temperature sensors are cool.

With the air / ground sensor in the ground mode and the WING ANTI-ICE switch ON, the switch remains in the ON position regardless of control valve position. The WING ANTI-ICE switch automatically trips OFF at lift-off when the air / ground sensor goes to the air mode.

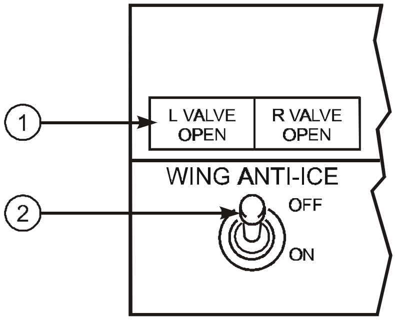
7 8 9

Positioning the WING ANTI-ICE switch to ON in flight:

- Opens both control valves.
- Sets stick shaker logic for icing conditions.
- Adjusts stick shaker and minimum maneuver speed bars on airspeed indications. FMC displayed V_{REF} is not adjusted automatically.
- Stick shaker logic remains set for icing conditions for the remainder of the flight, regardless of subsequent WING ANTI-ICE switch position.

Valve position is monitored by the blue **VALVE OPEN** lights. Duct temperature and thrust setting logic are disabled and have no affect on control valve operation in flight.

Wing Anti-Ice Panel



FORWARD OVERHEAD PANEL

7376-1001

① Wing Anti-Ice **VALVE OPEN** Lights

Illuminated (blue) –

- Bright – Related wing anti-ice control valve is in transit, or, related wing anti-ice control valve position disagrees with WING ANTI–ICE switch position.
- Dim – Related wing anti-ice control valve is open (switch ON).
- Extinguished – Related wing anti-ice control valve is closed (switch OFF).

② WING ANTI–ICE Switch

OFF – Wing anti-ice control valves are closed.

ON (in the air) –

- Wing anti-ice control valves are open

7 **8** **9**

- Stick shaker logic is set for icing conditions.
- Stick shaker logic remains set for icing conditions for the remainder of the flight, regardless of subsequent WING ANTI-ICE switch position.

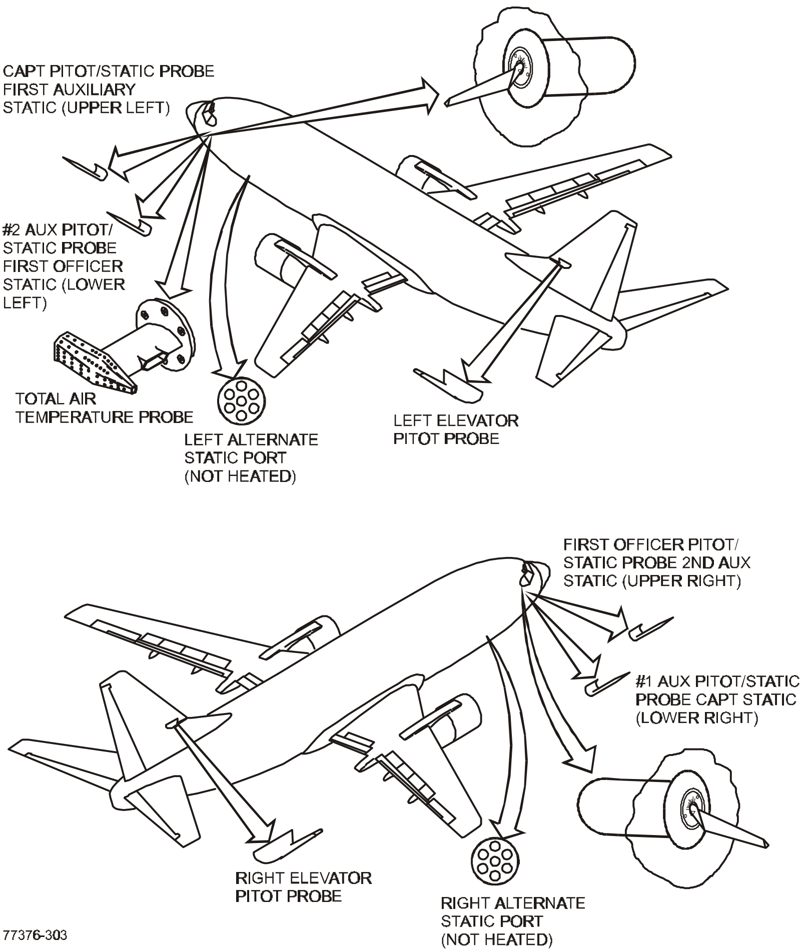
ON (on the ground) –

- Wing anti-ice control valves open if thrust on both engines is below takeoff warning setting and temperature inside both distribution ducts is below thermal switch activation temperature.
- Control valves close if either engine thrust is above takeoff warning setting or thermal switch is activated in either distribution duct. Switch remains ON.
- Switch trips OFF at lift-off.

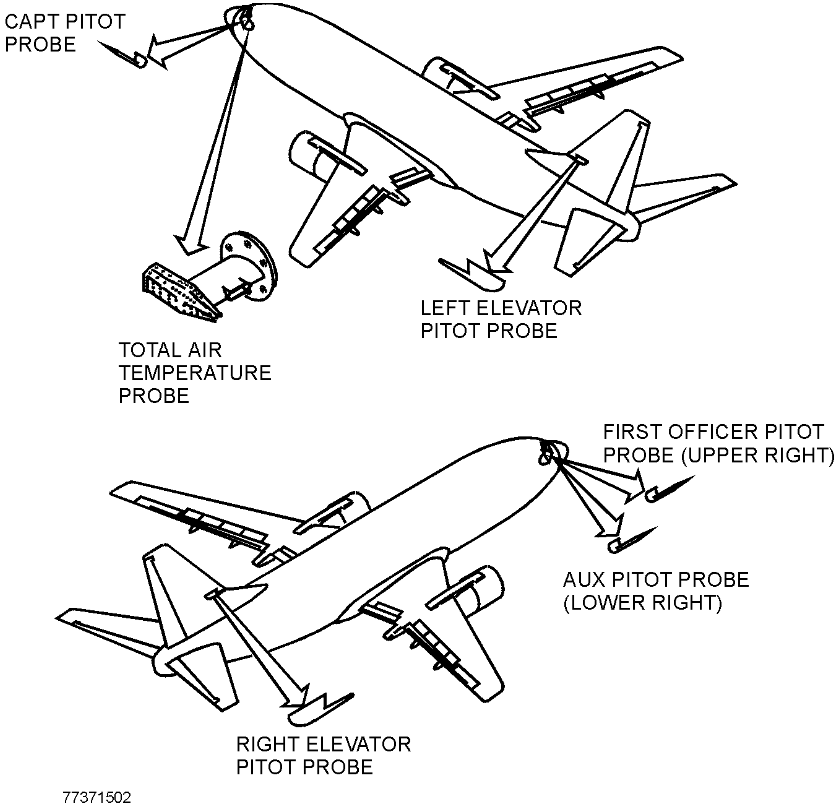
PROBE AND SENSOR HEAT

Pitot probes, the total air temperature probe and the alpha vanes are electrically heated. Static ports are not heated.

③❸❺ Probe, Alpha Vane And Static Port Locations

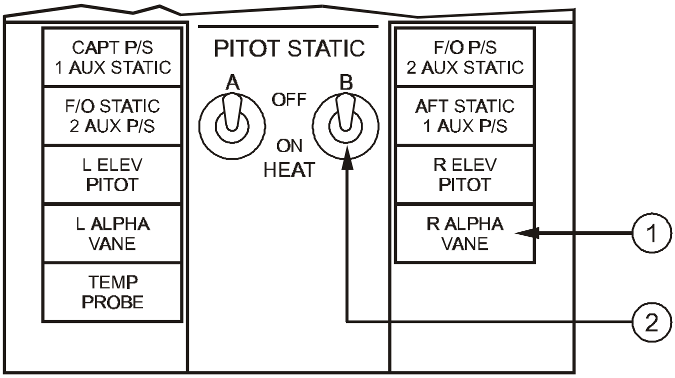


7 8 9 Probe And Sensor Locations



Note: Static ports (4), located on the fuselage, are not heated.

③❸❺ Probe Heat Panel



77376-304

① Probe Heat Lights

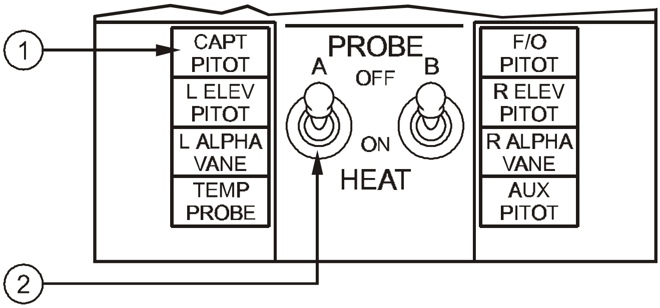
Illuminated (amber) – related probe not heated.

② PROBE HEAT Switches

ON – power is supplied to heat related system.

OFF – power off.

7 8 9 Probe Heat Panel



737610-06

① Probe Heat Lights

Illuminated (amber) – related probe not heated.

② PROBE HEAT Switches

ON – power is supplied to heat related system.

OFF – power off.

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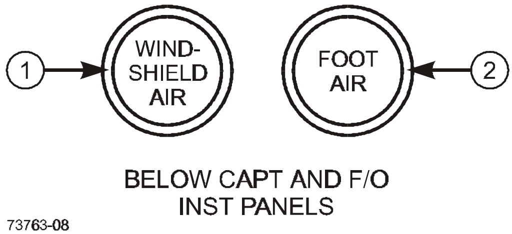
CONTROLS AND INDICATORS

WINDSHIELD / FOOT AIR CONTROLS



① WINDSHIELD AIR Controls

PULL – Supplies conditioned air to No. 1 windows for defogging.

② FOOT AIR Controls

PULL – Supplies conditioned air to pilots' leg positions.

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LIST OF EFFECTIVE PAGES

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AUTO FLIGHT

TABLE OF CONTENTS

AUTOMATIC FLIGHT SYSTEM DESCRIPTION

General

The Automatic Flight System (AFS) consists of the Autopilot Flight Director System (AFDS) and the Autothrottle (A/T). The Flight Management Computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are controlled using the AFDS mode control panel (MCP) and the FMC. Normally, the AFDS and A/T are controlled automatically by the FMC to fly an optimized lateral (LNAV) and vertical (VNAV) flight path through climb, cruise and descent.

AFS mode status is displayed on the flight mode annunciation on each pilot's primary display.

Autopilot Flight Director System (AFDS)

The AFDS is a dual system consisting of two individual flight control computers (FCCs) and a single mode control panel.

The two FCCs are identified as A and B. For A/P operation, they send control commands to their respective pitch and roll hydraulic servos, which operate the flight controls through two separate hydraulic systems.

For F/D operation, each FCC positions the F/D command bars on the respective attitude indicator.

MCP Mode Selector Switches

The mode selector switches are pushed to select desired command modes for the AFDS and A/T. The **ON** switch light illuminates to indicate the mode selection and that the mode can be deselected by pushing the switch again. While a mode is active, deselection can be automatically inhibited and is indicated by the switch being extinguished.

When engagement of a mode would conflict with current AFS operation, pushing the mode selector switch has no effect. All AFDS modes can be disengaged either by selecting another command mode or by disengaging the A/P and turning the F/Ds off.

Autopilot Engagement Criteria

Each A/P can be engaged by pushing a separate CMD or CWS engage switch or autopilot engage paddles. A/P engagement in CMD or CWS is inhibited unless both of the following pilot-controlled conditions are met:

- No force is being applied to the control wheel
- The STAB TRIM AUTOPILOT cutout switch is at NORMAL.

Only one A/P can be engaged at a given time unless the approach (APP) mode is engaged. Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides control through landing flare and touchdown or an automatic go-around.

In single A/P operation, full automatic flare and touchdown capability and A/P go-around capability are not available.

Autopilot Disengagement

The A/P automatically disengages when any of the following occurs:

- Pushing either A/P disengage switch
- Pushing either Takeoff / Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD below 2000 feet RA
- Pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD
- Pushing an illuminated **A/P ENGAGE** switch
- Activating either pilot's control wheel trim switch
- Moving the STAB TRIM AUTOPILOT cutout switch to CUTOUT
- Either left or right IRS system failure or **FAULT** light illuminated
- Loss of electrical power or a sensor input which prevents proper operation of the engaged A/P and mode
- Loss of respective hydraulic system pressure.

7 8 9

- Pushing the A/P DISENGAGE bar down

Loss of the system A engine-driven hydraulic pump, and a heavy demand on system A, may cause A/P A to disengage.

AFS Failures

Power interruption or loss may cause disengagement of the AFDS and/or A/T. Re-engagement is possible after power is restored.

Dual channel A/P operation is possible only when two generators are powering the busses.

Two independent radio altimeters provide radio altitude to the respective FCCs. With a radio altimeter inoperative, do not use the associated FCC for approach or landing, and do not use the associated autopilot for approach.

Flight Director Display

Turning a F/D switch ON displays command bars on the respective pilot attitude indicator if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear. The F/Ds can be operated with or without the A/P and A/T. F/D command modes can be used with an A/P engaged in CWS.

F/D commands operate in the same command modes as the A/P except:

- The takeoff mode is a F/D only mode
- Dual F/D guidance is available for single engine operation
- The F/D has no landing flare capability. F/D command bars retract from view at approximately 50 feet RA on an ILS approach.

Normally FCC A drives the Captain command bars and FCC B drives the First Officer command bars. With both F/D switches ON, the logic for both F/D modes is controlled by the master FCC, and both FMA displays show the same mode status.

The master FCC is indicated by illumination of the respective master (**MA**) F/D indicator light. The master FCC is determined as follows:

- With neither A/P engaged in CMD, the FCC for the first F/D turned on is the master
- With one or both A/Ps engaged in CMD, the FCC for the first A/P in CMD is the master FCC, regardless of which F/D is turned on first.

F/D modes are controlled directly from the respective FCC under certain conditions. This independent F/D operation occurs when neither A/P is engaged in CMD, both F/D switches are ON and one of the following mode conditions exists:

- APP mode engaged with LOC and G/S engaged
- GA mode engaged and below 400 feet RA
- TO mode engaged and below 400 feet RA.

Independent F/D operation is indicated by illumination of both **MA** lights. When independent operation terminates, the **MA** light extinguishes on the slaved side.

If a generator is lost during a F/D TO or GA, or while in dual F/D APP mode below 800 feet, the FCC on the unaffected side positions the F/D command bars on both attitude indicators. If the F/D **MA** light on the affected side had been illuminated, it extinguishes upon electrical bus transfer.

AFDS Status Annunciation

The following AFDS status annunciations are displayed in the A/P status display located above the attitude indicator.

- CMD (one or both autopilots are engaged)
- FD (the flight director is ON and the autopilot is either OFF or engaged in CWS)
- CWS P (pitch mode engaged in CWS)
- CWS R (roll mode engaged in CWS)
- 1 CH (for single A/P ILS approach, annunciates after localizer capture and remains on for entire approach. For dual A/P ILS approach, annunciates after localizer capture and extinguishes after pitch monitor confidence test is successfully completed).

AFDS Flight Mode Annunciations

The flight mode annunciations are displayed just above the attitude indicator. The mode annunciations, from left to right, are:

- Autothrottle
- Pitch
- Roll.

Engaged or captured modes are shown at the top of the flight mode annunciation boxes in large green letters. Armed modes are shown in smaller white letters at the bottom of the flight mode annunciation boxes.

Autothrottle Modes

- N1 – The autothrottle maintains thrust at the selected N1 limit displayed on the thrust mode display
- GA – The autothrottle maintains thrust at reduced go-around setting or full go-around N1 limit
- RETARD – Displayed while autothrottle moves thrust levers to the aft stop. RETARD mode is followed by ARM mode
- FMC SPD – The autothrottle maintains speed commanded by the FMC. The autothrottle is limited to the N1 value shown on the thrust mode display
- MCP SPD – The autothrottle maintains speed set in the MCP IAS/MACH display. The autothrottle is limited to the N1 value shown on the thrust mode display
- THR HLD – The thrust lever autothrottle servos are inhibited; the pilot can set the thrust levers manually
- ARM – No autothrottle mode engaged. The thrust lever autothrottle servos are inhibited; the pilot can set thrust levers manually.

Pitch Modes

- TO/GA – Takeoff (Flight Director Only)

  Engaged for takeoff by turning both F/D switches ON and pushing either TO/GA switch. Both F/Ds must be ON to engage TO/GA prior to starting takeoff.

  The AFDS commands pitch attitude in the following order:

  - 10 degrees nose down until 60 knots IAS
  - 15 degrees nose up after 60 knots IAS
  - 15 degrees nose up after lift–off until a sufficient climb rate is acquired. Then, pitch is commanded to maintain MCP speed plus 20 knots.
  - TO/GA can also be engaged for takeoff with F/D switches OFF if a TO/GA switch is pushed after 80 knots IAS below 2000 feet AGL and prior to 150 seconds after lift-off.

- TO/GA – Go-around

  Engaged for go-around by pushing the TO/GA switch under the following conditions:

  - Inflight below 2000 feet radio altitude
  - Not in takeoff mode
  - Either F/D ON or OFF.

    The F/Ds command 15 degrees nose up pitch and roll to hold the approach ground track at time of go-around engagement. After reaching a programmed rate of climb, pitch commands the target airspeed for each flap setting based on maximum takeoff weight calculations.

- VNAV –

  VNAV is engaged by pushing the VNAV switch. With a VNAV mode engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile.

  - VNAV SPD – The AFDS maintains the FMC speed displayed on the airspeed indicator and/or the CDU CLIMB or DESCENT pages
  - VNAV PTH – The AFDS maintains FMC altitude or descent path with pitch commands.
- V/S (engaged) – Commands pitch to hold selected vertical speed
- V/S (armed) – V/S mode can be engaged by moving vertical speed thumbwheel
- ALT ACQ – Transition maneuver entered automatically from a V/S, LVL CHG, or VNAV climb or descent to selected MCP altitude. Engages but does not annunciate during VNAV transition
- ALT HOLD – Commands pitch to hold MCP selected altitude or uncorrected barometric altitude at which ALT HOLD switch was pushed
- MCP SPD – Pitch commands maintain IAS/MACH window airspeed or Mach
- G/S (armed) – The AFDS is armed for G/S capture
- G/S (engaged) – The AFDS follows the ILS glideslope
- FLARE (armed) – During a dual A/P ILS approach, **FLARE** is displayed after LOC and G/S capture and below 1500 feet RA. The second A/P couples with the flight controls and A/P go-around mode arms
- FLARE (engaged) – During a dual A/P ILS approach, flare engages at 50 feet radio altitude. **FLARE** accomplishes the autoland flare maneuver.

Roll Modes

- LNAV – The AFDS intercepts and tracks the active FMC route. Either of the following capture criteria must be met:
  - On any heading and within 3 NM of the active route segment
  - If outside of 3 NM of active route segment, aircraft must be on an intercept course of 90 degrees or less and intercept the route segment before the active waypoint.
- HDG SEL – The aircraft is turning to, or is on the heading selected in the MCP Heading Display
- VOR/LOC (armed) – AFDS is armed to capture selected VOR or LOC COURSE
- VOR/LOC (engaged) – AFDS tracks selected VOR course or tracks selected localizer course along the inbound front course bearing.

Autopilot Control Wheel Steering

Paddle In CWS Or CWS Engage Switch Selected

Placing an engage paddle to CWS or pushing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays **CWS P** and **CWS R** on the FMAs.

With CWS engaged, the A/P maneuvers the aircraft in response to control pressures applied by either pilot. The control pressure is similar to that required for manual flight. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6 degrees or less bank, the A/P rolls the wings level and holds existing heading. This heading hold feature with bank less than 6 degrees is inhibited when any of the following conditions exists:

- Below 1,500 feet RA with the landing gear down
- After F/D VOR capture with TAS 250 knots or less
- After F/D LOC capture in the APP mode.

Pitch CWS With CMD Selected

The pitch axis engages in CWS while the roll axis is in CMD when:

- A command pitch mode has not been selected or was deselected
- A/P pitch has been manually overridden with control column force. The force required for override is greater than normal CWS control column force. This manual pitch override is inhibited in the APP mode with both A/Ps engaged.

CWS P is annunciated on the FMAs while this mode is engaged. Command pitch modes can then be selected.

When approaching a selected altitude in CWS P with a CMD engage switch selected, **CWS P** changes to **ALT ACQ**. When at the selected altitude, ALT HOLD engages.

If pitch is manually overridden while in **ALT HOLD** at the selected altitude, **ALT HOLD** changes to **CWS P**. If control force is released within 250 feet of the selected altitude, **CWS P** changes to **ALT ACQ**, the aircraft returns to the selected altitude, and **ALT HOLD** engages. If the elevator force is held until more than 250 feet from the selected altitude, pitch remains in **CWS P**.

Roll CWS With CMD Selected

The roll axis engages in CWS while the pitch axis is in CMD when:

- A command roll mode has not been selected or was deselected
- A/P roll has been manually overridden with control wheel force. The force required for override is greater than the normal CWS control wheel force.

CWS R is annunciated on the FMAs while this mode is engaged.

CWS R with a CMD engage switch illuminated can be used to capture a selected radio course while the VOR/LOC or APP mode is armed. Upon intercepting the radial or localizer, the **F/D** and **A/P** annunciations change from **CWS R** to **VOR/LOC** engaged, and the A/P tracks the selected course.

Autothrottle System

The A/T system provides automatic thrust control from the start of takeoff through climb, cruise, descent, approach and go-around or landing. In normal operation, the FMC provides the A/T system with N1 limit values.

The A/T moves the thrust levers with a separate servo motor on each thrust lever. Manually positioning the thrust levers does not cause A/T disengagement unless 10 degrees of thrust lever separation is exceeded during a dual channel approach after **FLARE** armed is annunciated. Following manual positioning, the A/T may reposition the thrust levers to comply with computed thrust requirements except while in the THR HLD and ARM modes.

7 8 9 The A/T system operates properly with the EECs ON or in ALTN. In either case, the A/T uses the FMC N1 limits. During A/T operation, it is recommended that both EECs be ON or both be in ALTN, as this produces minimum thrust lever separation.

A/T Engagement

Moving the A/T Arm switch to ARM, arms the A/T for engagement in the N1, MCP SPD or FMC SPD mode. The A/T Arm switch is magnetically held at ARM and releases to OFF when the A/T becomes disengaged.

A general summary of A/T mode engagement is as follows:

- A/T SPD or N1 modes automatically engage when AFDS command pitch modes become engaged
- Engaging LVL CHG or VNAV climb modes automatically engages the A/T N1 mode
- Engaging LVL CHG or VNAV descent modes automatically engages the A/T in RETARD and then ARM when thrust is at idle
- If not in a VNAV mode, engagement of ALT ACQ or ALT HOLD automatically engages the A/T in the MCP SPD mode; otherwise the A/T remains in FMC SPD
- Engagement of G/S capture automatically engages the A/T in the MCP SPD mode.

Autothrottle Disengagement

Any of the following conditions or actions disengages the A/T:

- Moving the A/T Arm switch to OFF
- Pushing either A/T Disengage switch
- An A/T system fault is detected
- Two seconds have elapsed since landing touchdown
- Thrust levers become separated more than 10 degrees during a dual channel approach after **FLARE** armed is annunciated
- Significant thrust difference along with control wheel roll input of 10 degrees or more, and flap position up through 10.

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

Automatic Flight Operations

The phases of flight for automatic flight operations are:

- Takeoff and climb
- Enroute
- Approach and landing
- Go-around

Automatic Flight Takeoff And Climb

Takeoff is a flight director only function of the TO/GA mode. Flight director pitch and roll commands are displayed and the autothrottle maintains takeoff N1 thrust limit as selected from the FMC. The autopilot may be engaged after takeoff.

Both F/Ds must be ON to engage the takeoff mode prior to starting the takeoff. The F/D takeoff mode is engaged by pushing the TO/GA switch on either thrust lever. The FMAs display FD as the A/P status, TO/GA as the pitch mode, and blank for the roll mode.

During takeoff, pushing a TO/GA switch engages the autothrottle in the N1 mode. The A/T annunciation changes from **ARM** to **N1** and thrust levers advance toward takeoff thrust.

The F/D can also be engaged in the takeoff mode with the F/D switches off. If a TO/GA switch is pushed after 80 knots below 2000 feet AGL and prior to 150 seconds after lift-off, the F/D command bars automatically appear for both pilots.

During takeoff, prior to 64 knots:

- The pitch command is 10 degrees nose down
- The roll command is wings level
- The autothrottle is engaged in the N1 mode
- Thrust levers advance until the engines reach takeoff thrust
- The FMAs display **N1** for the autothrottle mode, **TO/GA** for the pitch mode, and blank for the roll mode.

At 64 knots, the F/D pitch commands 15 degrees nose up.

3 5 7 8 9 At 84 knots, the A/T mode annunciates **THR HLD**.

At lift-off:

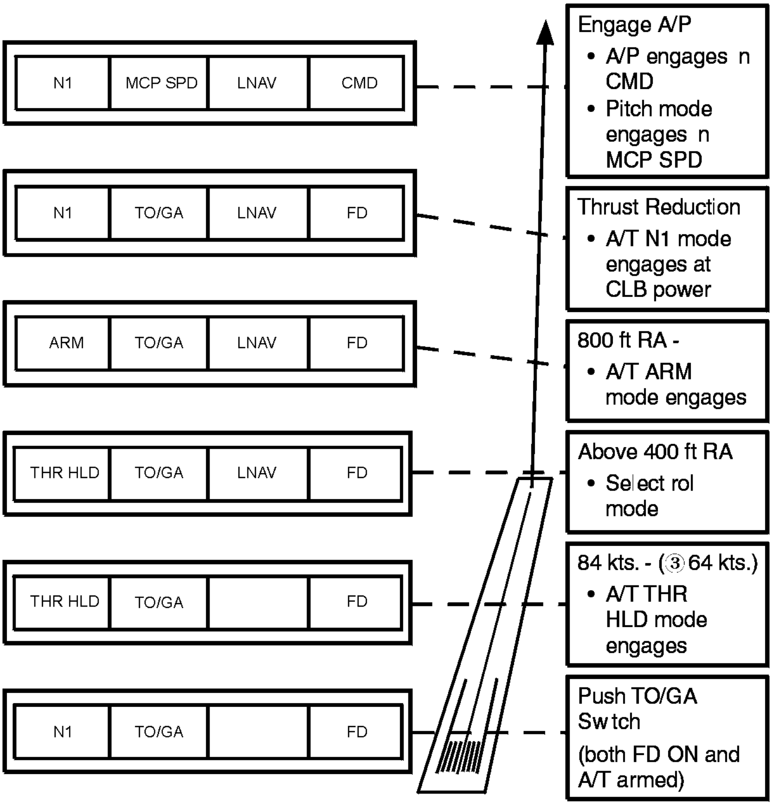
- The pitch command continues at 15 degrees until sufficient climb rate is acquired. Pitch then commands MCP speed (normally V2) plus 20 knots
- If an engine failure occurs during takeoff, the pitch command target speed is:
  - V2, if airspeed is below V2
  - Existing speed, if airspeed is between V2 and V2 + 20
  - V2 + 20, if airspeed is above V2 + 20
- The roll command maintains wings level.

After lift–off:

- The A/T remains in THR HLD until 400 feet RA and 18 seconds after lift-off or 800 feet RA as installed. A/T annunciation then changes from **THR HLD** to **ARM** and reduction to climb thrust can be made by pushing the N1 switch
- Automatic reduction to climb thrust occurs upon reaching the selected thrust reduction altitude which is shown on the FMC CDU TAKEOFF REF page 2/2 during preflight, or when the aircraft levels off in ALT HOLD or VNAV PTH. Pilot entries can be made to override the default value. Allowable entries are 800 feet to 9999 feet
- Flight director engaged status is terminated by engaging an autopilot in CMD (CMD replaces FD in A/P status display)
  - Pitch engages in LVL CHG and pitch mode FMA is MCP SPD unless another pitch mode has been selected
  - MCP IAS/Mach display and airspeed cursor change to V2 + 20 knots
  - Roll mode engages in HDG SEL unless another roll mode has been selected.

To terminate the takeoff mode below 400 feet RA, both F/D switches must be turned OFF. Above 400 feet RA, selection of another pitch mode or engaging an autopilot will terminate the takeoff mode; other F/D roll modes can be also selected.

AUTOMATIC FLIGHT TAKEOFF PROFILE



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Automatic Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMC.

Other roll modes available are:

- VOR course (VOR/LOC)
- Heading select (HDG SEL).

Other pitch modes available are:

- Altitude hold (ALT HOLD)
- Level change (MCP SPD)
- Vertical speed (V/S).

Automatic Flight Approach And Landing

The AFDS provides guidance for single A/P non-precision approaches. The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent may be accomplished using VNAV, LVL CHG, or V/S. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single or dual A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glideslope.

Approach (APP) Mode Dual A/Ps

Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides fail passive operation through landing flare and touchdown or an automatic go-around. During fail passive operation, the flight controls respond to the A/P commanding the lesser control movement. If a failure occurs in one A/P, the failed channel is counteracted by the second channel such that both A/Ps disconnect with minimal aircraft maneuvering and with aural and visual warnings to the pilot.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected. For a dual A/P approach, the second VHF NAV receiver must be tuned to the ILS frequency and the corresponding A/P engaged in CMD prior to 800 feet RA.

Localizer And Glideslope Armed

After setting the localizer frequency and course, pushing the APP switch selects the APP mode. The APP switch illuminates and **VOR/LOC** and **G/S** annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

The localizer can be intercepted in the HDG SEL, CWS R or LNAV mode.

Glideslope (G/S) capture is inhibited prior to localizer capture.

Localizer Capture

The LOC capture point is variable and depends on intercept angle and rate of closure, but does not occur at less than 1/2 dot. Upon LOC capture, **VOR/LOC** annunciates captured, **1 CH** is annunciated for A/P status, the previous roll mode disengages and the aircraft turns to track the LOC.

Glideslope Capture

Glideslope capture is inhibited prior to localizer capture.

The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- Previous pitch mode disengages
- **APP** light extinguishes if localizer has also been captured
- Aircraft pitch tracks the G/S
- **GA** displayed on thrust mode display (N1 thrust limit).

After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- Pushing a TO/GA switch
- Disengaging A/P and turning off both F/D switches
- Retuning a VHF NAV receiver.

After LOC And G/S Capture

Shortly after capturing both LOC and G/S and below 1500 feet RA:

- The second A/P couples with the flight controls
- Test of the ILS deviation monitor system is performed and the **G/S** and **LOC** displays turn amber and flash
- **FLARE** armed is annunciated
- The **1 CH** annunciation extinguishes
- A/P go-around mode arms but is not annunciated.

The A/Ps disengage and the F/D command bars retract to indicate an invalid ILS signal.

800 Feet Radio Altitude

The second A/P must be engaged in CMD by 800 feet RA to execute a dual channel A/P approach. Otherwise, CMD engagement of the second A/P is inhibited.

400 Feet Radio Altitude

The stabilizer is automatically trimmed an additional amount nose up. If the A/Ps subsequently disengage, forward control column force may be required to hold the desired pitch attitude.

If **FLARE** is not armed by approximately 350 feet RA, both A/Ps automatically disengage.

Flare

The A/P flare maneuver starts at approximately 50 feet RA and is completed at touchdown:

- **FLARE** engaged is annunciated and F/D command bars retract
- The stabilizer is automatically trimmed an additional amount nose up at 50 feet RA.
- The A/T begins retarding thrust at approximately 27 feet RA so as to reach idle at touchdown. A/T FMA annunciates **RETARD**.
- The A/T automatically disengages approximately 2 seconds after touchdown.
- The A/P must be manually disengaged after touchdown. Landing rollout is executed manually after disengaging the A/P.

Approach (APP) Mode Single A/P

A single A/P ILS approach can be executed by engaging only one A/P in CMD after pushing the APP mode select switch. Single A/P approach operation is the same as dual, with the following exceptions:

- Full automatic flare and touchdown capability is not available. **FLARE** is not annunciated and stabilizer trim bias is not applied
- A/P status of **1 CH** is annunciated for the entire approach after localizer capture
- An A/P go-around is not available.

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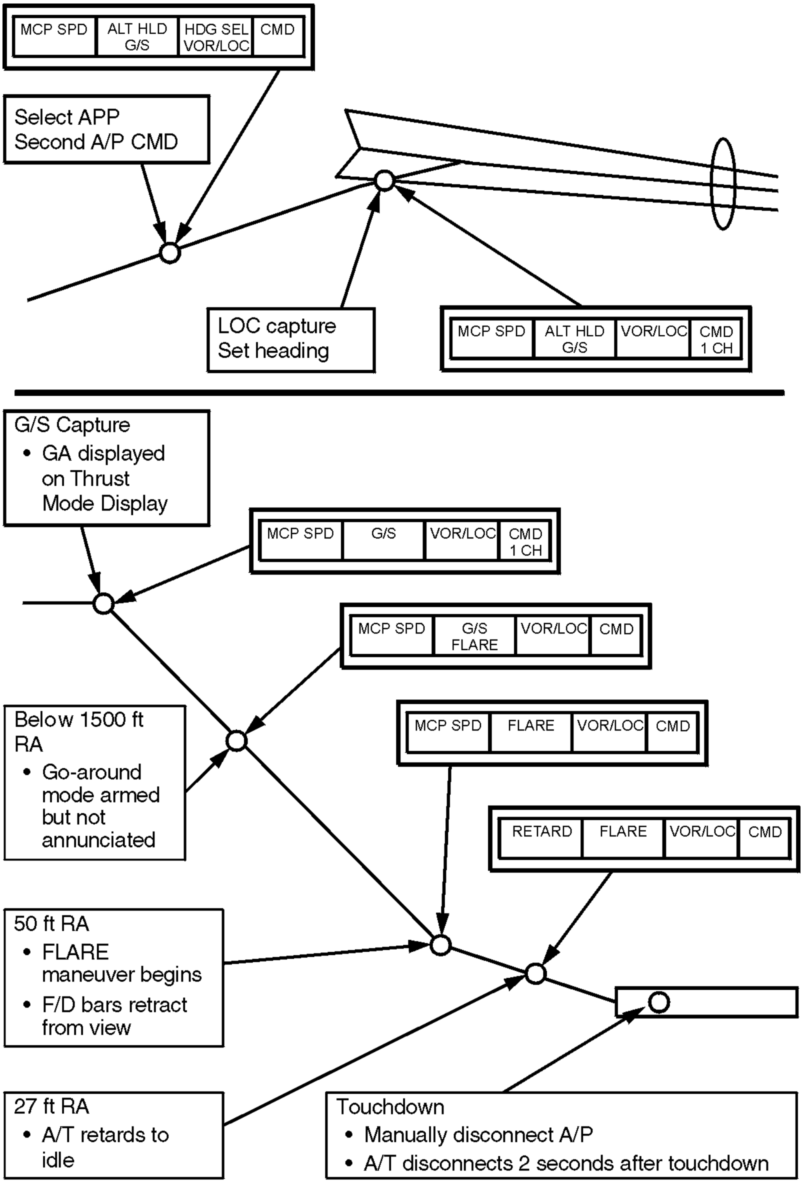
AUTOMATIC FLIGHT APPROACH PROFILE



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Go-Around

Go-Around (GA) mode is engaged by pushing either TO/GA switch. An A/P go-around requires dual A/P operation and is armed when **FLARE** armed is annunciated. If both A/Ps are not operating, a manual F/D go-around is available.

With the A/T Arm switch at ARM, the A/T go-around mode is armed when descending below 2000 feet RA, with or without the AFDS engaged. Once armed, the A/T go-around mode can be engaged until 2 seconds have elapsed after landing touchdown.

A/P Go-Around

The A/P GA mode requires dual A/P operation and is available after **FLARE** armed is annunciated and prior to the A/P sensing touchdown.

With the first push of either TO/GA switch:

- A/T (if armed) engages in GA and the A/T Engaged Mode annunciation on the FMA indicates **GA**
- Thrust advances toward the reduced go-around N1 to produce 1000 to 2000 fpm rate of climb
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates **TO/GA**
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands target airspeed for each flap setting based on maximum takeoff weight calculations
- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- The IAS/Mach display blanks
- The command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff weight calculations.

If the go-around mode is selected after touchdown and prior to A/T disengagement, the A/Ps disengage and the A/Ts may command GA thrust.

With the second push of either TO/GA switch after A/T reaches reduced go-around thrust:

- The A/T advances to the full go-around N1 limit.

TO/GA mode termination from A/P go-around:

- Below 400 feet RA, the AFDS remains in the go-around mode unless both A/Ps and F/Ds are disengaged
- Above 400 feet RA, select a different pitch or roll mode.
  - If the roll mode is changed first:
    - The selected mode engages in single A/P roll operation and is controlled by the A/P which was first in CMD
    - Pitch remains in dual A/P control in TO/GA mode.
  - If the pitch mode is changed first:
    - The selected mode engages in single A/P pitch operation and is controlled by the A/P which was first in CMD
    - The second A/P disengages
    - The roll mode engages in CWS R.
  - The A/T GA mode is terminated when:
    - Another pitch mode is selected
    - **ALT ACQ** annunciates engaged.
    - The pitch mode cannot be changed from TO/GA until sufficient nose-down trim has been input to allow single channel A/P operation. This nose-down trim is automatically added by the A/P to reset the trim input made by the A/P at 400 feet RA and at 50 feet RA during the approach.

With pitch mode engaged in TO/GA, ALT ACQ engages when approaching the selected altitude and ALT HOLD engages at the selected altitude if the stabilizer position is satisfactory for single A/P operation.

- If stabilizer trim position is not satisfactory for single A/P operation:
  - ALT ACQ is inhibited
  - A/P disengage lights illuminate steady red
  - Pitch remains in TO/GA.

  To extinguish A/P disengage lights, disengage A/Ps or select higher altitude on MCP.

F/D Go-Around

If both A/Ps are not engaged, a manual F/D only go-around is available under the following conditions:

- Inflight below 2000 feet RA
- Not in takeoff mode.

With the first push of either TO/GA switch:

- A/T (if armed) engages in GA and advances thrust toward the reduced go-around N1 to produce 1000 to 2000 fpm rate of climb. The A/T Engaged Mode annunciation on the FMA indicates **GA**
- Autopilot (if engaged) disengages
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates **TO/GA**
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands target airspeed for each flap setting based on maximum takeoff weight calculations
- F/D roll commands approach ground track at time of engagement. The Roll Engaged Mode annunciation on the FMA is blank
- The IAS/Mach display blanks
- The command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff weight calculations.

With the second push of either TO/GA switch (if A/T engaged and after A/T reaches reduced go-around thrust):

- The A/T advances to the full go-around N1 limit

TO/GA mode termination from F/D go-around:

- Below 400 feet RA, both F/D switches must be turned off.
- Above 400 feet RA, select a different pitch or roll mode.
  - If the roll mode is changed first:
    - F/D roll engages in the selected mode
    - The F/D pitch mode remains in TO/GA.

- If the pitch mode is changed first:
  - The F/D roll mode automatically changes to HDG SEL
  - F/D pitch engages in the selected mode.
- The A/T GA mode (if engaged) is terminated when:
  - Another pitch mode is selected
  - **ALT ACQ** annunciates engaged.

Engaging an A/P in CMD automatically engages the A/P and F/Ds in LVL CHG for pitch and HDG SEL for roll.

Single Engine F/D Go-Around

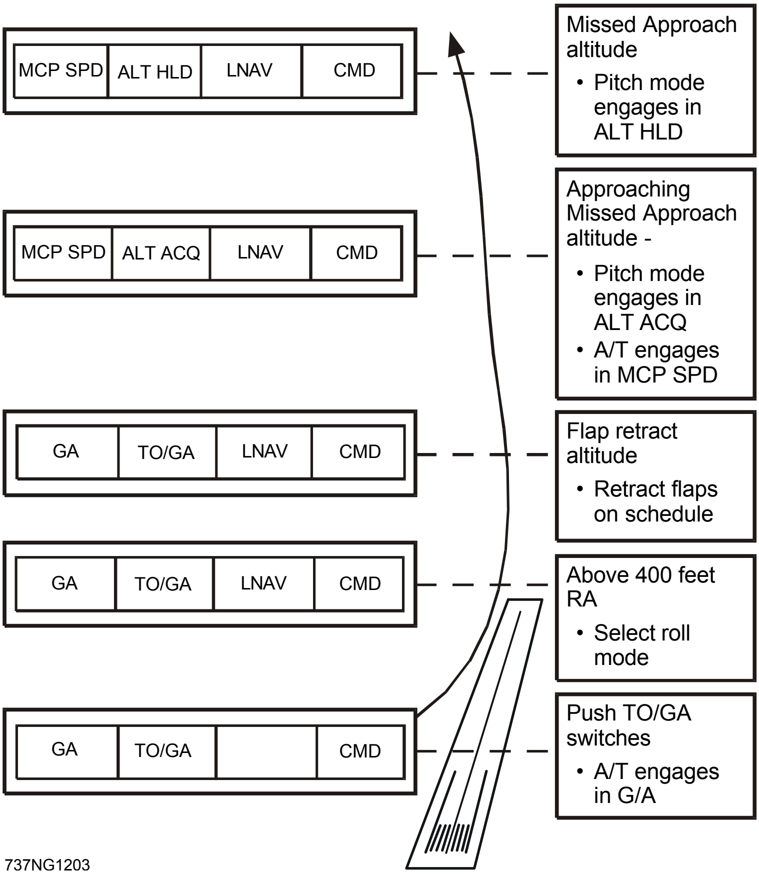
With a push of either TO/GA switch:

- F/D roll commands hold current ground track. The roll engaged mode annunciation on the FMA is blank
- Pitch mode engages in TO/GA and the pitch engaged mode annunciation on the FMA indicates **TO/GA**
- The F/D target speed is displayed on IAS/Mach display
- The F/D target speed is displayed on the airspeed cursor
- F/D pitch commands 13 degrees nose up. As climb rate increases, F/D pitch commands maintain a target speed.
- If engine failure occurs prior to go-around engagement, then F/D target speed is the selected MCP speed.
- If engine failure occurs after go-around engagement, then F/D target speed depends on whether ten seconds have elapsed since go-around engagement:
  - If prior to ten seconds, the MCP selected approach speed becomes target speed
  - If after ten seconds and the airspeed at engine failure is within five knots of the go-around engagement speed, the airspeed that existed at go-around engagement becomes target speed
  - If after ten seconds and the airspeed at engine failure is more than five knots above go-around engagement speed, then the current airspeed becomes target speed.

Note: The target speed is never less than V2 speed based on flap position unless in windshear conditions.

F/D commanded acceleration cannot occur until a higher speed is selected on the MCP IAS/Mach display.

AUTOMATIC FLIGHT GO-AROUND PROFILE



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AFS Operation In Windshear

General

The autopilot and flight director provide positive corrective action to counteract most windshears. The autothrottle system also aids in windshear recovery by providing quick response to any increase or decrease in speed. The commanded levels of power may be beyond what the average pilot considers necessary but, in fact, are required by the situation.

Takeoff Or Go-Around

If windshear is encountered during F/D takeoff or go-around, the F/D pitch command bar provides commands to maintain V2 + 20 kts until vertical speed decreases to approximately +600 fpm. At this point, the F/D pitch bar commands a 15 degree nose-up pitch attitude and disregards airspeed.
V/S 600 fpm Down to 0 fpm – The F/D will slowly adjust from 15° pitch toward optimum pitch (the angle of attack for stick shaker minus 2 degrees).
V/S Less than 0 fpm – The F/D will maintain the angle of attack for stick shaker minus 2 degrees.
As the aircraft transits the windshear condition, the F/D programming reverses. As climb rate increases above approximately +600 fpm, the F/D commands pitch attitudes which result in acceleration back to V2 + 20 kts. The A/P and F/D both operate in a similar manner during A/P or F/D go-around.

Approach And Landing

If windshear is encountered during an ILS approach, both the F/D and A/P attempt to hold the aircraft on altitude, or on glideslope after glideslope capture, without regard to angle of attack or stick shaker limitations. Airspeed could decrease below stick shaker and into a stall if the pilot does not intervene by pushing the TO/GA switch or disconnecting the A/P and flying manually.

WARNING: Although the F/D, A/P and A/T may be performing as previously described, severe windshear may exceed the performance capability of the system and/or the aircraft. In this situation, the flight crew must, if necessary to avoid ground contact, be prepared to disconnect the autothrottle, advance thrust levers to the forward stop, disconnect the autopilot and manually fly the aircraft.

Command Speed Limiting And Reversion Modes

AFS command limiting and reversion operation is independent of the stall warning and mach warning systems.

Command Speed Limiting

The AFS provides speed, pitch and thrust commands to avoid exceeding the following limit speeds:

- Vmo/Mmo
- Wing flap placards
- Landing gear placard
- Minimum speed.

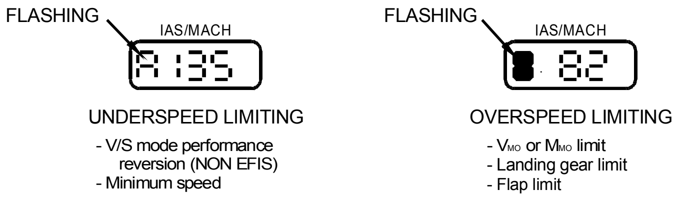
The commanded speed can be equal to, but does not exceed a limit speed.

Speeds greater than Vmo/Mmo cannot be selected from the MCP. Speeds can be selected which exceed flap and gear placards or are less than minimum speed.

Minimum speed is based on angle of attack and is approximately 1.3 Vs for the current flap configuration. It is sensed by the angle of attack vanes, one on either side of the forward fuselage.

If a speed greater than a placard speed, or less than minimum speed is selected, the AFS allows acceleration or deceleration to slightly short of the limit, then commands the limit speed. The overspeed or underspeed limiting symbol appears in the MCP IAS/Mach display when the commanded speed cannot be reached.

Either pitch or thrust, whichever is engaged in a speed mode, attempts to hold the limit speed. The commanded limit speed and MCP speed condition symbol, remain until another speed is selected which does not exceed the limit. A speed 15 knots greater than the minimum speed must be selected to remove the underspeed limiting symbol.



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Reversion Modes

During some flight situations, speed control by the AFDS or A/T alone could be insufficient to prevent exceeding a limit speed. If this occurs, AFDS or A/T modes automatically revert to a more effective combination. The reversion modes are:

- Placard limit reversion
- Minimum airspeed reversion.

Mode reversion occurs slightly before reaching the limit speed. Both the AFDS and A/T have reversion modes which activate according to the condition causing the reversion.

Placard Limit Reversion

When one of the placard limit reversions (gear, flap or Vmo/Mmo) is reached, the overspeed limiting symbol appears in the MCP IAS/Mach display and the following occurs:

- If not in AFDS or A/T speed control and the A/T is armed, the A/T reverts to SPEED and controls speed to the placard limit
- If in AFDS or A/T speed control, no reversion is necessary. The AFDS or A/T, whichever is controlling speed, holds speed slightly below the placard limit
- If the A/T is not available, no reversion response to gear or flap placard speeds is available. The AFDS reverts to speed control for Vmo/Mmo speed limiting.

Minimum Speed Reversion

The AFDS and A/T do not control to a speed which is less than minimum speed for the current flap configuration. This speed is approximately 1.3 Vs. Minimum speed, FMC speed, or selected speed, whichever is higher, becomes the AFS commanded speed. If actual speed becomes equal to or slightly less than the minimum speed, the underspeed limiting symbol appears in the MCP IAS/Mach Display, and if operating in the V/S mode, the AFDS reverts to LVL CHG.

The AFS commands a speed 5 knots greater than minimum speed. Selecting a speed 15 knots greater than minimum speed reactivates normal MCP speed selection control. The AFDS commands nose down pitch to increase airspeed if the thrust levers are not advanced. When actual speed becomes 15 knots greater than minimum speed, the underspeed limiting symbol disappears.

The A/P disengages and the F/D command bars retract when in a LVL CHG climb with a command speed equal to minimum speed and a minimum rate of climb cannot be maintained without decelerating.

Minimum speed reversion is not available when the A/T is OFF and the AFDS is in ALT HOLD, ALT ACQ or after G/S capture.

③ Performance Limit Reversion

This function occurs only while operating in the V/S mode when the selected vertical speed and airspeed combination exceeds the thrust capability to maintain the selected airspeed. If airspeed becomes more than 5 knots below the MCP selected airspeed and is not increasing, the AFS reverts to LVL CHG and the underspeed symbol appears in the MCP IAS/Mach display.

The underspeed symbol remains displayed until a difference speed or a different pitch mode is selected.

Performance limit reversion can occur with the A/T OFF and the Autopilot ON.

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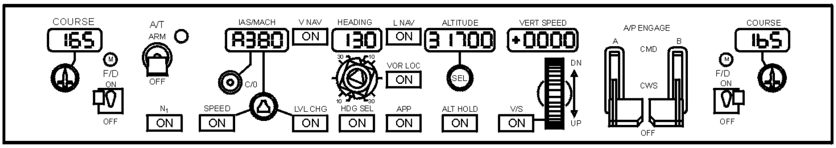
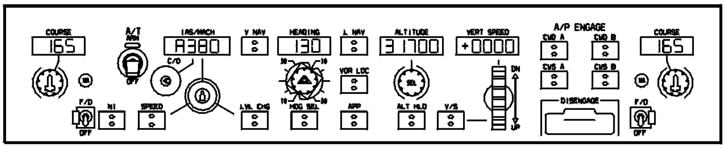
CONTROLS AND INDICATORS

Mode Control Panel (MCP)

EARLY 737s
AS INSTALLED



LATER 737s
AS INSTALLED



GLARESHIELD

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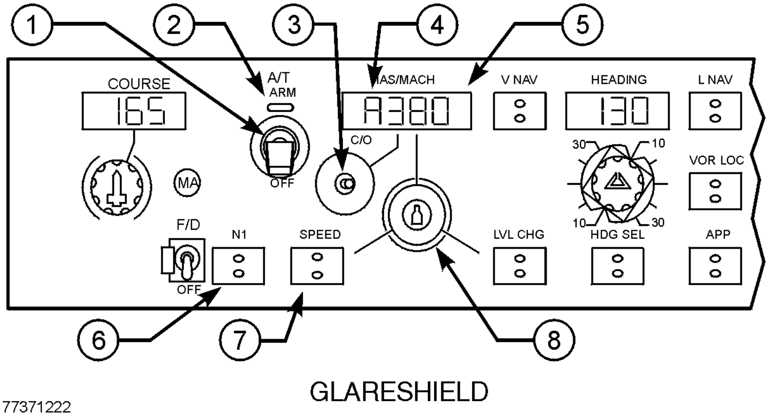
Two different mode control panel formats are found in the B737 fleet. Later B737s have mode selector switch lights that show two small green lights when illuminated. Earlier B737s switch lights annunciate **ON** when the switch light is illuminated. Mode selector switch light functions are the same on all B737s. Later B737s have individual switch lights for respective autopilot engagement in command (CMD) and control wheel steering (CWS). Earlier B737s have "paddle" switches for respective autopilot engagement. A disengage bar for simultaneous disengagement of both autopilots is installed on later aircraft. The mode selector switch light format is used throughout the flight manual.

Speed Controls



GLARESHIELD

① Autothrottle (A/T) Arm Switch

ARM – Arms A/T for engagement. Magnetically held at ARM. A/T engages automatically when following AFDS modes are engaged:

- LVL CHG
- ALT ACQ
- V/S
- VNAV
- ALT HOLD
- G/S capture
- TO/GA.

OFF – Disengages A/T and prevents A/T engagement.

② Autothrottle Indicator Light

Illuminated (green) – A/T ARM switch in ARM position.

③ Changeover (C/O) Switch

Push –

- Changes IAS/MACH display between **IAS** and **MACH**
- Automatic changeover occurs at approximately FL260.

④ MCP Speed Condition Symbols

Overspeed or underspeed limiting symbol appears when commanded speed cannot be reached.

Underspeed limiting (flashing character **A**) – minimum speed

Overspeed limiting (flashing character **8**) –

- Vmo or Mmo limit
- Landing gear limit
- Flap limit.

⑤ IAS/MACH Display

Displays speed selected by IAS/MACH selector

- Display is blank when:
  - VNAV mode engaged
  - A/T engaged in FMC SPD mode
  - During 2 engine AFDS go-around
- Displays 100 / 110 knots when power is first applied (as installed)
- Display range is:
  - 100 / 110 KIAS – Vmo in 1 knot increments (as installed)
  - .60M – Mmo in .01M increments.

⑥ N1 Switch

Push – (light **ON** not illuminated)

- Engages A/T in N1 mode if compatible with AFDS modes already engaged
- Illuminates **N1** switch light
- Annunciates **N1** autothrottle mode.

Push – (light **ON** illuminated)

- Deselects N1 mode and extinguishes switch light
- Engages autothrottles in ARM mode.

N1 Mode

- A/T maintains thrust at N1 limit selected from FMC CDU. N1 mode engaged manually by pushing N1 switch if N1 mode is compatible with existing AFDS modes. N1 mode engages automatically when:
  – Engaging LVL CHG in climb (except during inhibit period for 2 1/2 minutes after lift-off)
  – Engaging VNAV in climb.

⑦ SPEED Switch

Push – (light **ON** not illuminated)

- Engages A/T in SPEED mode if compatible with engaged AFDS modes
- Illuminates **SPEED** switch light
- Annunciates **MCP SPD** autothrottle mode
- Maintains speed in **MCP IAS/MACH** display.

Push – (light **ON** illuminated)

- Deselects speed mode and extinguishes switch light
- Engages A/T in ARM mode.

Speed Mode

Autothrottle holds speed in IAS/MACH display or a performance or limit speed. Speed mode engaged manually by pushing SPEED switch if speed mode is compatible with existing AFDS modes. Speed mode engages automatically when:

- ALT ACQ engages
- ALT HOLD engages
- V/S engages
- G/S capture occurs.

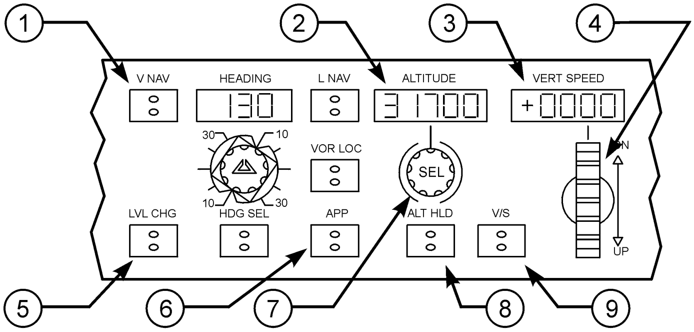
A/T does not set thrust above displayed N1 limit, however, A/T can exceed N1 value manually set by N1 manual set knob.

⑧ Speed Selector

Rotate –

- Sets speed in IAS/MACH display and positions airspeed cursor
- Selected speed is reference speed for AFDS and A/T
- Not operative when IAS/MACH display is blank.

Vertical Navigation



GLARESHIELD

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① VNAV Switch

Push –

- VNAV switch light illuminates
- Pitch mode annunciates **VNAV SPD**, **VNAV PTH**
- A/T mode annunciates **FMC SPD**, **N1**, **RETARD**, or **ARM**
- IAS/MACH display blanks and airspeed cursors positioned to FMC commanded airspeed.

VNAV Mode

The FMC commands AFDS pitch and autothrottle to fly vertical profile selected on FMC CDUs. Profile includes climb, cruise, descent, speeds, and can also include waypoint altitude constraints.

If the aircraft is between the FMC target altitude (depicted on the RTE LEGS page for the active waypoint) and the manually entered MCP target altitude, VNAV will not engage. To enable VNAV, adjust the FMC or MCP target altitude as appropriate.

Climb –

- Autothrottle holds FMC thrust limit
- AFDS holds FMC target speed
- Automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
- VNAV constrained level-off annunciates **VNAV PTH**.

Cruise –

- Autothrottle holds FMC target speed
- AFDS holds FMC altitude
- Selecting a lower MCP altitude arms FMC to automatically begin descent upon arrival at FMC top of descent point.

Descent –

- VNAV SPD descent
  - Autothrottle holds idle
  - AFDS holds FMC target speed.
- VNAV PTH descent
  - Autothrottle holds idle but can command FMC SPD mode if ground speed becomes too low to maintain FMC vertical path
  - AFDS tracks FMC descent path.
- Automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
  - VNAV constrained altitude annunciates **VNAV PTH**.

Inhibited below 400 ft RA or if performance initialization not complete.

VNAV mode is terminated by any one of the following:

- Selecting another pitch mode
- Glideslope capture
- Reaching end of LNAV route
- Transition of glideslope intercept waypoint or transition of glideslope intercept waypoint if G/S is armed (as installed)
- Crosstrack deviation exceeds the RNP value during PTH descent for an active leg with a database vertical angle and LNAV not engaged or crosstrack deviation exceeds twice the RNP value during PTH descent for an active leg with a database vertical angle and LNAV not engaged (as installed)
- If the aircraft altitude is more than 200 feet below MCP altitude and the autoflight system is not in altitude acquire.

In the event of glideslope intercept waypoint transition, VNAV can be re-engaged.

② ALTITUDE Display

Displays selected altitude

- Displayed altitude is reference for altitude alerting and automatic level-offs
- Altitude range is 0 to 50,000 feet in 100 foot increments
- Displays previously selected altitude when power first applied.

③ Vertical Speed (VERT SPEED) Display

Displays:

- Blank when V/S mode not active
- Present V/S when V/S mode is engaged with V/S switch
- Selected V/S when V/S set with thumbwheel
- Range is -7900 to +6000 fpm.

Display increments are:

- 50 fpm if V/S is less than 1000 fpm
- 100 fpm if V/S is 1000 fpm or greater.

④ Vertical Speed Thumbwheel

Rotate -

- DN –
  - Sets vertical speed in VERT SPEED display
  - Increases rate of descent or reduces rate of ascent.
- UP –
  - Sets vertical speed in VERT SPEED display
  - Increases rate of ascent or reduces rate of descent.

⑤ Level Change (LVL CHG) Switch

Push –

- LVL CHG switch light illuminates
- Pitch mode annunciates MCP SPD for climb or descent
- Autothrottle mode annunciates N1 for climb and RETARD followed by ARM for descent
- IAS/MACH display and airspeed cursors display target speed.

LVL CHG Mode

The LVL CHG mode coordinates pitch and thrust commands to make automatic climbs and descents to preselected altitudes at selected airspeeds.

A LVL CHG climb or descent is initiated by:

- Selecting a new altitude
- Pushing LVL CHG switch
- Setting desired airspeed.

Climb –

- Autothrottle holds limit thrust
- AFDS holds selected airspeed.

Descent –

- Autothrottle holds idle thrust
- AFDS holds selected airspeed.

Airspeed –

- If a speed mode is active when LVL CHG is engaged, this speed is retained as target speed
- If a speed mode is not active when LVL CHG is engaged, existing speed becomes target speed
- Speed can be changed with MCP speed selector.

The LVL CHG mode is inhibited after glideslope capture.

⑥ Approach (APP) Switch

(See Lateral Navigation)

⑦ Altitude Selector (SEL)

Rotate –

- Sets altitude in **ALTITUDE** display in 100 foot increments
- Arms V/S mode if rotated while in ALT HOLD at selected altitude.

⑧ Altitude Hold (ALT HLD) Switch

Push –

- Engages ALT HLD command mode
- Commands pitch to hold uncorrected barometric altitude at which switch was pressed
- Annunciates ALT HLD pitch mode and illuminates **ALT HLD** switch light.

Altitude Hold Command Mode

ALT HLD mode commands pitch to hold either:

- MCP selected altitude
  - Pitch mode annunciates **ALT HOLD**
  - **ALT HOLD** switch light extinguishes.
- Uncorrected barometric altitude at which ALT HOLD switch was pressed if not at MCP selected altitude
  - Pitch mode annunciates **ALT HOLD**
  - **ALT HOLD** switch light illuminates.

When in ALT HOLD at selected MCP altitude:

- Selecting a new MCP altitude illuminates the **ALT HOLD** switch light and arms V/S mode
- LVL CHG, V/S, and VNAV climb and descent functions are inhibited until a new MCP altitude is selected.

ALT HOLD mode is inhibited after G/S capture.

The selected MCP altitude is referenced to:

- Captain's barometric altimeter setting for A A/P and F/D
- First Officer's barometric altimeter setting for B A/P and F/D.

Note: After ALT HOLD engages, changes in altimeter barometric settings do not change the selected altitude reference.

⑨ Vertical Speed (V/S) Switch

Push –

- Arms or engages V/S command mode
- Commands pitch to hold vertical speed
- Engages A/T in speed mode to hold selected airspeed
- Annunciates V/S pitch mode and illuminates **V/S** switch light.

Vertical Speed Command Mode

The V/S mode commands pitch to hold selected vertical speed and engages A/T in SPEED mode to hold selected airspeed. V/S mode has both an armed and an engaged state.

Engaged –

- Annunciates V/S pitch mode
- Vertical speed display changes from blank to present vertical speed
- Desired vertical speeds can be selected with vertical speed thumbwheel.

V/S becomes armed if:

- Pitch mode is ALT HLD at selected MCP altitude and
- New MCP altitude is selected (more than 100 feet from current altitude).

With V/S armed, V/S mode is engaged by moving vertical speed thumbwheel.

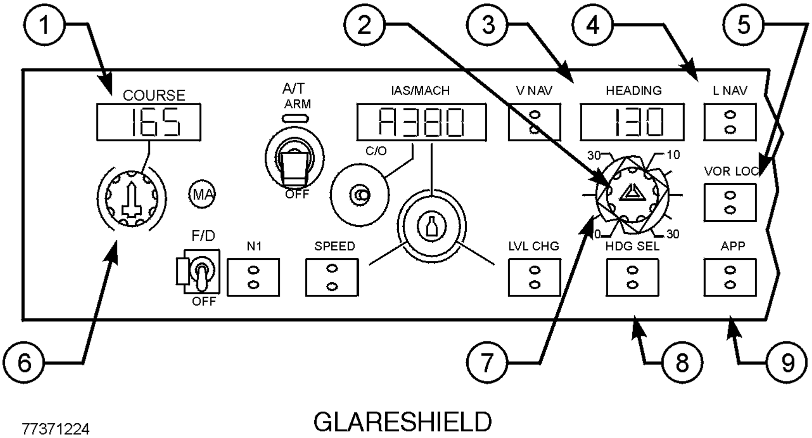
V/S mode automatically engages if ALT ACQ mode is engaged and a new MCP altitude is selected which is more than 100 feet different from previously selected altitude.

- Vertical speeds can be selected which command flight toward or away from selected altitude.

Inhibited if:

- ALT HOLD mode is active at selected MCP altitude
- Glideslope captured in APP mode.

Lateral Navigation



GLARESHIELD

① **COURSE** Display

Displays course set by course selector.

Different courses and frequencies on two VHF NAV receivers can cause disagreement between Captain and First Officer F/D displays and affect A/P operation.

② Heading Selector

Rotate –

- Sets heading in **HEADING** display
- Positions selected heading bugs on the HSI.

③ **HEADING** Display

Displays selected heading.

④ LNAV Switch

Push –

- Commands AFDS roll to intercept and track the active FMC route
- Annunciates LNAV as roll mode and illuminates **LNAV** switch light.

LNAV Mode

In LNAV mode, the FMC controls AFDS roll to intercept and track active FMC route. Active route is entered and modified through FMC CDUs and can include SIDs, STARs, and instrument approaches.

LNAV engagement criteria on the ground:

- Origin runway on the ROUTE page
- Active route entered in FMC
- Track of first leg within 5 degrees of runway heading
- LNAV selected prior to TO/GA. Once TO/GA is engaged, the **LNAV** switch light is extinguished until 400 feet AGL
  - LNAV guidance becomes active at 50 feet AGL
  - Bank angle is limited to 8 degrees from 50 feet to 200 feet and 15 degrees from 200 feet to 400 feet AGL.

LNAV engagement criteria in flight:

- Active route entered in FMC
- Within 3 NM of active route, LNAV engagement occurs with any aircraft heading
- Outside of 3 NM, aircraft must:
  - Be on intercept course of 90 degrees or less
  - Intercept route segment before active waypoint.

LNAV automatically disconnects for following reasons:

- Reaching end of active route
- Reaching a route discontinuity
- Intercepting a selected approach course in VOR LOC or APP modes (VOR/LOC armed)
- Selecting HDG SEL
- Loss of capture criteria.

⑤ VOR Localizer (LOC) Switch

Push –

- Commands AFDS roll to capture and track selected VOR or LOC course
- Annunciates **VOR/LOC** armed or engaged as roll mode and illuminates **VOR LOC** switch light.

VOR LOC Mode

Pushing the VOR LOC switch selects VOR mode if a VOR frequency is tuned or selects LOC mode if a localizer frequency is tuned.

The VOR mode provides roll commands to track selected VOR course.

The LOC mode provides roll commands to track selected localizer course along inbound front course bearing.

The selected course can be intercepted while engaged in:

- LNAV
- HDG SEL
- CWS R if an autopilot is engaged in CMD.

The capture point is variable and depends on intercept angle and closure rate. Localizer capture occurs not later than 1/2 dot deviation. Course capture is indicated when **VOR/LOC** annunciation changes from armed to engaged.

While engaged in VOR or LOC modes:

- A autopilot and Captain F/D use information from Captain course selector and No. 1 VHF NAV receiver
- B autopilot and First Officer F/D use information from First Officer course selector and No. 2 VHF NAV receiver
- Different courses and/or frequencies for two VHF NAV receivers can cause disagreement between the Captain and First Officer F/D displays and affect A/P operation.

When a localizer frequency is selected, VHF NAV radios automatically switch from tail antenna to nose antenna when **VOR/LOC** is annunciated (armed or engaged). If antenna switching does not occur, LOC mode is inhibited.

Note: Localizer backcourse tracking is not available.

⑥ Course Selector

Sets course in **COURSE** display for related VHF NAV receiver, AFDS and DU. Two course selectors and **COURSE** displays are located on the MCP.

Rotate Captain's course selector – provides selected course information to:

- A FCC
- No. 1 VHF NAV receiver
- Captain's course pointer and course deviation bar.
- In VOR LOC or APP mode, the A A/P and Captain F/D use selected course and navigation data from the No. 1 VHF NAV receiver.

Rotate First Officer's course selector – provides selected course information to:

- B FCC
- No. 2 VHF NAV receiver
- First Officer's course pointer and course deviation bar.

Note: In VOR LOC or APP mode, B A/P and First Officer F/D use selected course and navigation data from No. 2 VHF NAV receiver.

⑦ Bank Angle Selector

Rotate –

- Sets maximum bank angle for AFDS operation in HDG SEL or VOR modes
- Commanded bank angle can be selected at 10, 15, 20, 25, or 30 degrees.

⑧ Heading Select (HDG SEL) Switch

Push –

- Engages HDG SEL command mode
- Commands roll to follow selected heading
- Annunciates **HDG SEL** as FMA roll mode and illuminates **HDG SEL** switch light.

Heading Select Command Mode

The HDG SEL mode commands roll to turn to and maintain heading shown in **MCP HEADING** display:

- Initial selection commands turn in shortest direction toward selected heading bug
- After mode engagement, roll commands are given to turn in same direction as rotation of heading selector

- Bank angle limit is established by bank angle selector
- HDG SEL mode automatically disengages upon capture of selected radio course in VOR LOC and APP modes (VOR/LOC armed).

③ Always turns to the nearest direction to each selected heading.

⑨ Approach (APP) Switch

Push –

- Illuminates **APP** switch light
- Arms the AFDS for localizer and glideslope capture
- Roll mode annunciates **VOR/LOC** armed
- Pitch mode annunciates **G/S** armed
- Enables engagement of both autopilots.

APP Mode

The approach mode arms AFDS to capture and track localizer and glideslope and can be engaged for dual or single autopilot operation.

One VHF NAV receiver must be tuned to an ILS frequency before approach mode can be engaged. With one VHF NAV receiver tuned, oneside AFDS is enabled for guidance and operation.

For dual autopilot operation, both VHF NAV receivers must be tuned to the ILS frequency and both autopilots must be selected in CMD prior to 800 feet RA.

APP mode operation:

- Localizer must be captured prior to glideslope
- Localizer can be intercepted in HDG SEL, LNAV, or CWS R
- **1 CH** annunciates in A/P Status Display after localizer capture
  - For single autopilot approach, **1 CH** remains annunciated for entire approach
  - For dual autopilot approach, **1 CH** annunciation extinguishes when second autopilot engages and **FLARE** armed is annunciated
- Glideslope capture occurs at 2/5 dot below glideslope
- **APP** switch light extinguishes after localizer and glideslope capture.

After localizer and glideslope capture, APP mode can be disengaged by:

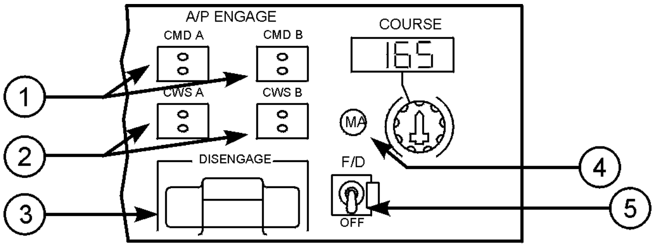
- Pushing a TO/GA switch
- Disengaging autopilot(s) and turning off both F/D switches
- Retuning the VHF NAV receiver.

While engaged in the APP mode:

- The A autopilot and Captain F/D use information from Captain Course Selector and No. 1 VHF NAV receiver
- The B autopilot and First Officer F/D use information from First Officer Course Selector and No. 2 VHF NAV receiver
- Different courses and/or frequencies for the two VHF NAV receivers can cause disagreement between Captain and First Officer F/D displays and affect A/P operation.

Autopilot / Flight Director (As Installed)

7 8 9 Pushing a CMD or CWS switch engages related A/P in **CMD** or **CWS** and illuminates switch lights. A/P can operate in CMD, CWS, or a combination of CMD and CWS.



GLARESHIELD

77371225

① Command Engage (CMD ENGAGE) Switch (A or B):

Push –

- Engages A/P
- Enables all command modes
- Displays **CMD** in A/P status display
- Pushing an engage switch or engaging paddle for second A/P, while not in approach mode, engages second A/P and disengages first A/P
- Enables CWS operation
- CWS engages if:
  - Pitch or roll mode not selected
  - Pitch or roll mode deselected
  - Pitch or roll mode manually overridden with control column force.
- CWS engaged displays:
  - **CWS P** and/or **CWS R** in A/P status display
  - Blank in pitch and/or roll mode FMA
- When approaching a selected altitude in CWS P, the pitch mode engages in ALT ACQ and ALT HOLD when reaching selected altitude
- When approaching a selected radio course in CWS R with VOR/LOC or approach mode armed, VOR/LOC engages when course is intercepted

- If pitch is manually overridden while in ALT HOLD and control force is released within 250 feet of selected altitude, A/P pitch mode engages in ALT ACQ and returns to selected altitude in ALT HOLD mode.

During F/D only operation while pitch or roll commands are more than 1/2 scale from center, pushing a CMD A or B switch engages the A/P in CWS for pitch and/or roll and the related F/D bar(s) retract.

② Control Wheel Steering Engage (CWS ENGAGE) Switch (A or B):

Push –

- Engages A/P
- Engages pitch and roll modes in CWS. Other pitch and roll modes not enabled
- Displays **CWS P** and **CWS R** in A/P status display
- **CMD** not displayed in A/P status display
- F/Ds, if ON, display guidance commands and FD annunciates in A/P status display. A/P does not follow commands while in CWS
- A/P pitch and roll controlled by pilot with control wheel pressure
- When control pressure released, A/P holds existing attitude. If aileron pressure released with 6 degrees or less bank, the A/P rolls wings level and holds existing heading. Heading hold feature inhibited:
  - Below 1500 feet RA with gear down
  - After LOC capture in APP mode
  - After VOR capture with TAS 250 knots or less.

③ Autopilot Disengage (DISENGAGE) Bar (As Installed)

Pull down –

- Exposes yellow background
- Disengages both A/Ps
- Prevents A/P engagement.

Lift up –

- Conceals yellow background
- Enables A/P engagement.

④ Master (MA) Flight Director Indicators (white letters)

If a F/D switch is ON, the light indicates which FCC is controlling the F/D modes.

- Illuminated – related FCC is controlling F/D modes.
- Extinguished – F/D modes are controlled from opposite FCC
- Both lights illuminated – each FCC is controlling modes for related F/D.

⑤ Flight Director (F/D) Switch

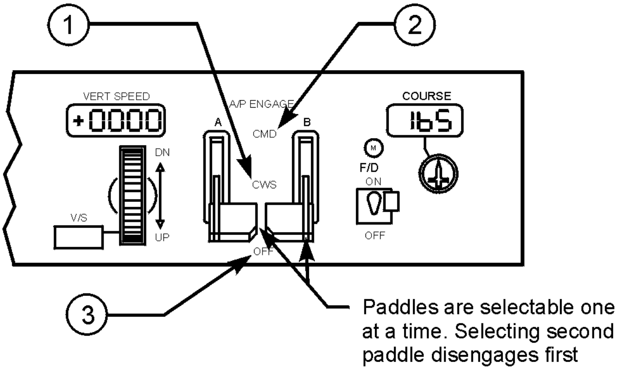
Left F/D switch activates command bars on the Captain attitude indicator. Right F/D switch activates command bars on the First Officer attitude indicator.

ON –

- In flight with A/P ON and F/Ds OFF, turning a F/D switch ON engages F/D in currently selected A/P modes
- Displays FD in A/P status display if A/P is OFF or engaged in CWS
- Enables command bar display on related pilot's attitude indicator
- Command bars are displayed if command pitch and/or roll modes are engaged
- On ground, arms pitch and roll modes for engagement in TO/GA and wings level when TO/GA switch is pushed.

OFF – Command bars retract from related pilot attitude indicator.

③ 3 5 Autopilot Engage Paddles (As Installed)



GLARESHIELD

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① CMD – Enables all command modes for AFDS in addition to CWS.

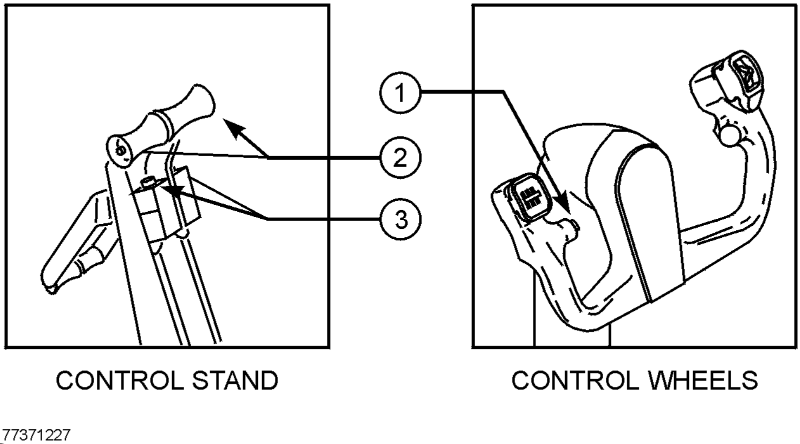
- With no pitch or roll command mode active, autopilot pitch and roll will be in CWS.

② CWS – Autopilot pitch and roll are controlled through control wheel and column pressures.

- If attitudes acquired exceed autopilot limits, autopilot returns to attitude limits when control force is released.
- If roll control force is released with less than 6 degrees of bank, autopilot rolls wing level and holds existing heading.
- Command modes are available for F/D operation through the mode selector switches.

③ OFF – Respective autopilot is disengaged.

Autopilot / Autothrottle Controls



① Autopilot Disengage Switch

Push –

- Disengages both autopilots
- A/P disengage lights flash
- A/P disengage warning tone sounds for a minimum of two seconds
- Second push extinguishes disengage lights and silences disengage warning tone
- If autopilot automatically disengages, extinguishes A/P disengage lights and silences A/P warning tone.

② Autothrottle Disengage Switches

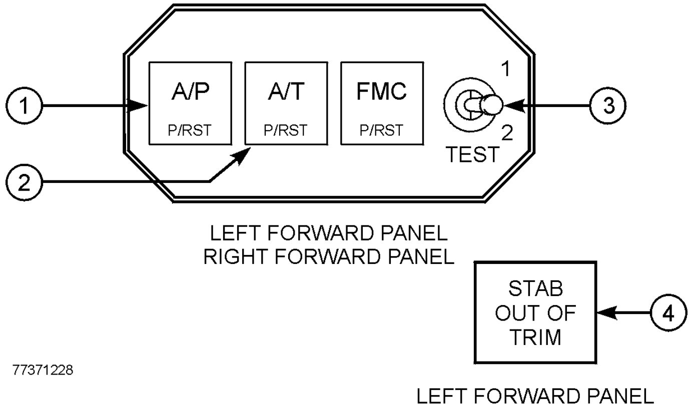
Push –

- Disengages autothrottle
- A/T disengage lights flash
- A/T ARM switch trips OFF
- Second press extinguishes A/T disengage lights
- Extinguishes A/T disengage lights after automatic A/T disengagement.

③ Takeoff / Go-Around (TO/GA) Switches

Push – Engages AFDS and A/T in takeoff or go-around mode if previously armed.

Autopilot / Autothrottle Indicators



① Autopilot (A/P) Disengage Light

Illuminated (red) –

- Flashes and tone sounds when autopilot has disengaged
- Reset by pushing either disengage light or either A/P disengage switch
- Steady for any of following conditions:
  - Stabilizer out of trim below 800 feet RA on dual channel approach
  - ALT ACQ mode inhibited during A/P go-around if stabilizer not trimmed for single A/P operation
  - Disengage light test switch held in position 2
  - Automatic ground system tests fail.

Illuminated (amber) –

- Steady – disengage light test switch held in position 1.

② Autothrottle (A/T) Disengage Light

Illuminated (red) –

- Flashing – autothrottle has disengaged
- Steady – disengage light test switch held in position 2.

Illuminated (amber) –

- Steady – disengage light test switch held in position 1

③ Disengage Light Test (TEST) Switch

TEST 1 – illuminates autopilot / autothrottle degraded mode and FMC alert lights steady amber.

TEST 2 – illuminates autopilot / autothrottle disengage steady red.

Spring-loaded to center position.

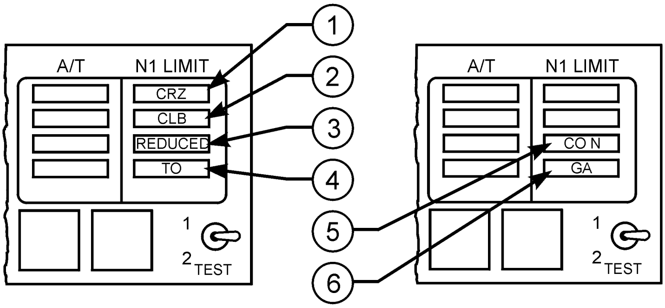
④ Stabilizer Out Of Trim (**STAB OUT OF TRIM**) Light

Operates only with autopilot engaged. Remains extinguished with autopilot not engaged.

Illuminated (amber) – autopilot not trimming stabilizer properly.

③ Thrust Mode Annunciators

FMC N1 LIMIT ANNUNCIATIONS



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① Cruise (**CRZ**)

(White on black) – Indicates cruise mode is engaged.

② Climb (**CLB**)

(White on black) – Indicates climb mode is engaged.

③ **REDUCED**

(White on black) – Indicates reduced takeoff or reduced climb mode is engaged.

④ Takeoff (**TO**)

(White on black) – Indicates takeoff mode is engaged.

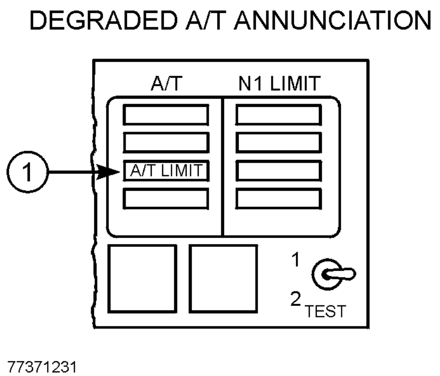
⑤ Continuous (**CON**)

(White on black) – Indicates maximum continuous thrust mode is engaged.

⑥ Go Around (**GA**)

(White on black) – Indicates a go around mode is engaged.

③ Degraded A/T Annunciation



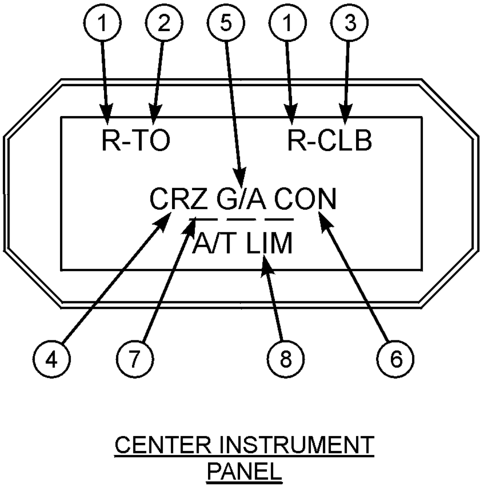
① **A/T LIMIT**

(Black on white) – Indicates degraded autothrottle operation due to loss of FMC or N_1 signals. Appears with active autothrottle mode.

3 5 Thrust Mode Annunciator (As Installed)

The thrust mode annunciator panel is on the center instrument panel above the N_1 RPM indicators. It displays the active N_1 limit reference mode for autothrottle and manual thrust control. N_1 limits are also displayed on the N_1 RPM indicator cursors with the reference knobs pushed in.

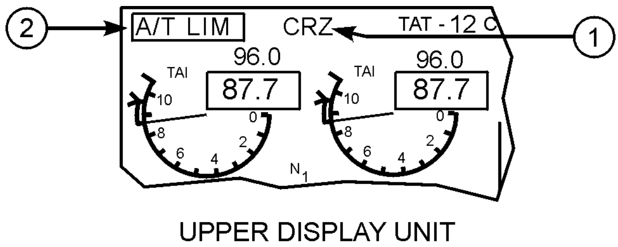
N_1 limits are normally calculated by the FMC. When FMC N_1 limit calculations become invalid, or if either engine N_1 is less than 18%, **A/T LIM** is annunciated. The autothrottle computer then calculates a single N_1 limit for the affected engine(s).



77371229

1. **R** – Reduced. Can appear with **TO** and CLB.
2. **TO** – Takeoff.
3. CLB – Climb.
4. **CRZ** – Cruise.
5. **G/A** – Go-around.
6. **CON** – Continuous.
7. - - - FMC is not computing thrust limit.
8. **A/T LIM** – Autothrottle limit. Indicates that A/T computer is calculating a degraded N_1 thrust limit for the affected engine or engines.

7 8 9 Thrust Mode Display (As Installed)



77371232

① Thrust Mode Display

N_1 limit reference is the active N_1 limit for autothrottle and manual thrust control.

N_1 limit reference is also displayed by N_1 reference bugs with N_1 SET control in AUTO position.

N_1 limit reference is normally calculated by the FMC.

Thrust mode display annunciations are:

- **R-TO** – Reduced takeoff.
- **R-CLB** – Reduced climb.
- **TO** – Takeoff.
- **CLB** – Climb.
- **CRZ** – Cruise.
- **G/A** – Go-around.
- **CON** – Continuous.
- - - - FMC is not computing thrust limit.

② Autothrottle Limit (**A/T LIM**) Indication

Illuminated (white) – The FMC is not providing the A/T system with N_1 limit values. The A/T is using a degraded N_1 thrust limit from the related EEC.

③ Flight Mode Annunciator Panels

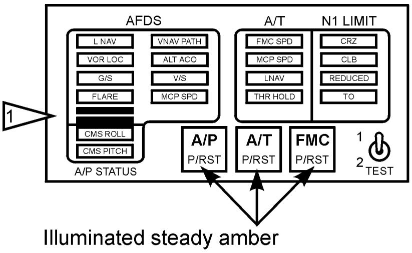
A mode annunciator is on each pilot instrument panel. The annunciator panels are identical and display mode status of the AFDS, A/T and N_1 limit.

The individual annunciators are three-sided prisms which mechanically rotate to the appropriate display and are externally illuminated.

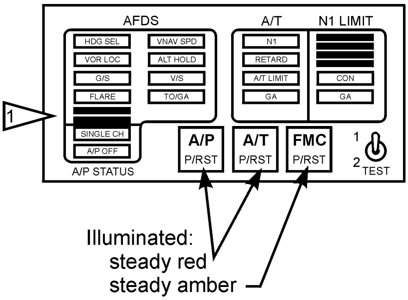
The **A/P** and **A/T** disengage lights and FMC alert light are internally illuminated light caps.

When the test switch is held at the 1 and 2 positions, the following displays are annunciated.

A white horizontal line on a black background indicates a spare annunciator and is displayed only during test.



TEST 1



TEST 2

1 FLARE is annunciated only during test.

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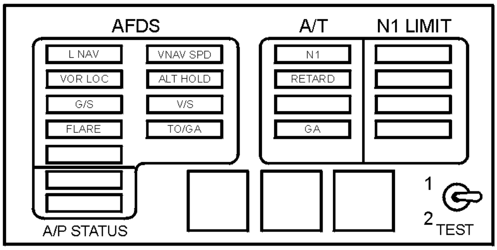
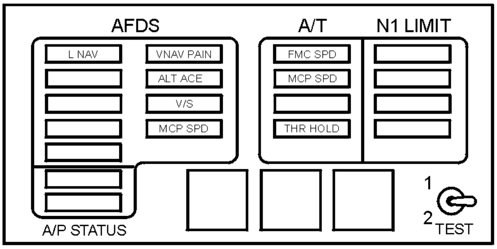
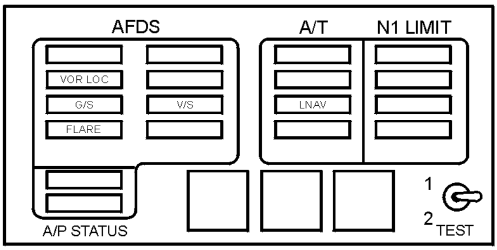
③ Flight Mode Annunciators

ENGAGED MODE ANNUNCIATIONS
– Black letters on a green background.





ARMED MODE ANNUNCIATIONS
– White letters on a black background.



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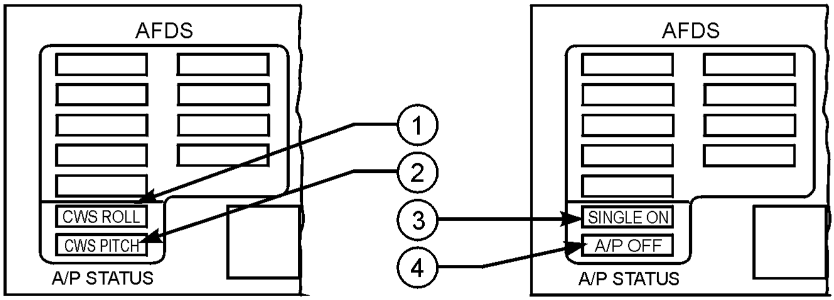
A/P STATUS ANNUNCIATORS



77371234

① **CWS / ROLL**

② **CWS / PITCH** – (black on amber)

Indicates axis in CWS mode.

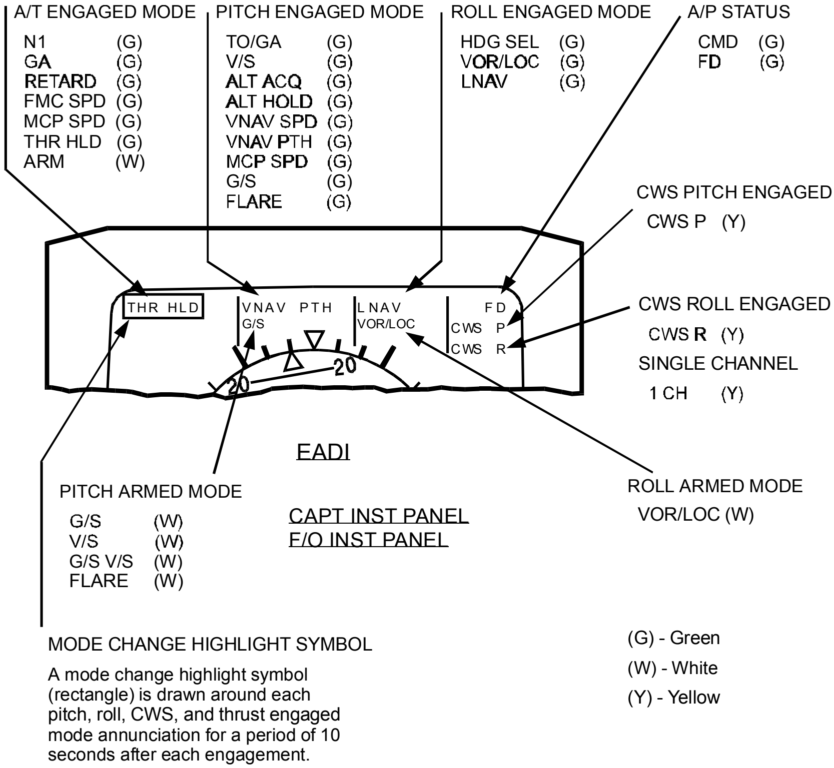
③ **SINGLE CHANNEL** (black on amber)

Annunciated in APP mode from LOC capture until the APP mode is disengaged.

④ **A/P OFF** (black on white)

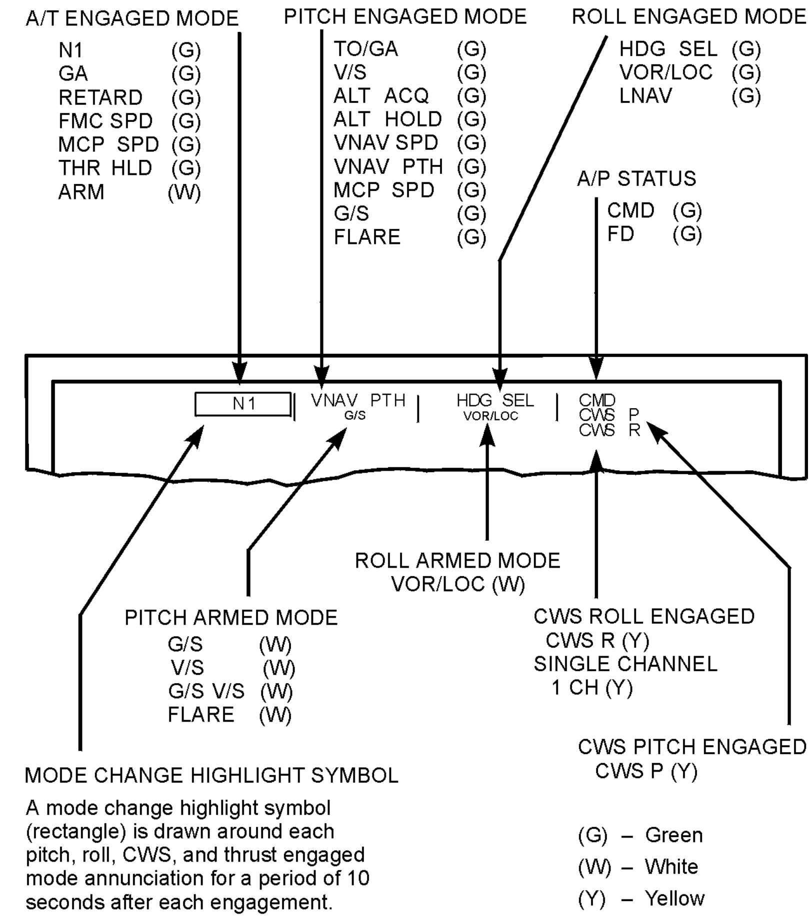
Neither autopilot engaged and at least one F/D is ON.

3 5 Flight Mode Annunciations (As Installed)



37371292

7 8 9 Flight Mode Annunciations (FMA's) (As Installed)



CAPTAIN AND FIRST OFFICER
DISPLAY UNITS

77371235

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COMMUNICATIONS

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SYSTEM DESCRIPTION

INTRODUCTION

The communication system includes:

- Radio communication system
- Interphone communication system
- Voice recorder system
- Communication crew alerting system.

The communication systems are controlled using the:

- Audio control panels
- Radio tuning panels.

Audio Systems & Audio Selector Panels

An audio selector panel (ASP) is installed at the Captain, First Officer, and observer stations. Each panel controls an independent crew station audio system and allows the crewmember to select the desired radios, navigation aids, interphones, and PA system for monitoring or transmission.

Transmitter selectors on each ASP select one radio or interphone for transmission by that crewmember. Any microphone at that crew station may then be keyed to transmit on the selected system.

③ Receiver switches select the systems to be monitored. Any combination of systems may be selected. Receiver switches also control the volume at the respective crew stations. Audio from the selected systems is adjusted for volume and amplified by an amplifier in the audio selector panel. This audio is then routed to the headset jack and speaker at that crew station.

A second amplifier is provided in each ASP as an alternate in the event of an amplifier failure. It can be selected with the ASP amplifier switch.

3 5 7 8 9 Receiver switches select the systems to be monitored. Any combination of systems may be selected. Receiver switches also control the volume for the headset and speaker at the respective crew stations. Speaker and headset audio for each crew station come from a Remote Electronics Unit located in the E & E compartment. It is controlled by the Audio Selector Panels, and has separate independent circuits for each crew stations.

Audio warnings for altitude alert, the ground proximity warning system and windshear are also heard through the speakers and headsets at preset volumes. They cannot be controlled or turned off by the crew.

Speakers and Headsets

Each crew station has a headset or headphone jack. The Captain and First Officer have speakers on the ceiling above their seats. There is no speaker at the observer station.

③ Headset volume is only controlled by the receiver switches. Speaker volume is controlled by the receiver switches and also the speaker on / off volume control. Each speaker has an integral amplifier which only amplifies audio for that speaker.

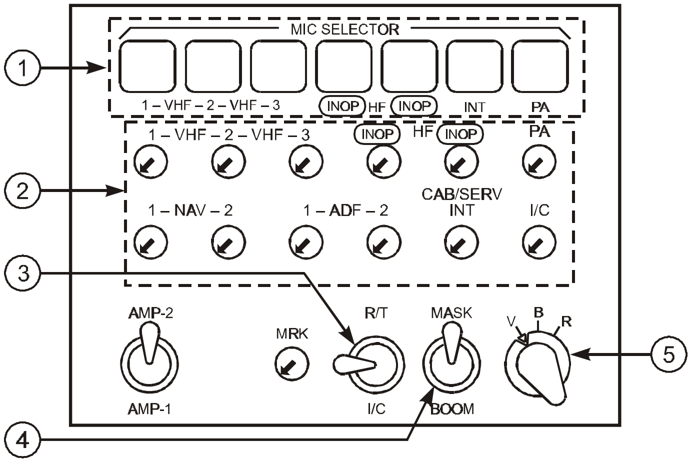
3 5 7 8 9 The speakers and headsets receive audio from the Remote Electronics Unit, as controlled by the respective Audio Selector Panels. Headset volume is controlled by the receiver switches and also the speaker switch.

Microphones

Hand microphones and boom microphones may be plugged into the respective jacks at the flight deck crew stations. Each oxygen mask also has an integral microphone.

Each hand microphone has a push-to-talk switch to key the selected audio system. The push-to-talk switches on the control wheel or ASP are used to key the oxygen mask or boom microphone, as selected by the MASK-BOOM switch. The MASK-BOOM switch does not affect the operation of the hand microphone.

③ Audio Selector Panel (ASP)



FLIGHT DECK CREW STATIONS

7376-5001

① Transmitter Selector (MIC SELECTOR) Switches

Illuminated (white) – Related switch is active.

Push –

- Selects related communication system for transmission
- Only one switch may be selected at a time; pushing a different switch deselects active switch
- Receiver also selected on regardless of whether related receiver switch is on.

② Receiver Switches

Illuminated (white) – Related switch is active.

Rotate – Adjusts volume.

Push –

- Receiver selected for related communication system or navigation receiver
- Multiple switches may be selected.

Push again – Deselects related system or receiver.

③ Push-To-Talk Switch (spring-loaded to neutral position)

R/T (Radio-Transmit) – Keys oxygen mask or boom microphone for transmissions as selected by transmitter selector.

I/C (Intercom) – Keys oxygen mask or boom microphone for direct transmission over flight interphone and bypasses transmitter selector.

④ MASK-BOOM Switch

MASK – Selects oxygen mask for transmissions.

BOOM – Selects boom microphone for transmissions.

⑤ Filter Switch

V (Voice) – Receive NAV and ADF voice audio.

B (Both) – Receive NAV and ADF voice and range audio.

R (Range) – Receive NAV and ADF station identifier range (code) audio.

3 5 7 8 9 Normal Audio System Mode

The Captain, First Officer, and Observer audio systems are located in a common Remote Electronics Unit in the E & E compartment. They function independently and have separate circuit breakers. The audio systems are normally controlled by the respective Audio Selector Panels through digital or computerized control circuits.

3 5 7 8 9 Degraded Audio System Mode

If electrical power is lost to an audio system, the ASP cannot control the Remote Electronics Unit and the audio system reverts to the degraded mode. Aircraft with an ALT/NORM switch can manually be placed in the degraded mode by placing the switch to ALT. In this mode, the Audio Selector Panel at that station is inoperative and the crewmember can only communicate on one radio.

The ASP transmitter selectors are not functional and any transmission from that station is on the radio shown on the chart below. The transmitter selector for the useable radio will illuminate when a station is in degraded mode. The receiver switches are not functional, and the only useable radio is heard at a preset volume, through the headset. The speaker and speaker switch are not functional at that station.

The mask and boom microphones can be used for transmission on the useable radio. The MASK-BOOM switch works normally in the degraded mode. The mask and boom microphones can be keyed with the control wheel push-to-talk switch MIC position or ASP push-to-talk switch R/T position. The hand microphone is not useable in the degraded mode.

The flight interphone and service interphone cannot be used on an audio system in degraded mode. The control wheel push-to-talk switch INT position and ASP push-to-talk switch I/C position are not functional since the flight interphone is not functional.

Audio warnings for altitude alert, the ground proximity warning system, and windshear are heard on an audio system in degraded mode.

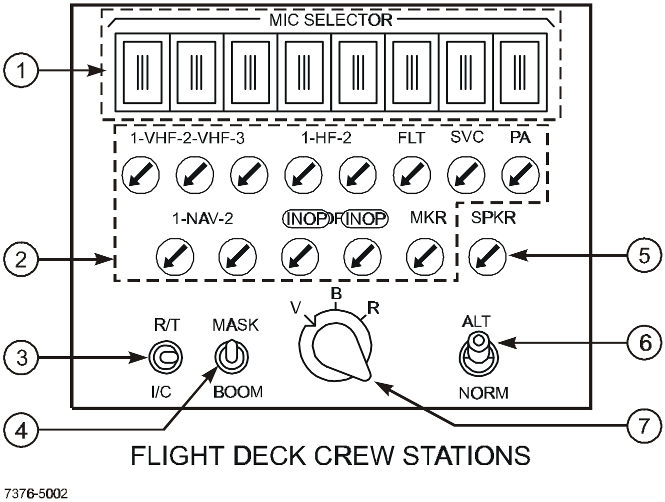
In the degraded mode, the passenger address system cannot be accessed through the Audio Selector Panel.

If an audio system is in degraded mode, the crewmember can still use the service interphone handset and PA microphone, if they are installed on the control stand.

DEGRADED AUDIO SYSTEM OPERATION

CREW STATION AUDIO SYSTEM IN DEGRADED MODE	RADIO AVAILABLE FOR TRANSMISSION AND RECEPTION AT DEGRADED STATION
CAPTAIN	VHF-1
FIRST OFFICER	VHF-2
OBSERVER	VHF-1

3 5 7 8 9 Audio Selector Panel (ASP)



① Transmitter Selector (MIC SELECTOR) Switches

Illuminated – Related switch is active.

Push –

- Selects related communication system for subsequent transmission
- Only one switch may be selected at a time; pushing a second switch deselects first switch
- Reception possible over selected system regardless of whether related receiver switch is on.

② Receiver Switches

Illuminated (white) – Related switch is active.

Rotate – Adjusts volume.

Push –

- Allows reception of related communication system or navigation receiver
- Multiple switches may be selected.

Push again – Deselects related system or receiver.

③ Push-To-Talk Switch (spring-loaded to neutral position)

R/T (Radio-Transmit) – Keys oxygen mask or boom microphone for transmission as selected by transmitter selector.

I/C (Intercom) – Keys oxygen mask or boom microphone for direct transmission over flight interphone and bypasses transmitter selector.

④ MASK-BOOM Switch

MASK – Selects oxygen mask microphone for transmissions.

BOOM – Selects boom microphone for transmissions.

⑤ Speaker (SPKR) Switch

Illuminated (white) – SPKR switch is active.

Push – Audio from selected receiver is heard on overhead speaker.

Rotate – Adjust overhead speaker volume.

Push again – Deselects audio from selected receiver to be heard on overhead speaker.

⑥ Alternate – Normal (ALT-NORM) Switch

NORM (Normal) – ASP operates normally.

ALT (Alternate – ASP operates in degraded mode.

⑦ Filter Switch

V (Voice) – Receive NAV and ADF voice audio.

B (Both) – Receive NAV and ADF voice and range audio.

R (Range) – Receive NAV and ADF station identifier range (code) audio.

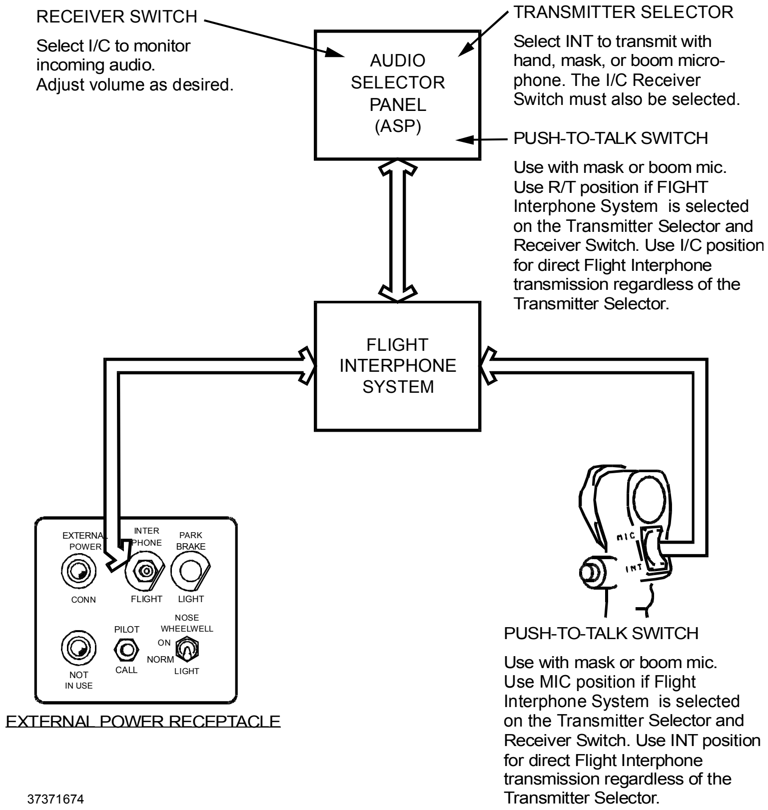
FLIGHT INTERPHONE SYSTEM

The flight interphone system is an independent communications network. Its primary purpose is to provide private communication between flight deck crewmembers without intrusion from the service interphone system. The ground crew may also use flight interphone through a jack at the external power receptacle.

The pilots can transmit directly over flight interphone by using the control wheel PTT switch. Alternately, any crewmember with an audio selector panel can transmit / receive over flight interphone by using their respective ASP and normal push-to-talk switches. Any standard microphone may be used with the flight interphone system.

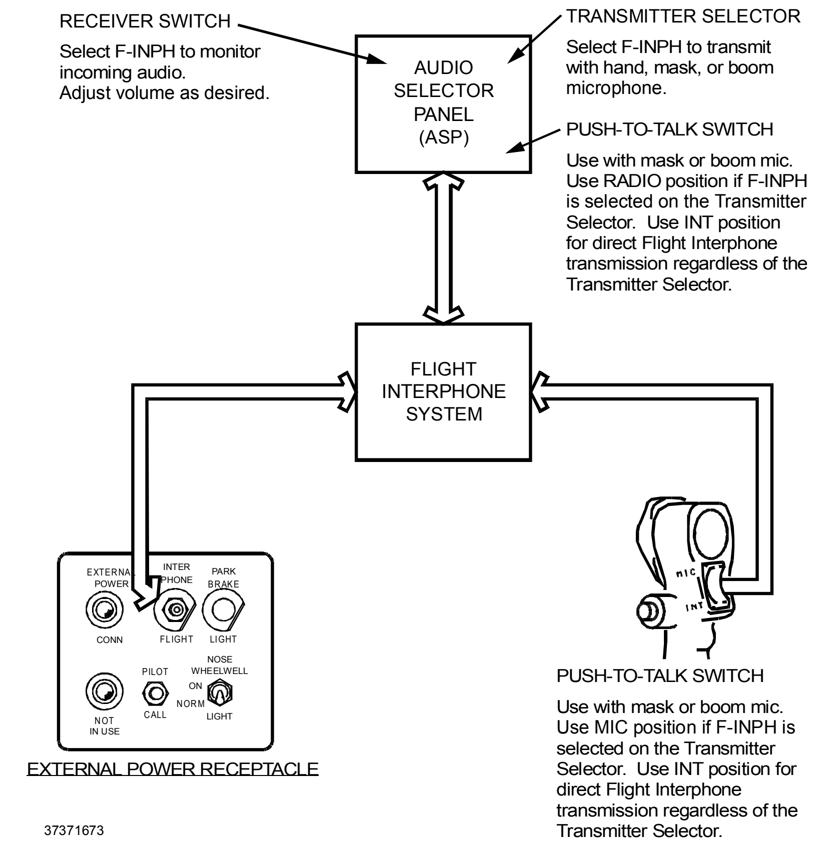
FLIGHT INTERPHONE SYSTEM

③



FLIGHT INTERPHONE SYSTEM

3 5 7 8 9

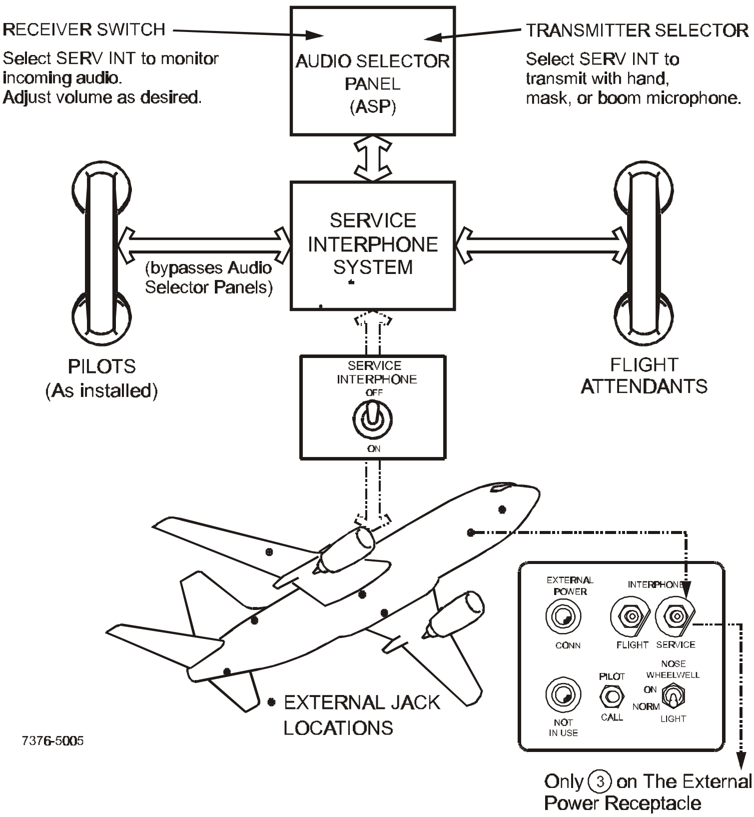


SERVICE (ATTENDANT) INTERPHONE SYSTEM

The service interphone system provides intercommunication between the flight deck, flight attendants, and ground personnel. Flight deck crewmembers communicate using either a separate handset (if installed) or their respective audio selector panel and any standard microphone.

The flight attendants communicate between flight attendant stations or with the flight deck using any of the attendant handsets. The system is a party line, in that anyone who picks up a handset / microphone is automatically connected to the system.

External jacks for use by maintenance or service personnel can be added to the system by use of the service interphone switch.



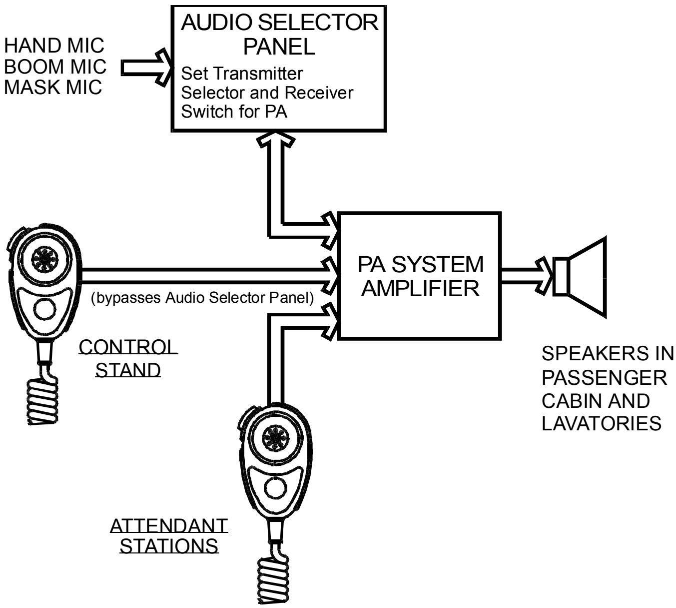
SERVICE (ATTENDANT) INTERPHONE SYSTEM

PASSENGER ADDRESS SYSTEM

The passenger address (PA) system allows flight deck crewmembers and flight attendants to make announcements throughout the passenger cabin. Announcements are audible through speakers located in the cabin and in the lavatories.

The flight deck crewmembers may make announcements using either a separate PA hand microphone or by using any standard microphone and the respective audio selector panel. Flight attendants make announcements using PA hand microphones located at their stations. The attendants use the PA system to play recorded music for passenger entertainment.

PA system use is prioritized. Flight deck announcements have first priority and override all other uses. Flight attendant announcement override the music system.



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Flight Interphone System

- Pilot to Pilot
- Pilot to Ground Personnel through FLIGHT jack on the External Power Receptacle.

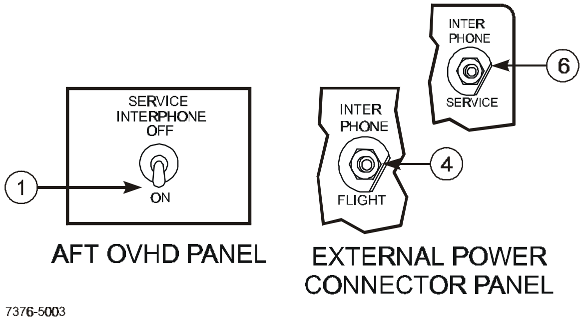
Service Interphone System

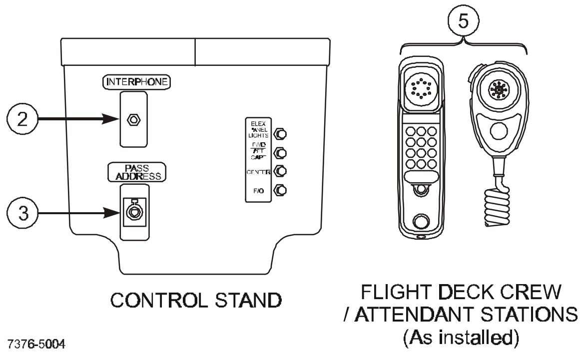
- Pilot to Attendant
- Attendant to Attendant
- Pilot and/or Attendant to Ground SERVICE jacks via Service Interphone Switch located on the aft overhead panel.

Passenger Address System

- Hand mic, Boom mic or Mask mic through the flight deck Audio Selector Panel
- Hand mic located on the Control Panel
- Hand mic – any Attendant station.

Interphone And Passenger Address Controls





① SERVICE INTERPHONE Switch

OFF –

- External jacks are deactivated
- Communication between flight deck and flight attendants is still possible.

ON – Adds external jacks to service interphone system.

② Service INTERPHONE Handset Jack

With microphone installed, used to communicate with flight attendant stations:

- With SERVICE INTERPHONE switch ON, also used to communicate with any external jack location
- Bypasses ACP.

③ Passenger Address (PASS ADDRESS) Hand Microphone Jack

With microphone installed:

- Used to make PA announcements
- Bypasses ACPs.

④ INTERPHONE FLIGHT Jack

Connects ground crew to flight interphone system.

⑤ Flight Deck / Attendant PA Hand Microphone

Used to make PA announcements.

⑥ SERVICE INTERPHONE Jack

- Connects the ground crew to the Service Interphone System if the SERVICE INTERPHONE Switch is ON.
- External jack around the aircraft.

CALL SYSTEM

The call system is used as a means for various crewmembers to gain the attention of other crewmembers and to indicate that interphone communication is desired. Attention is gained through the use of lights and aural signals (chimes or horn). The system can be activated from the flight deck, either flight attendant station, or from the external power receptacle. Passengers may also use the system to summon an attendant, through the use of individual call switches at each seat.

The flight deck may be called by either flight attendant station or by the ground crew. The ground crew may only be called by the flight deck. Flight attendants may be called by the flight deck, the other attendant station, or by any passenger seat or lavatory. Master call lights in the passenger cabin identify the source of incoming calls to the attendants.

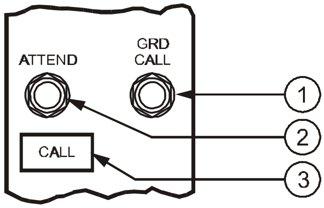
Call system chime signals are audible in the passenger cabin through the PA system speakers. The PA speakers also provide an alerting chime signal whenever the **NO SMOKING** or **FASTEN SEAT BELT** signs illuminate or extinguish.

LOCATION OF CALL ORIGINATOR	CALLED POSITION	VISUAL SIGNAL AT CALLED POSITION	AURAL SIGNAL AT CALLED POSITION
Flight Deck	Attendants	Pink Master Call Lights	Two-Tone Chime
Flight Deck	Ground Crew		Horn In Nose Wheel Well
Attendant	Flight Deck	Blue Flight Deck Call Light	Single High-Tone Chime
Attendant	Attendants	Pink Master Call Lights	Two-Tone Chime
External Power Receptacle	Flight Deck	Blue Flight Deck Call Light	Single High-Tone Chime
Passenger	Attendants	Blue Master Call Light	Single High-Tone Chime
Lavatory	Attendants	Amber Master Call Light	Single High-Tone Chime
Flight Deck	Passenger Cabin	No Smoking or Fasten Belt Signs Illuminated/Extinguish	Single Low-Tone Chime

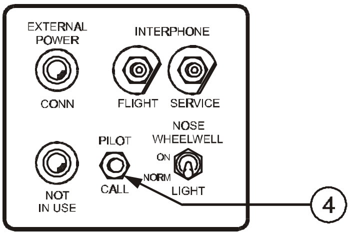
CALL SYSTEM

CONTROLS AND INDICATORS

CALL SYSTEM



FWD OVHD PANEL



EXTERNAL POWER RECEPTACLE

7376-5006

① Ground (GRD) CALL Switch

PRESS – A horn sounds in the nose wheel well until released.

② Attendant (ATTEND) Call Switch

PRESS – A two-tone chime sounds in the passenger cabin and both pink Master Call Lights illuminate.

③ Flight Deck **CALL** Light (blue)

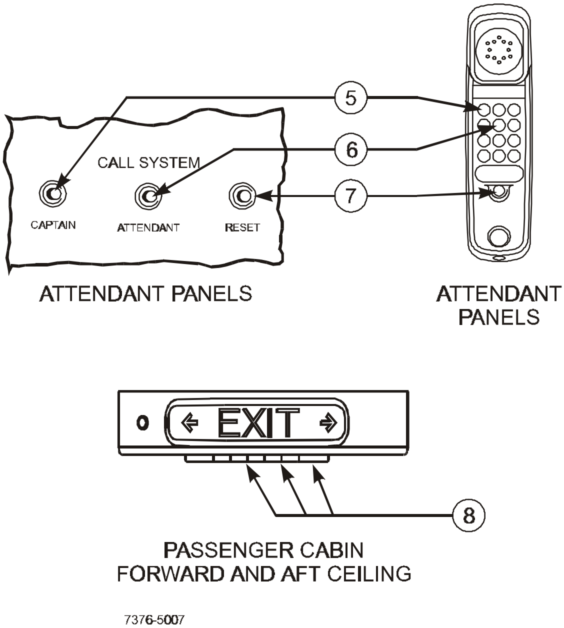
ILLUMINATED – Flight deck is being called by the flight attendants or the ground crew.

- Remains illuminated until the Captain Call or Pilot Call Switch is released.

④ PILOT CALL Switch

PRESS – A single-tone chime sounds on the flight deck.

- Flight deck **CALL** Light remains illuminated until released.



⑤ CAPTAIN Call Switch

PRESS – A single-tone chime sounds on the flight deck.

- Flight deck **CALL** Light remains illuminated until released.

⑥ ATTENDANT Call Switch

PRESS – A two-tone chime sounds in the passenger cabin and both pink Master Call Lights illuminate.

⑦ Call RESET Switch

Push –

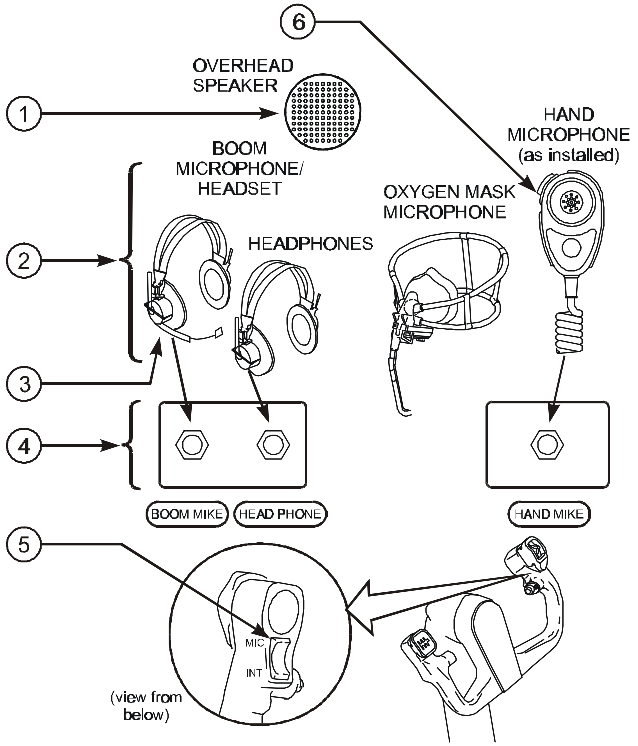
- Extinguishes both pink Master Call Lights.
- Cancels Call.
- Disconnects the handset from the Public Address System.

⑧ Master Call Light

ILLUMINATED –

AMBER – A lavatory call switch is activated.
PINK – The flight deck or other flight attendant station is calling.
BLUE – A passenger seat call switch is activated.

MISCELLANEOUS COMMUNICATION CONTROLS (TYPICAL)



FLIGHT DECK CREW STATIONS

7376-5008

① Overhead Speaker

Monitors audio from related pilot's ASP.

② Headset or Headphones

Monitors audio from related ASP.

③ Standard Microphones

Choose desired microphone for voice transmission through selected radio, interphone system, or passenger address (PA).

④ Communication Jacks

Used for appropriate microphone or headphone plugs.

⑤ Push-To-Talk Switch

MIC (microphone) –

- Selects oxygen mask or boom microphone for transmission, as selected by ASP transmitter selector.
- Same as using ASP PTT switch (R/T position).

OFF – Center position.

INT (interphone) –

- Selects oxygen mask or boom microphone for direct transmission over flight interphone.
- Bypasses ASP transmitter selector.
- Same as using ASP PTT switch (I/C position)

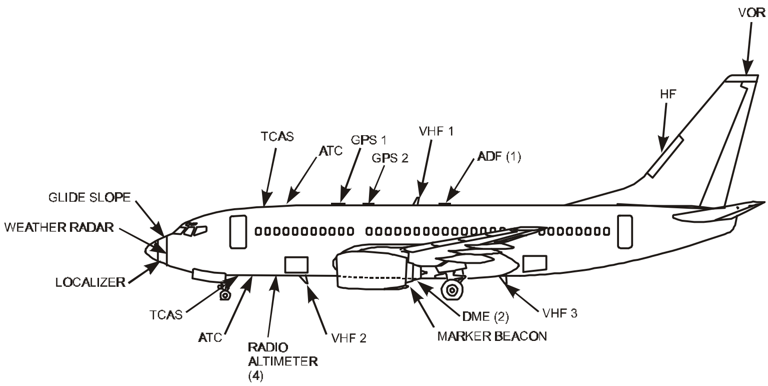
⑥ Push-To-Talk Switch

Push – Keys hand microphone for transmission, as selected by ASP transmitter selector.

VHF COMMUNICATIONS

Primary short-range voice communications is provided in the VHF range by three independent radios. Each radio provides for selection of an active frequency and an inactive (preselected) frequency. Voice transmission and reception are controlled at the related ASP.

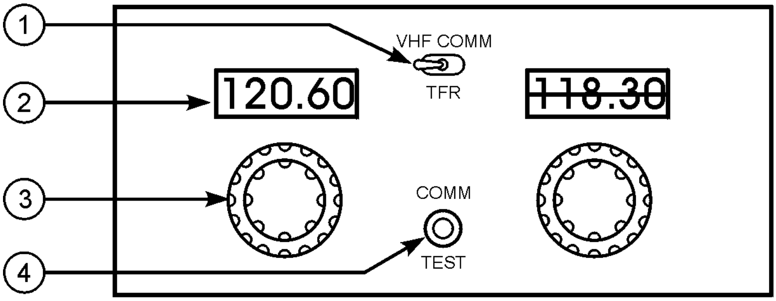
Note: VHF antennae located on the lower fuselage are susceptible to multipath interference from nearby structures or vehicles. This may disrupt VHF communications. VHF antennae located on the upper fuselage are not as susceptible to this interference and is recommended for use on the ground.



737 GENERAL - ANTENNA LOCATIONS (Typical)

7376-5009

③ VHF Communication Panel



AFT ELECTRONIC PANEL

7376-5010

① VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

② Frequency Indicator

Indicates selected frequency.

- A shutter covers inactive frequency.

③ Frequency Selector

Rotate – Selects frequency in related indicator:

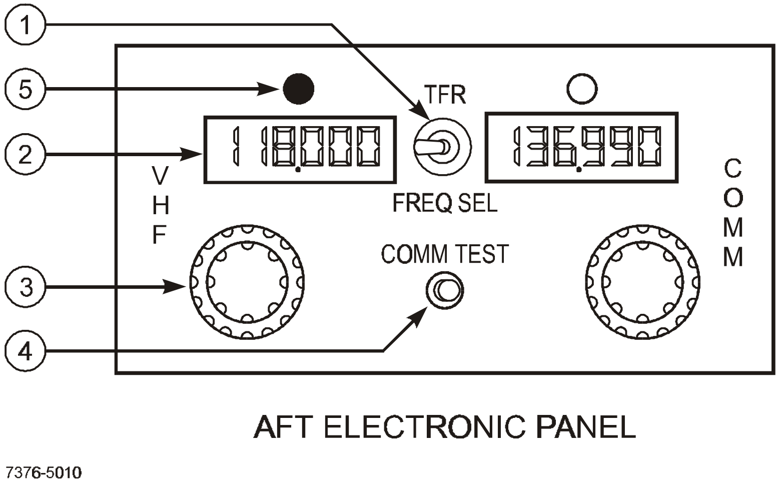
- Outer selector changes three left digits.
- Inner selector changes two right digits.

④ Communication (COMM) TEST Switch

Push –

- Removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation.
- Improves reception of weak signals.

3 5 VHF Communication Panel



① VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

② Frequency Indicator

Indicates selected frequency.

③ Frequency Selector

Rotate – Selects frequency in related indicator:

- Outer selector changes three left digits.
- Inner selector changes two right digits.

④ Communication (COMM) TEST Switch

Push –

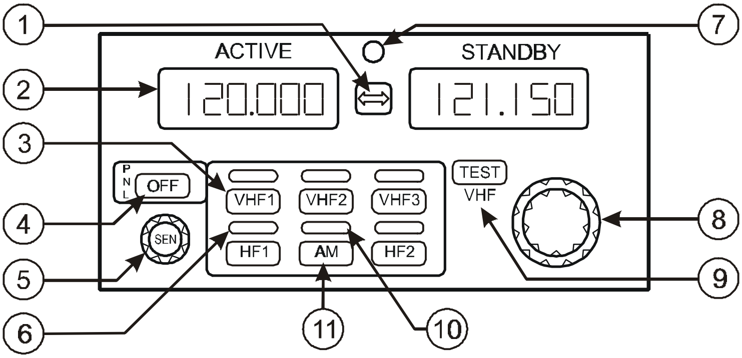
- Removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation.
- Improves reception of weak signals.

⑤ Active Frequency Light

Illuminated (white) – Indicates related frequency is selected.

7 8 9 The VHF / HF RTP-1 is located on the forward left side of the aft electronic panel, VHF / HF RTP-2 is on the forward right side and VHF / HF RTP-3 is on the aft portion of the panel. The VHF-2 and VHF-3 antennae are located on the lower fuselage, VHF-1 is on the upper fuselage.

RADIO TUNING PANEL



AFT ELECTRONIC PANEL

7376-5012

① Frequency Transfer Switch

Push –

- Transfers the STANDBY window frequency to the ACTIVE window and tunes the selected radio to the new active frequency.
- Transfers the ACTIVE window frequency to the STANDBY window.

② Frequency Indicator

ACTIVE – Displays the tuned frequency of the selected radio.

STANDBY – Displays the pre-selected or previously tuned frequency of the selected radio.

③ Radio Tuning Switch

Push –

- Selects the VHF or HF radio to be tuned.
- The tuned frequency is displayed in the ACTIVE frequency indicator.
- The standby frequency is displayed in the STANDBY frequency indicator.

④ Radio Tuning Panel Off (OFF) Switch

Push –

- Disconnects the panel from the communication radios.
- Switch illuminates (white).

⑤ HF Sensitivity Control

Rotate – Adjusts the sensitivity of the on-side HF receiver.

⑥ Radio Tuning Light

Illuminated (white) – Indicates the selected radio.

⑦ Offside Tuning Light

Illuminated (white) –

- The radio normally associated with this panel is being tuned by another radio tuning panel, or
- The radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel.

⑧ Frequency Selector

Rotate – Selects frequency in the STANDBY frequency indicator:

- First digit is always 1.
- Outer selector changes second and third digits in 1 MHz increments.
- Inner selector changes fourth, fifth, and sixth digits in 25 KHz increments.

⑨ Communication (VHF) Test (TEST) Switch

Push –

- Removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation.
- Improves reception of weak signals.

⑩ **AM** Light

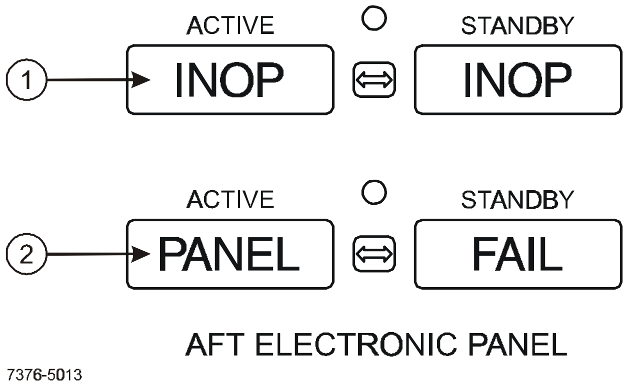
Illuminated (white) – HF AM is selected.

Extinguished – HF USB is selected.

⑪ AM Switch

Push – Sets the AM (amplitude modulation) or USB (upper side band) mode for the selected HF.

Radio Tuning Panel Fail Modes



① **INOP** Indication

The selected radio is not available.

② **PANEL FAIL**

The radio tuning panel has failed.

Note: The selected frequencies may continue to be displayed in the frequency indicator when the radio is not available.

7 8 9 HF COMMUNICATIONS

General

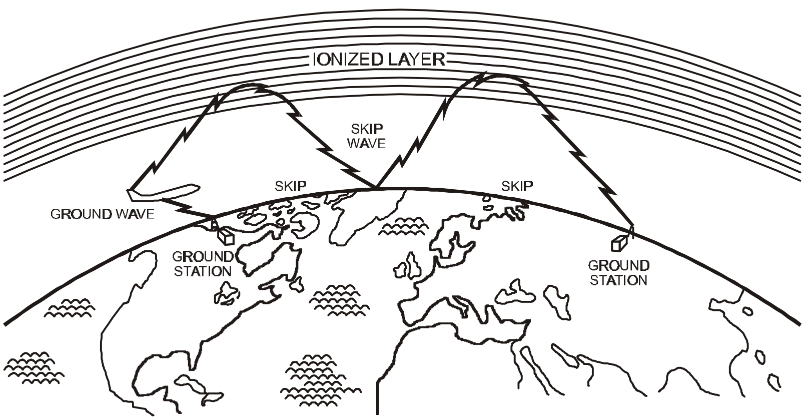
The high frequency (HF) communication system supplies voice communication over long distances. It provides communication between aircraft or between ground stations and aircraft.

The HF system operates in the aeronautical frequency range of 2 MHz to 29.999 MHz. The system uses the surface of the earth and an ionized layer to cause a reflection (skip) of the communication signal. The distance between skips is dependent on the time of day, radio frequency, and aircraft altitude.

There are two independent HF communication radios, designated HF 1 and HF 2. Each HF radio can be tuned by any radio tuning panel. HF radio sensitivity can only be set on the on-side radio tuning panel.

The audio control panels are used to control voice transmission and receiver monitoring. When an HF transmitter is keyed after a frequency change, the antenna tunes. While the antenna is being tuned, a steady or intermittent tone may be heard through the audio system (tuning takes a maximum of 15 seconds). The antenna is located in the vertical stabilizer.

Both HF radios use a common antenna. When either HF radio is transmitting, the antenna is disconnected from the other HF radio, and it cannot be used to transmit or receive. However, both HF radios can receive simultaneously if neither is being used for transmitting.



7376-5014

HF COMMUNICATION SYSTEM – GENERAL DESCRIPTION

General

The HF communication system has two HF systems. Each system has these components:

- Radio communication panel
- HF transceiver
- HF antenna coupler
- Common or shared HF antenna.

Description

The HF communication system interfaces with these components:

- Audio control panel (ACP)
- Remote electronics unit (REU)
- SELCAL decoder
- Flight data acquisition unit.

The REU receives HF radio selection and volume control from the ACP.

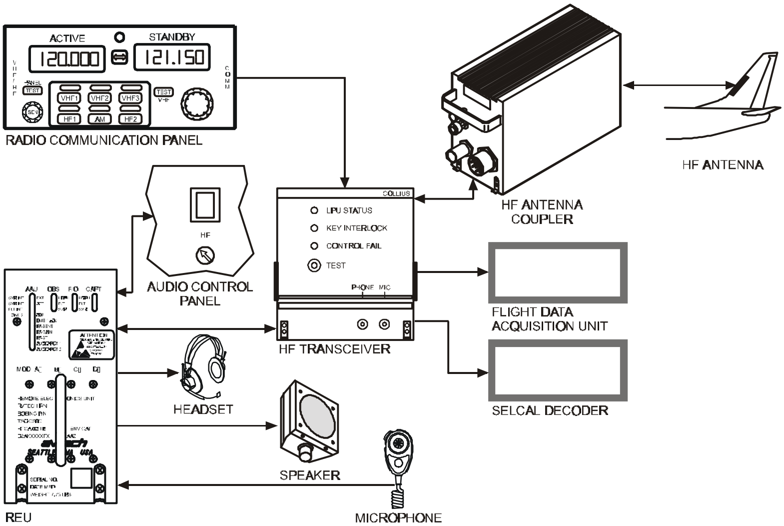
The HF transceiver receives microphone (mic) audio from the REU. Receiver audio goes from the HF transceiver, through the REU, to the flight interphone speakers and headsets.

The HF transceiver supplies the received audio to the SELCAL decoder. The SELCAL decoder monitors the audio for SELCAL calls that come from the airline ground operations.

The HF transceiver supplies a key event to the flight data acquisition unit for key event marking.

Electrical Power

The 115v AC transfer (XPR) bus supplies power to the HF transceiver.



HF COMMUNICATION SYSTEM - GENERAL DESCRIPTION

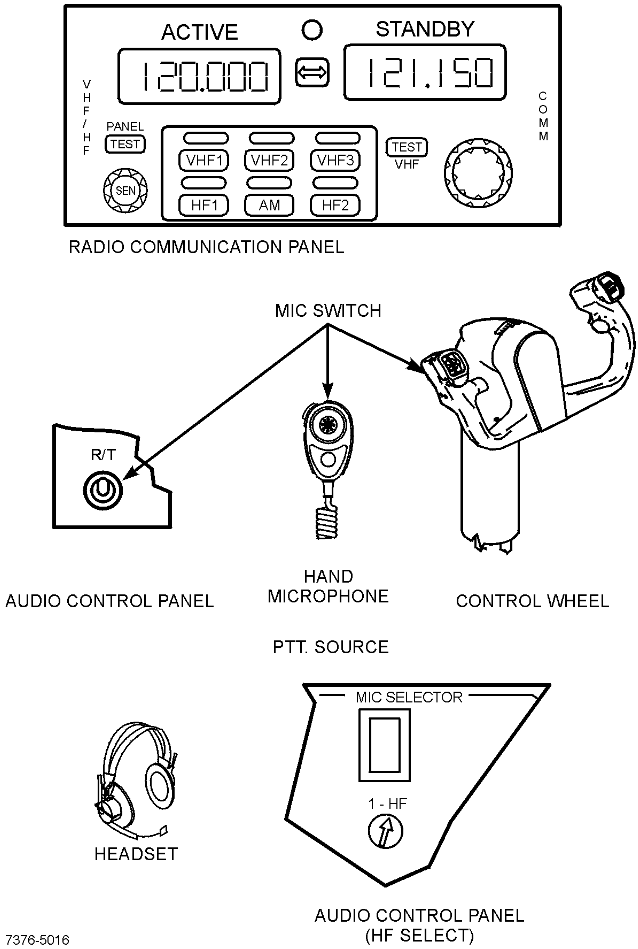
7376-5015

HF COMMUNICATION SYSTEM – OPERATION

General

These components are used to operate the HF radio:

- Hand microphone or headset
- Radio communication panel
- Audio control panel.



Receive Operation

The radio communication panel and the audio control panel are used to receive transmissions on the HF radio.

On the audio control panel, push the receiver volume control for the HF radio. Turn the control to adjust the volume from the HF radio.

Use the ON / OFF control to turn on the radio communication panel. When first turned on, the radio communication panel tunes the VHF radio. Push the HF 1 switch to make the radio communication panel tune the HF radio. A light above the switch comes on to show which radio the panel controls. The HF radio uses the frequency in the active frequency display.

Use the HF sensitivity (HF SENS) control on the radio communication panel to adjust the sensitivity of the HF radio receiver.

Verify amplitude modulation (AM) is not selected.

Transmit Operation

WARNING: Make sure personnel stay a minimum of six feet away from the vertical stabilizer when the HF system transmits. RF energy from the HF communication antenna can cause injuries to personnel.

WARNING: Do not operate the HF communication system while fueling the aircraft. Injury to persons and damage to equipment can occur.

Make sure the active frequency display shows a valid transmit frequency.

Listen for transmissions on the selected frequency. When the frequency is clear, push and release the push-to-talk for the microphone prior to communication. This causes the HF coupler to tune to the transmission frequency. While the coupler tunes, the HF transceiver supplies a 1 kHz tone.

Normally, it takes several seconds for the coupler to tune. When the 1 kHz tone stops, the HF system is ready to transmit.

Transmit the message when frequency is clear. A 1Mz side tone will be heard in the headphone along with a muted side tone in the speaker, if selected. The flight interphone system mutes the side tone to the speaker system when the boom microphone or hand microphone is used. Transmitting or receiving can continue on the selected frequency.

When you select another frequency, and key the microphone, the HF coupler tunes, and the 1Mz tone sounds again.

Non-Normal Indications

If the 1Mz tone continues for more than 15 seconds, when the coupler tunes, there may be a coupler fault.

If the tone lasts only as long as the keyed microphone, the tuned frequency is outside the frequency range for the HF transceiver.

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HF DATA LINK (HFDL)

A High Frequency Data Link (HFDL) radio has been installed on some aircraft. The HFDL will provide these aircraft with additional data link capabilities outside the range of the VHF radios. On these aircraft, there will be an additional switch behind the No. 3 Radio Tuning Panel (RTP). This switch is labeled, GROUND TRANSMIT INHIBIT OVERRIDE.

HFDL OPERATIONS

HFDL is enabled when one or both HF radios are in the DATA mode. The HF data radio is in the DATA mode when **DATA** is displayed in the RTP Active Frequency window. No further crew action is required; the ACARS will automatically select when to use HFDL.

GROUND TRANSMIT INHIBIT OVERRIDE

HFDL transmissions are inhibited during ground operations even if the RTP displays **DATA** in the ACTIVE Frequency Window. The aircraft weight-on-wheels (air / ground switch) inhibits HFDL transmissions during ground operations to ensure the safety of ground personnel and the aircraft. There is an additional switch behind the No. 3 RTP labeled, GROUND TRANSMIT INHIBIT OVERRIDE. Placing this switch in the OVERRIDE position will enable HFDL on the ground. In normal operations HFDL is used when airborne. All HF operations are inhibited when the fueling panel door is open.

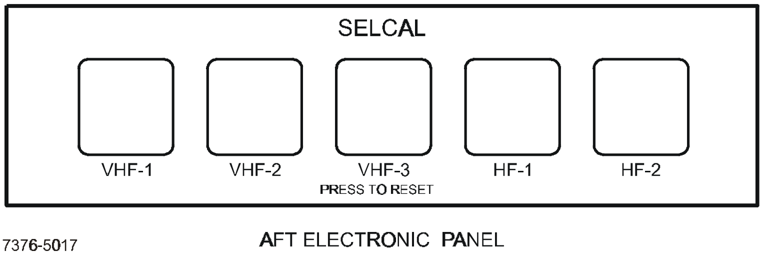
SELECTIVE CALLING (SELCAL)

A ground station desiring communications with the flight deck can use the SELCAL system. SELCAL monitors selected frequencies on VHF and HF radios. Each aircraft is assigned a unique four-letter SELCAL code.

③ 3 5 When the system receives an incoming call from a ground station, a two-tone chime sounds through the ACARS system.

7 8 9 When the system receives an incoming call from a ground station, a two-tone chime sounds and the respective SELCAL light illuminates.

7 8 9 SELCAL Panel



① **SELCAL** Light

Illuminated (white) – Alerts crew to incoming communication on indicated radio.

Push – Extinguishes and resets **SELCAL** light.

③ ACARS

General

The ARINC communications addressing and reporting system (ACARS) is an addressable, digital, data-link system which permits communication between the aircraft and a ground station. The aircraft installed units of the system provide a means of automatically reporting routine flight information to the ground station, such as the "out / off / on / in" times, as well as pertinent engine and aircraft performance values.

In addition to automatic transmission of data, the system provides for manual routing of messages to and from the aircraft and the ground station, and also provides the capability of opening a channel for voice communications.

The airborne subsystem consists of a control unit (CU) and a management unit (MU). These units are the heart of the subsystem and operate in conjunction with VHF No. 3 to process messages to and from the aircraft.

When a message is sent to the aircraft, a call chime sounds on the flight deck. The chime will not stop until the crew selects VOX mode.

Automatic Functions

The MU receives ground-to-air messages from VHF No. 3, controls the transmission of air-to-ground messages through the same transceiver, and performs the following functions:

- Monitors the aircraft "out," "off," "on," and "in" event sensors. Stores the GMT time as each event occurs, and automatically outputs this data to VHF No. 3 for transmission to the ground station.
- Accepts messages and commands from the ground station, which are addressed to the particular aircraft which the unit is installed.
- Accepts messages and commands from the CU for air-to-ground transmission.
- Controls the ACARS mode of operation.
- Controls the sequential transmission of priority messages.
- Performs error check or messages sent, and alerts the crew if the message is received incorrectly by the ground station.

The “out / off / on / in” reports are generated for automatic transmission by the following sensors:

Out - Parking brake released, all entry / service / cargo doors closed, either engine normal oil pressure.

Off - Landing gear strut extension.

On - Landing gear strut compression.

In - Parking brake set, any entry / service / cargo door open, both engines low oil pressure.

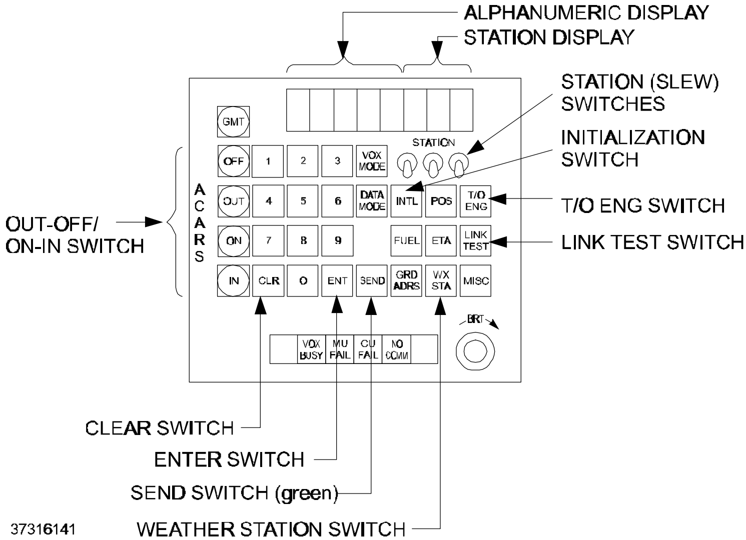
The time of each event is recorded from the GMT clock and the report is transmitted immediately after the event occurs (when in data mode.)

Manual Functions

The CU provides the means for manual operation of the ACARS and also provides for a visual observation of the system mode of operation and status. Functions performed using the CU are as follows:

- Call-up and display of GMT.
- Select and enter various data messages into the MU.
- Call-up and display “out / off / on / in” event times during flight.
- Manually select system mode of operation.
- Monitor system status.

ACARS Control Unit



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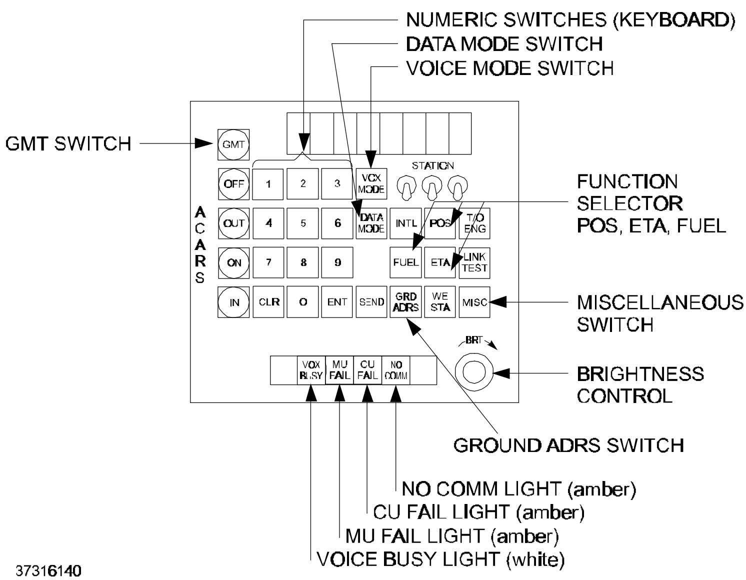

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ALPHANUMERIC DISPLAY

- Display data selected from the keyboard.
- This display is often referred to as the "scratch pad" since it is used to check inputs before entering and sending.

STATION DISPLAY

- Displays the departure or destination station as selected by the appropriate switches.
- Destination station automatically changes to the departure station eight minutes after the IN event occurs.

STATION (SLEW) SWITCHES

- Used to set in the departure or destination station in the Station Display.
- UP/DOWN (momentarily - less than .5 second) - Characters in the Station Display rotate once per actuation.
- UP/DOWN (hold) - Characters rotate at a rate of 5 characters per second.

INITIALIZATION SWITCH

- Activates the data entry sub-routine and automatically sequences the standard data required.
- Allows for entry of departure information such as flight number, station of destination and fuel on board.

T/O ENG SWITCH

- Allows computerized systems to analyze engine performance information.
- Provides a means to supply reduced take-off thrust and engine data to a ground station through the data link system.

LINK TEST SWITCH

- PRESS (momentarily) - Initiates a system self test which generates an aircraft to ground station test message and a ground station to aircraft test message which includes a GMT clock update if aircraft is at the gate, i.e., between IN and OUT times.
- All Alphanumeric and station display lights, Function Selector Keyboard and annunciator lights illuminate.
- A SELCAL chime sounds and the **SELCAL #2** light illuminates.

WEATHER STATION SWITCH

- Allows the current sequenced weather at the destination station (or the station of choice) to be received and printed on the flight deck printer (when installed).

SEND SWITCH (Green)

- Used to send crew-initiated messages.
- ILLUMINATED - Indicates transmission of automatically sent messages or that data mode is selected (to advise the ground station that the aircraft is signing in). Illuminates for at least 2 seconds.
- EXTINGUISHED - Indicates acknowledgment from the ground station.

ENTER SWITCH

- Transfers data into the MU that was manually entered via the Keyboard.

CLEAR SWITCH

- Clears the displayed data if not yet entered, and clears the system if an error was made during entry.

OUT - OFF - ON - IN SWITCHES

- PRESS (hold) - Displays the GMT when the selected event last occurred.
- RELEASE - Display returns to blank or previous status.

GMT SWITCH

- PRESS - Present GMT is displayed.
- RELEASE - Clears the GMT display.

NUMERIC SWITCHES (KEYBOARD)

Used to insert numeric data for:
- Flight Number
- Fuel
- ETA
- Engine Data
- Other functions related to the GND ADRS and MISC switches.

DATA MODE SWITCH (Blue)

- PRESS - Switch illuminates to verify selection of data mode.
- ACARS transmits data automatically over VHF No. 3 on the discrete frequency of 131.55 MHz.

VOICE MODE SWITCH (Blue)

- Used to transfer from data mode to voice mode. If while in data mode a SELCAL two-tone alert chime is received, the **VOX MODE** light flashes for 5 seconds, then illuminates steady. This alerts the crew that the system has automatically switched to voice mode communication with the ground. Approximately 2 minutes after voice mode is activated, the **DATA MODE** light starts flashing as an alert to switch back to data mode. If it is desired to remain in the voice mode, press the VOX MODE switch to extinguish the **DATA MODE** light. If data mode is desired, press the DATA MODE switch. The **DATA MODE** light changes from flashing to steady, indicating that the system has switched back to the data mode, and the **VOX MODE** light will extinguish. Voice mode may also be manually selected in conjunction with the MISC switch. Either the **VOX MODE** or **DATA MODE** light is illuminated at all times.

FUNCTION SELECTOR POS, ETA, FUEL

- Used with the keyboard to enter appropriate data into the MU for transmission.

MISCELLANEOUS SWITCH

- Used with the keyboard to select coded messages or to select a voice mode frequency.

GROUND ADRS SWITCH

- Used with the keyboard to enter a telephone number or code which is transmitted to the ground station for a direct phone patch to the aircraft.
- BRIGHTNESS CONTROL (Dual control).
- ROTATE - Sets brightness of background lighting and display intensity.

NO COMM LIGHT (Amber)

- ILLUMINATED - A message has been transmitted either automatically or manually, and receipt was not acknowledged by the ground station.

CU FAIL LIGHT (Amber)

- ILLUMINATED - The system has detected a failure in the control unit.

MU FAIL LIGHT (Amber)

- ILLUMINATED - The system has detected a failure in the management unit.

VOICE BUSY LIGHT (White)

- ILLUMINATED - A GND ADRS has been initiated by the crew and the ground station is in use (busy).

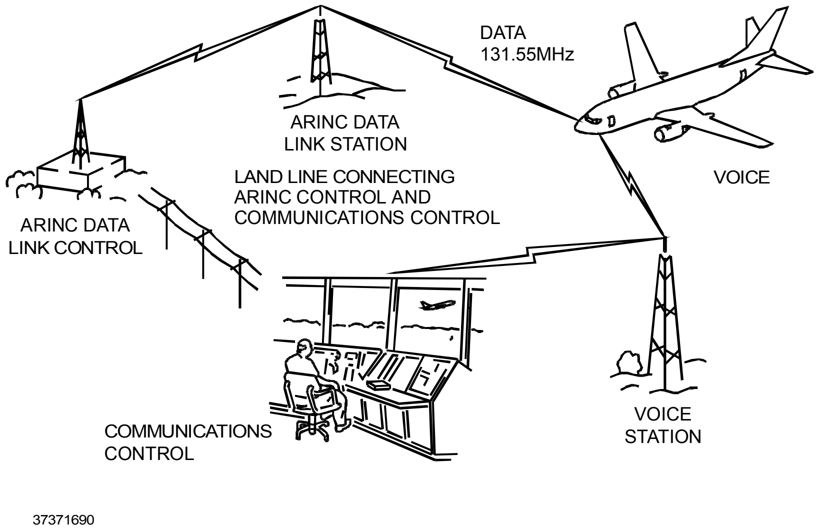
ARINC COMMUNICATIONS ADDRESSING AND REPORTING SYSTEM

3 5 ACARS System

The ARINC Communications Addressing and Reporting System (ACARS) is an addressable, digital, data link system which permits exchange of data and messages between the aircraft and a ground-based operations center utilizing the on-board VHF-3 communication system.

The ACARS airborne subsystem provides for the manual entry of routine data such as departure / arrival information. Also possible is the manual entry of addresses (telephone codes) of parties on the ground for voice communication.

The airborne system consists of a Management Unit (MU) in the E & E compartment and an Interactive Display Unit (IDU.) Data is entered and automatically transmitted to the ground operations center. The system also provides monitoring of the aircraft Out / Off / On / In (OOOI) sensors. These OOOI times are automatically transmitted to the ground station at times specified by the built-in program.



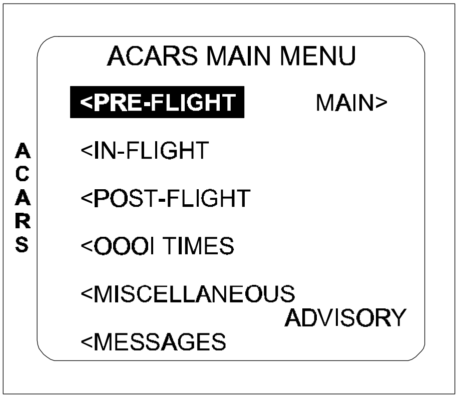
ACARS SYSTEM

When the IDU is initially powered up (AC busses powered) it establishes contact with the ACARS and the Digital Flight Data Acquisition Unit (DFDAU). The IDU screen then displays the MAIN MENU. This is the root page for accessing all other ACARS pages. Return to this MAIN MENU is possible by touching the MENU cue on any displayed page.

When a cue is touched on the IDU screen, the cue name is highlighted in reverse video. Moving the finger to another cue without breaking screen contact returns the cue first touched to normal video and highlights the new cue being touched. Releasing the highlighted cue activates the cue's function.

The following cues are special in that they always perform the same functions: MENU, RTN, ENT, CLR, SEND RE-DO and VOX. Other cues are advisory cues. Advisory cues appear in place of **** on the standard ACARS menu. Some advisory cues flash from normal to reverse video: FAIL, DATA, SELC, *MSG*, and INIT. Other advisories are displayed in normal video: SEND, NOCOM, VOICE; and in reverse video: FAIL.

ACARS Operation



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Introduction

ACARS (Aircraft Communications Addressing and Reporting System) is a digital air-to-ground data communications link between the aircraft and the Continental host computer.

The IDU (Interactive Display Unit) is located on the pedestal and used by the pilot for input to the ACARS or DFDMU. It uses an infrared LED matrix to detect touches on the screen. There are no hard keys on the IDU, rather menus and keyboards are drawn on the display. Empty data fields shall be dashed. Data required for operation but not provided will be indicated by slashes.

The Management Unit (MU) gathers and stores data from the aircraft, receives uplink data messages and controls the downlink of data messages through the VHF transceiver.

DFDMU (Digital Flight Data Management Unit) is used to monitor over 700 parameters and streams this information to the Flight Data Recorder. Some event initiated maintenance reports are automatically transmitted, including engine reports.

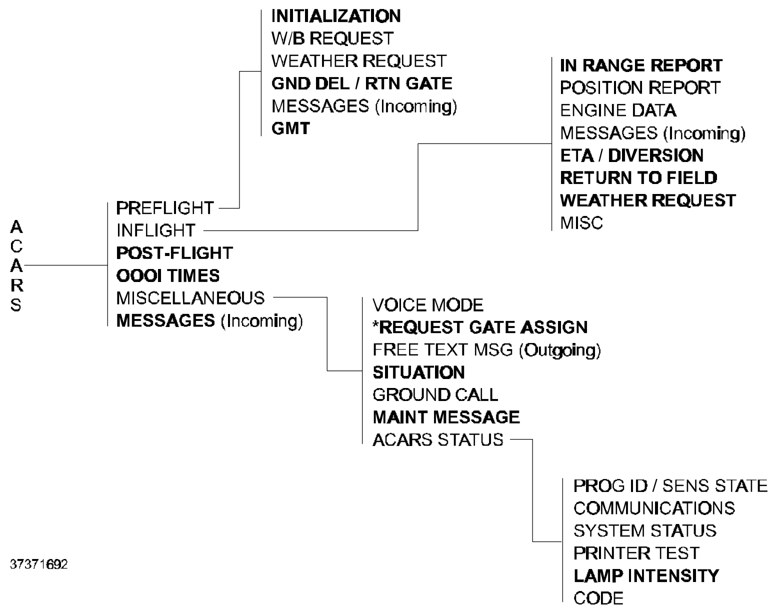
When the ACARS system is selected and the VHF transceiver is in the DATA mode, the pilot can display, printout and downlink DATA mode messages.

Each downlink data message, whether pilot initiated on the IDU or MU initiated, requires a ground radio station to acknowledge the message. If an acknowledgment is not received, the MU re-transmits the message several times. If the message is still not acknowledged, the pilot is informed there has been no response to the message. High priority messages will be held in memory.

Each uplink message, initiated by the Continental ground computer, requires the MU on the aircraft to acknowledge the message. The pilot is notified by the display of the MSG> advisory.

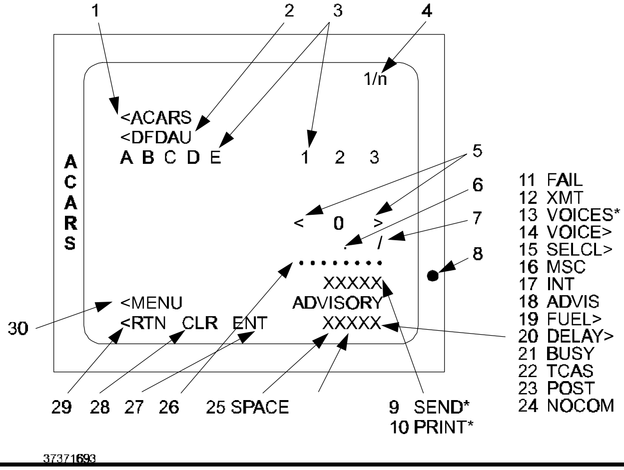
Because the VHF frequency employed in the air-ground link is not universal, as the aircraft flies from one jurisdiction to another, the ACARS frequency can change.

VOICE mode can be selected on the IDU by the pilot or by a ground station VOICE mode command message. When in VOICE mode, the transceiver is tuned by the MU to a frequency entered on the IDU or by the flight deck control head. DATA mode can only be re-selected on the IDU by the pilot.



ACARS ROAD MAP

Controls And Indicators

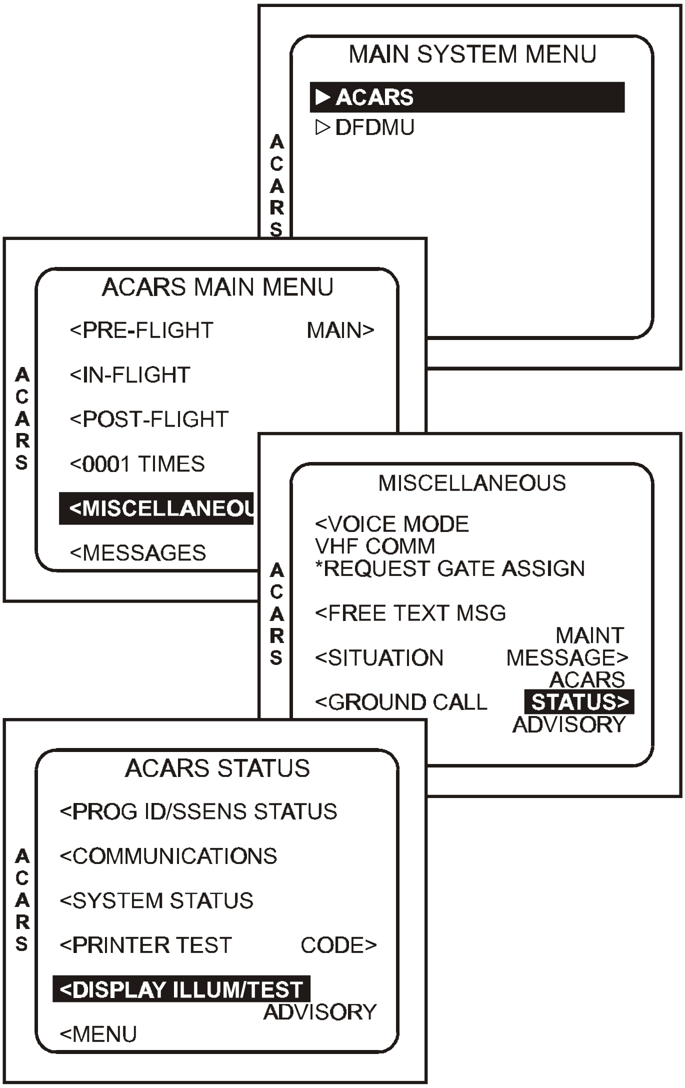


Index No.	Control or Indicator	Description	Function
1		Display/touch switch panel	*Display:* Indicates selections of functions using lines of text, prompts, graphic symbols and/or reverse video for display and touch switch panel operation. Also indicates cursor underlined fields for data entry. Displays dynamic data using lower case letters as follows: *h* is hours *m* is minutes *s* following mm is seconds *s* preceding n is sign + or - *n* is any numeric character *a* is any alphabetic character *x* is any ASCII character (some restrictions) *Touch Switch Panel*: When finger touched and released at highlighted function, activates that function.
2	**<ACARS <DFDAU**	Touch switch	When touched, selects ACARS or DFDAU menu for display.
3	**ABCDE 123**	Touch keypad	When touched, a character is entered above the underlined cursor and the underlined cursor moves to the next space for character entry.
4	**1/n**	Touch switch	When touched, indexes the display to the next page of a multi-page display. If the last page is on display, returns to the first page.
5	**< >**	Touch switches	When left or right arrow is touched, moves the underlined cursor to the left or right, respectively.
6	**.**	Touch switch	When touched, enters a period or decimal point.

Index No.	Control or Indicator	Description	Function
7	**/**	Touch switch	If touched when the cursor is in a multiple parameter data field containing a slash, moves the cursor to the right of the slash in the data field.
8		Cabin brightness sensor	Senses the brightness of light in the cabin for IDU automatic adjustment of display light intensity.
9	**SEND***	Touch switch	When touched, **SEND*** prepares and sends a downlink transmission of the indicated message and returns to the menu from which the display was called.
10	**PRINT***	Touch switch	When touched, **PRINT*** sends the displayed message or report to the printer and leaves the display was called.
11-24	**XXXXXX**	Touch switches	Advisories. Refer to the Advisory Messages.
25	**SPACE**	Touch switch	When touched while entering a free text message, moves the cursor one space.
26	*******	Indicator	After a downlink transmission has been sent, using the SEND* touch switch, the status of the displayed message is indicated in the line. The status indications for the displayed message are: **QUEUED** - The message on this page is in queue to be sent. **SENDING** - The message on this page has been transmitted. **ACKD** - The message on this page has been received. If no message has been sent from this display since the last time it was called up, the status indications are as follows: **VHF COMM** - If VHF DATA is selected and the VHF link is available, otherwise SAT COMM - if **SAT COMM** is selected and is available, otherwise **VOX MODE** - if in voice mode, otherwise **NO COMM** - if no VHF data link is available.
27	**ENT**	Touch switch	When touched, **ENT** enters the contents above an underlined cursor into storage and moves the cursor to the next field. When the cursor underlines the last field ENT also advances the display to the next page.
28	**CLR**	Touch switch	When touched, **CLR** clears the contents of the current data field. If **ENT** is subsequently selected, the field will revert to its default display.
29	**RTN**	Touch switch	When touched, **RTN** returns the display to the previously active page.
30	**<MENU**	Touch switch	When touched, **MENU** returns the display to the previously active menu.

Pre-Flight Functions

To adjust the light intensity on the IDU, go to the MAIN SYSTEM MENU page and touch ACARS, MISCELLANEOUS, ACARS STATUS, and finally, DISPLAY ILLUM/TEST.



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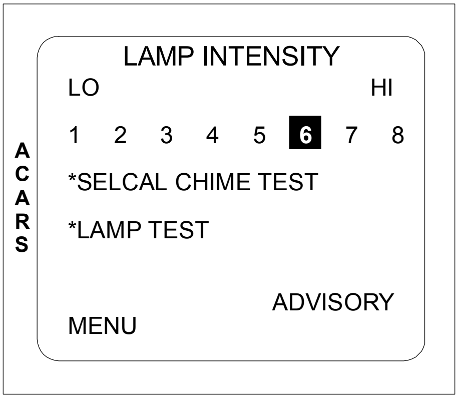
On the LAMP INTENSITY page, select the intensity level.

The cabin light sensor on the lower right side of the display continues to keep the illumination at the same relative intensity as set from this page. The display initializes on system cold starts to the brightest setting.



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Touching SELCAL CHIME TEST sounds the 2-chime bell and illuminates the SELC> advisory. Touch the SELCAL> to end the test.

Chimes sound for the following Advisory messages:

SELCAL>	Data message received for establishing Voice contact.
MSG>	Data message has been received.
INIT>	Door is closed, brake released, and INITIALIZATION has not been completed.
DELAY>	Off event is delayed (long taxi).
POST>	If event has occurred and POST-FLIGHT REPORT is not complete.

Touching LAMP TEST sequences the LEDs through a test pattern.

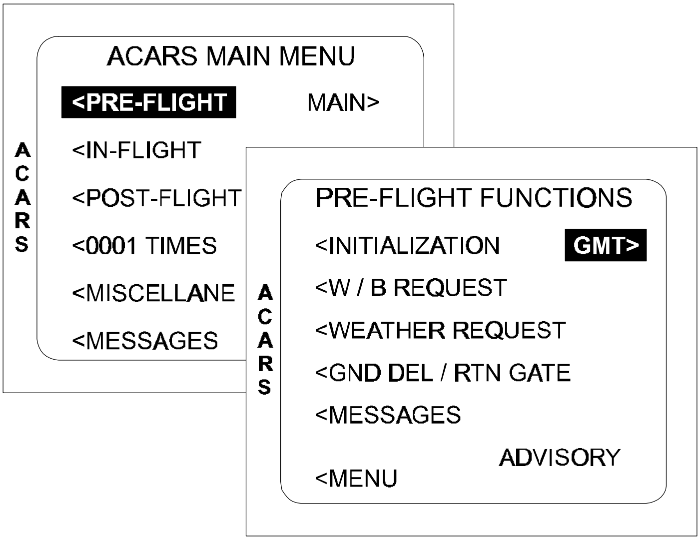
GMT Update

Use the GMT routine to obtain current time. If *in the gate* at a station equipped with an ACARS antenna, automatic update to correct ARINC system GMT is available.

When *in the gate* at a station, which does not have an ACARS antenna, use MANUAL UPDATE if desired.

In the gate is defined as being on the ground, between the last In event and prior to the Out event.

From the ACARS MAIN MENU page, touch PRE-FLIGHT and GMT.



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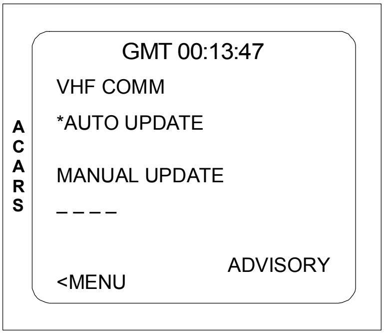
If the aircraft is in the gate, the GMT Update Display is displayed.



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Touch AUTO UPDATE to transmit a GMT update request message to the Continental ground computer. When received, the running GMT clock will be updated and the message AUTO UPDATE COMPLETE will display.

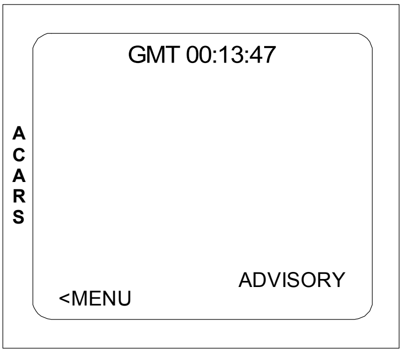
An auto Update is required for the first flight of the day.

After any update the page reverts to the PRE-FLIGHT FUNCTIONS page after 30 seconds.

If not *in the gate*, only the current GMT is displayed and NO update is permitted.

An uplink GMT takes priority over the Captain's clock. A manual update takes priority over an AUTO update or the Captain's clock.

The ACARS assumes the Captain's clock time only when re-booted from a cold start (both AC and DC circuit breakers pulled.)



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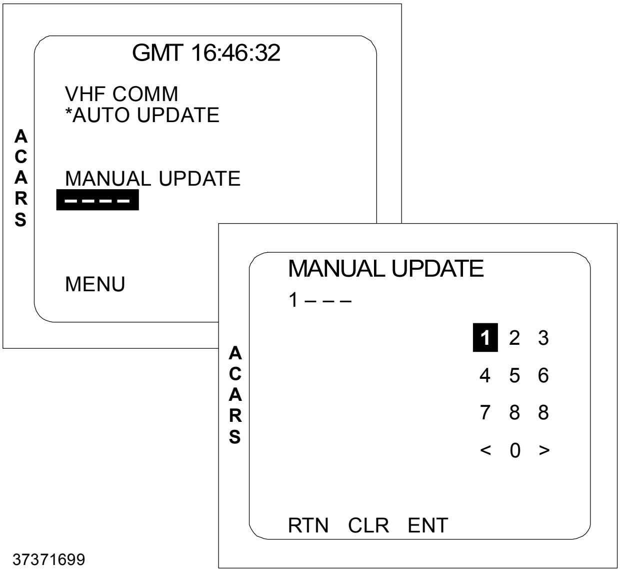
To accomplish a Manual update, touch the dashed field line.



This causes the applicable IDU keyboard to be displayed. The top line of the display will contain the title of the particular data field where information is to be entered or changed. Touch the appropriate letters, numbers, slash, or decimal point. Touch ENT when complete.

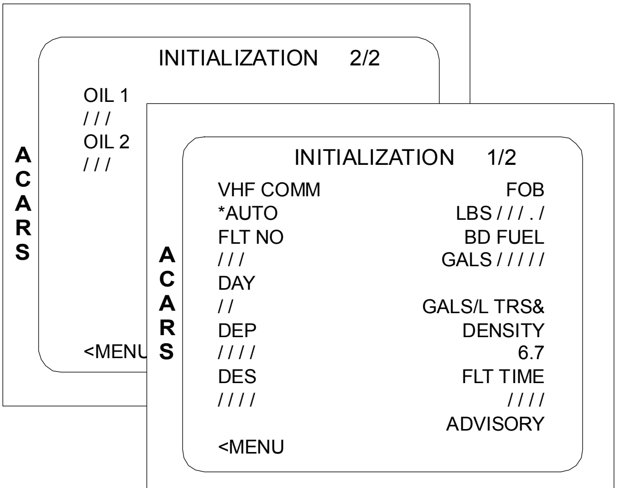
The running GMT clock will be updated to the manually entered time, with seconds set to zero.

When completed, select MENU to return to the PRE-FLIGHT FUNCTIONS page.

A manual update cannot be done during taxi or flight. It can only be done *in the gate*, i.e., prior to the Out event.

Initialization

<ACARS ③ <PRE FLIGHT ③ <INITIALIZATION



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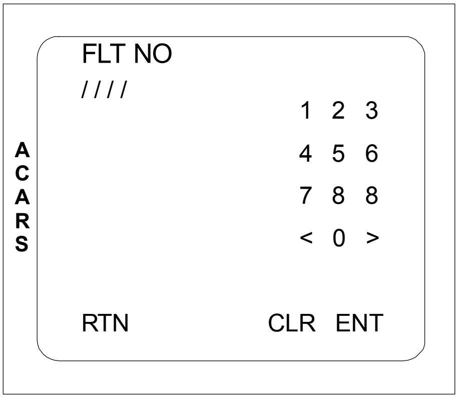
Touching AUTO sends the request message. Upon receipt of the uplink message, the INIT advisory is activated. Touch INIT> and the pages will display the data contained in the uplink.

For manual Initialization proceed: Touch the FLT NO field. This will display the IDU keyboard with the title of the active data field. As data is entered, the order will progress down the left side of the screen and then subsequently to the right side fields.

Enter the FLT NO, DAY, DEP station, DES station, and BD FUEL in GALS. If no fuel is boarded, enter a zero. The FOB is displayed automatically. Each field on the current page sequences automatically. Entries requiring a numerical entry are padded with leading zeros.

Select GAS/LTRS toggle if liters is used.



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DENSITY will default to 6.7. Manual entry is accepted. The FLT TIME requires 4 characters, in hours and minutes.

No changes can be made after takeoff. FIELD LOCKED will appear.

The Management Unit (MU) will perform the following calculation using the BD FUEL and DENSITY fields.

Previous flight arrival fuel + (boarded fuel x density) = FOB

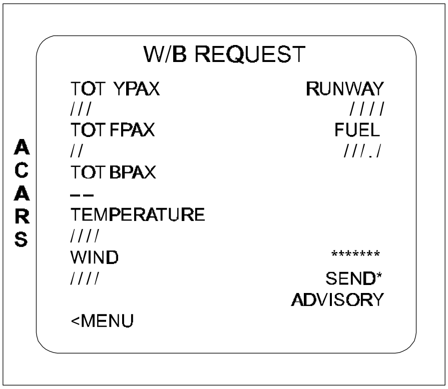
This calculated FOB is compared to the value displayed in the FOB.

Note: If FIELD LOCKED appears during FLT NO entry, the last POST FLIGHT REPORT has not been sent. Send it. As a last resort, cycle the AC and DC circuit breakers. 75 second re-boot time required.

WB Request

To activate the W/B REQUEST press:

<ACARS ③ <PRE FLIGHT ③<W/B REQUEST



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Entry notes:

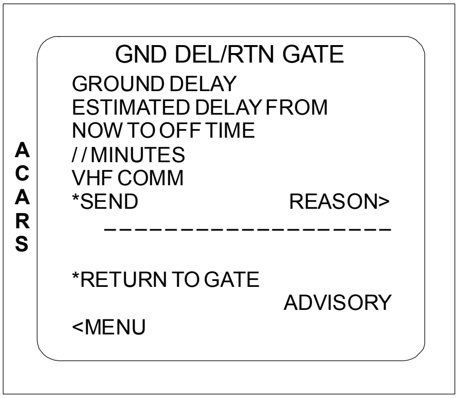
TOT YPAX	nnn	Number of Coach class passengers. Padded with leading zeros.
TOT FPAX	nn	Number of First class passengers. Padded with leading zero.
TOT BPAX	nn	Number of Business class passengers. Entry not req'd. Padded with leading zero.
TEMPERATURE	nnna	Mandatory trailing alpha character (C or F only) is required.
WIND	nnnn	Field is padded with leading zeros if required.
RUNWAY	nnna	Three numeric characters plus an optional trailing alpha character (C, L or R only). Degrees Celsius or Center of Runway (RUNWAY entry).
F		Degrees Fahrenheit
L		Left Runway
R		Right Runway
FUEL	nnn.n	Total FOB. Padded with leading zeros.

Ground Delay

To choose a reason for a Ground Delay press:

<ACARS ③ <PRE FLIGHT ③ <GND DEL/RTN GATE

If GND DEL/RTN GATE is selected prior to leaving the gate or after take-off, the message FUNCTION AVAILABLE ONLY ON GROUND AFTER OUT TIME IS POSTED will display.



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If a delay is experienced in taxi, touch the MINUTES field and enter minutes to the estimated take-off time.

To downlink the Ground Delay message and return to the PRE-FLIGHT FUNCTIONS menu, touch SEND.

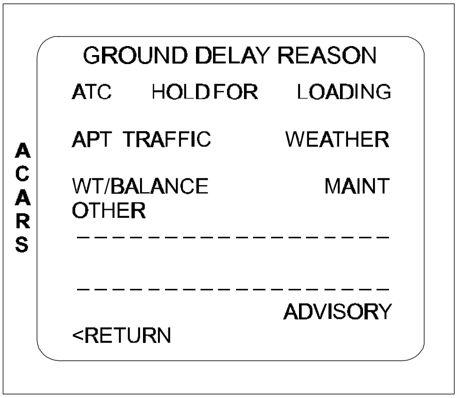
If the Off event is delayed, the DELAY> advisory is triggered 20 minutes after the Out event.

RETURN TO GATE is touched to downlink this message. The status shown in the area above the field will reflect the status of the last message queued by this key.

The REQUEST GATE ASSIGN message is automatically transmitted with RETURN TO GATE or RETURN TO FIELD.

If it is desired to include a reason in the ground delay message, select the REASON> prompt. A new page GROUND DELAY REASON will appear, inviting your selection.

If none is appropriate, you may enter the reason in the form of a free text message up to two lines long - 21 characters per line - under OTHER.

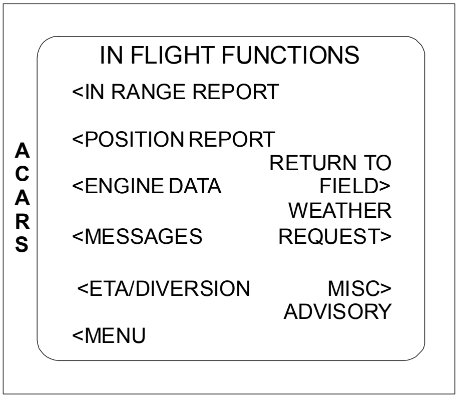


37316104

In-Flight Functions

To display the IN-FLIGHT FUNCTIONS page press:

<ACARS ③ < IN FLIGHT



37316105

The IN-FLIGHT menu is used to activate display functions normally used during flight.

In Range Report

To select the IN RANGE REPORT, press:

<ACARS ③ < IN FLIGHT ③ <IN RANGE REPORT

```
     IN RANGE REPORT
  WHEELCHAIRS          RED COAT
A 00                          –
C UNAC MINOR         GND POWER
A 00                          –
R LAV SERV            AIR COND
S –                           –
  OTHER
  – – – – – – – – – – – – –
                      VHF COMM
  – – – – – – – – – – – – –   SEND*
                      ADVISORY
  <MENU
```

37316106

The Wheelchairs and Unaccompanied Minor fields need numerical entries. Default value is zero.

To request Lav Service, a Red Coat, Gnd Power, or Air Conditioning, enter a Y. A blank answer is assumed No (N).

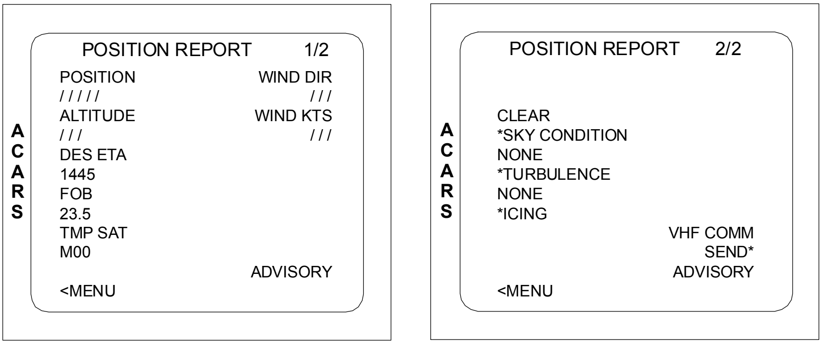
You may enter up to two lines of free text - 13 characters per line, under the word OTHER.

When completed, touch SEND.

Position Report

To select the POSITION REPORT, press:

<ACARS ③ <IN FLIGHT ③ <POSITION REPORT



37316107

POSITION	aaaaa	Entries less than 5 characters will be left justified and padded with trailing spaces.
ALT and WIND	nnn	Entries of less than 3 characters will be right justified and padded with leading zeros.
DES ETA	hhmm	Calculated from INITIALIZATION page. Defaults to Off time plus flight time.
FOB		Defaults to the latest FOB value from the DFDMU.
TMP SAT	snn	First enter either an M or a P (minus or plus), followed by up to two numerals. Defaults to M00.
*SKY CONDITION	Each time this key is pressed, one of the following 4 descriptions will be displayed above the key: CLEAR, IN CLOUDS, ON TOP, and BETWEEN LAYERS.	
C	Each time this key is pressed, one of the following 4 descriptions will be displayed above the key: NONE, LIGHT, MODERATE, and SEVERE.	
ICING	Each time this key is pressed, one of the following 4 descriptions will be displayed above the key: NONE, LIGHT, MODERATE, and HEAVY.	

Engine Report

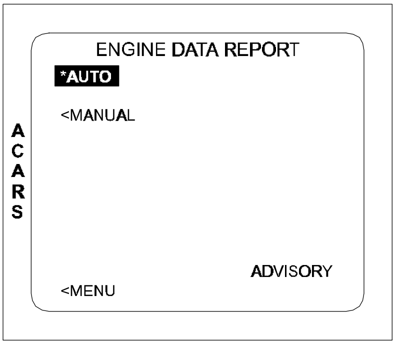
Engine Data Reports are transmitted automatically. No crew action is required. Maintenance may also request a report without crew input.

If Maintenance requests a Engine Report from the crew, use the following steps:

To select the ENGINE DATA REPORT, press:

<ACARS ③ <IN FLIGHT ③ <ENGINE DATA

Touch AUTO to activate an Automatic Engine Data Report.

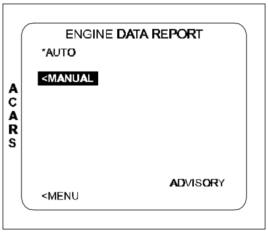


37316108

The MU then sends a request for Engine Performance data to the DFDMU system. In the space above AUTO, the MU will display the status of the request as follows:

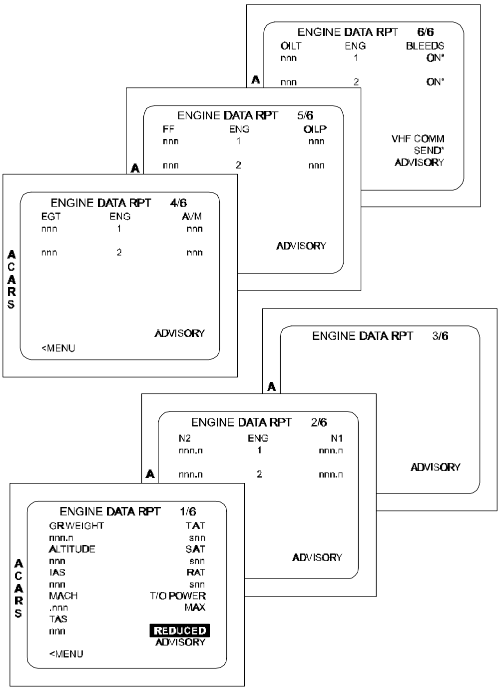
STAND BY	MU sending request
ACCEPTED	MU has sent request and received acknowledgment. When ACCEPTED has been displayed, select <MENU to return to the previous active menu.
NO DATA	MU has sent request but no acknowledgment has been received.

The Engine Data Report can also be sent manually. Select MANUAL to activate the Manual Engine Data Report.



37316109

TAT, SAT, RAT	snn	First enter either an M or a P (minus or plus), followed by up to two numerals. TAT and SAT fields default to M00 if nothing has been entered.
T/O POWER		Select one of the two keys below T/O POWER to specify the take-off power, MAX or REDUCED.
Bleeds		Toggles between ON and OFF.

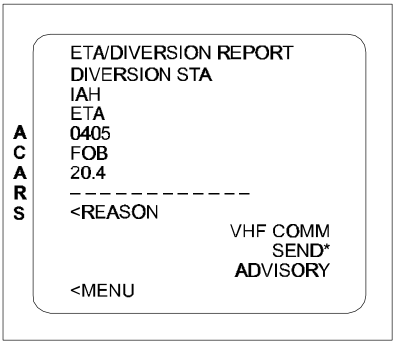


37316110

ETA / Diversion

To select the ETA/DIVERSION REPORT, press:

<ACARS ③ <IN FLIGHT ③ ETA/DIVERSION



37316111

The ETA / DIVERSION REPORT is used for revising the destination station and/or ETA.

The current destination station is indicated under the DIVERSION STA field and can be altered if the flight is being diverted.

The ETA is calculated automatically from the INITIALIZATION page. It is of the Off time plus the flight time.

FOB is obtained from the DFDMU so it appears automatically; it may be manually altered if necessary.

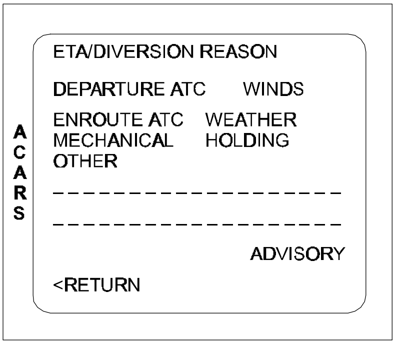
To include a reason for the diversion or ETA change in the message, select the REASON prompt. This causes the ETA / DIVERSION REASON page to appear.

Note: Always communicate directly with Dispatch prior to diverting.

To select one of these reasons, touch the applicable line.

If necessary, you may enter your own reason in the form of a free text message up to two lines long. Enter your reason in the lines under OTHER, using the procedure for free text entry.

When the reason has been selected or entered, touch RETURN to return to the ETA / DIVERSION REPORT display. The selected or entered reason will now appear in the line above REASON.

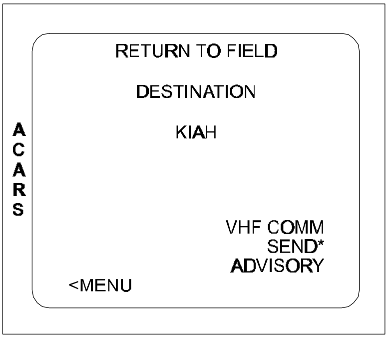


37316112

Return To Field

To select the RETURN TO FIELD, press:

<ACARS ③ <IN FLIGHT ③ <RETURN TO FIELD



37316113

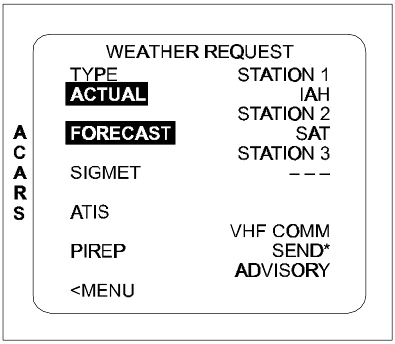
Activating the SEND key causes the Departure station to be copied as the Destination station. No entries are permitted.

The REQUEST GATE ASSIGN message is automatically transmitted with RETURN TO GATE or RETURN TO FIELD.

Weather Request

To select the WEATHER REQUEST, press:

<ACARS ③ <IN FLIGHT ③ <WEATHER REQUEST



37316114

Any or all of the types may be selected at a time. When this page is first called up, the ACTUAL line will be pre-selected.

Uplinked weather is then printed automatically.

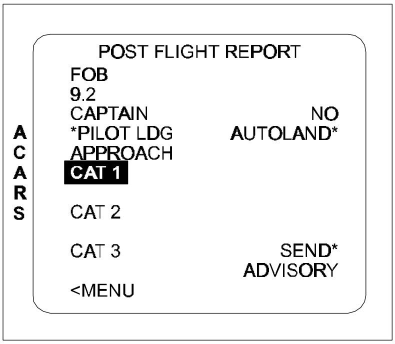
Station 1 defaults to the current destination station.

To clear a station, touch the Station field; this brings up the keyboard. Press CLR and ENT.

Post Flight

Select the POST-FLIGHT REPORT after the In event. Press:

<ACARS ③ <POST FLIGHT



37316115

POST-FLIGHT is not available until after the In event. If selected prior to the In event, message FUNCTION AVAILABLE AFTER IN EVENT is displayed. A fuel data request is made to the DFDMU to obtain the current Fuel On Board. It is displayed automatically. The FOB entry may be overridden with a manual entry.

The PILOT LDG line is a toggle switch. Toggle between CAPTAIN and FIRST OFFICER to choose the correct response. Default is CAPTAIN.

The APPROACH field allows you to select the type of approach. Default is CAT 1.

AUTOLAND is also a toggle switch, between NO and YES. Choose the correct response. Defaults to NO.

If the AUTOLAND is selected to YES, the SUCC / UNSUC line will appear. It is not displayed otherwise.

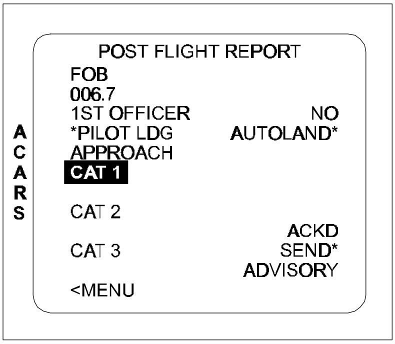
Selecting the SUCC / UNSUC line toggles the text above that line between SUCC and UNSUC. The default is SUCC.

If AUTOLAND was not successful, select the SUCC / UNSUC line to toggle the response to UNSUC.

After all the required information has been entered, touch SEND to queue the In Report message for downlink transmission and return the display to the screen from which the POST FLIGHT REPORT was called. SEND has no effect if any required information is missing. The status shown in the area above the SEND will reflect the status of the last message sent from this display.

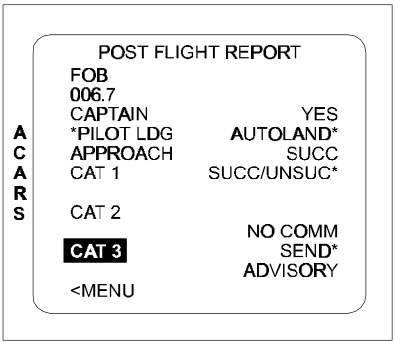
If the POST FLIGHT REPORT is not sent, the FIELD LOCKED message will appear when an attempt is made to initialize the hardware for next flight.

This is an example of a successful CAT 1 approach made by the First Officer.



37316116

This is an example of a successful autoland following a CAT 3 approach made by the Captain. No data link has been established (NO COMM.)

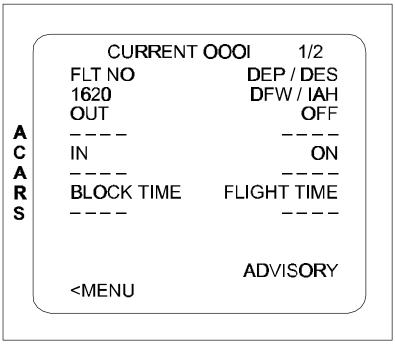


37316117

Out Off On In (OOOI) Times

To select the OOOI TIMES page:

<ACARS ③ <OOOI TIMES



37316118

The CURRENT OOOI (pronounced "oowee") provides **O**ut, **O**ff, **O**n, and **I**n events.

The FLT NO and DEP / DES fields propagate from the Initialization page.

The Out time is recorded after all doors are closed and the brake is released. This is the *Out A*.

<u>It is not displayed until oil pressure is sensed from the first engine start</u>. At that point, it is displayed and transmitted. This is *Out B*. To verify the Out A event has occurred, you may check the GMT page (update display no longer displayed) or Prog Id / Sens State display.

If a *Return To Gate* occurs (any passenger or service door is re-opened), the *Out A* time is lost unless you pull the ACARS MU AC circuit breaker (P 18-3, E-14). Don't pull both AC and DC, as this dumps all memory and requires ~75 seconds for re-boot. Cargo doors do not affect the *Out A* time.

When the *Out B* event occurs, the ACARS monitors the VHF frequency message traffic to ensure that no other ACARS equipped aircraft or ground stations are transmitting. When the frequency is not being used, ACARS will downlink the event.

When the downlink message is accepted, the ground station sends an acknowledgment (ACKD) to the aircraft. If ACKD is not received, the MU will automatically repeat the Out message up to six times to receive an ACKD.

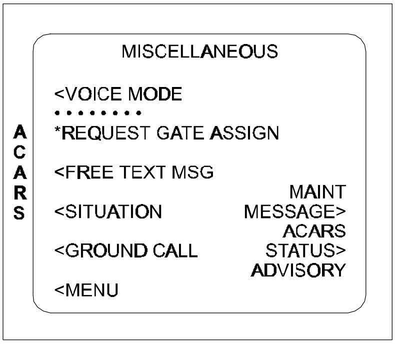
If no response has been received after the sixth attempt, a NOCOM advisory will be displayed.

To view the Previous Times page (from the previous flight) touch the 1/2 (the page icon) on the CURRENT OOOI display.

Miscellaneous

To select the MISCELLANEOUS page, press:

<ACARS ③ <MISCELLANEOUS or
<ACARS ③ <IN FLIGHT ③ <MISC



37316119

Voice Mode

<ACARS ③ <MISCELLANEOUS ③<VOICE MODE

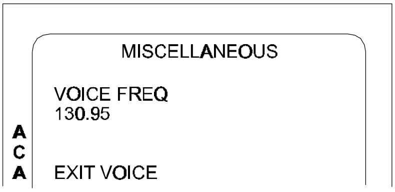
The VOICE Mode permits voice transmissions via the #3 VHF transceiver. Touch the Voice Freq field, enter the desired frequency, and press ENT. Number 3 can now be used for voice.

When VOICE is active, no data messages can be received or sent.

If left in the VOICE Mode, the DATA Mode is automatically reset two minutes after the last key of the microphone. Fifteen seconds prior to switching to DATA Mode, a **VOICE** advisory is displayed. Activating the VOICE* advisory resets the timer to 2 minutes.

DATA MSG WAITING will be displayed on the IDU if while in VOICE Mode the system has a downlink message placed in the queue.

Advisory field is not selectable on VOICE Mode pages.

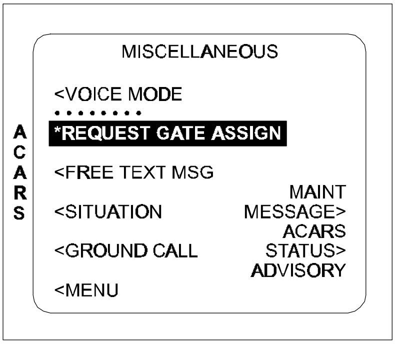


37316120

Request Gate Assign

<ACARS ③ <MISCELLANEOUS

Touching REQUEST GATE ASSIGN downlinks this message. No other display will be activated. The status shown in the area above the key will reflect the status of the last message queued from this page. Reference #26 on fold-out page.



37316121

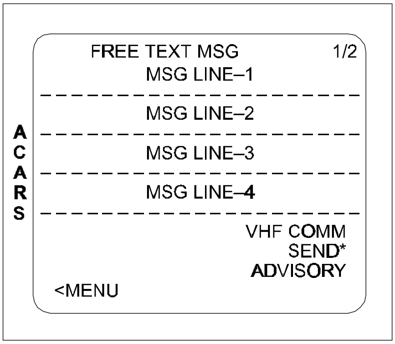
The gate information will be displayed as a Free Text message.

In addition, the Request Gate Assignment message will be automatically transmitted when the Return to Gate or Return to Field message is transmitted.

Free Text Message

<ACARS ③ MISCELLANEOUS ③ <FREE TEXT MSG

The FREE TEXT MESSAGE display is used to enter free text messages.



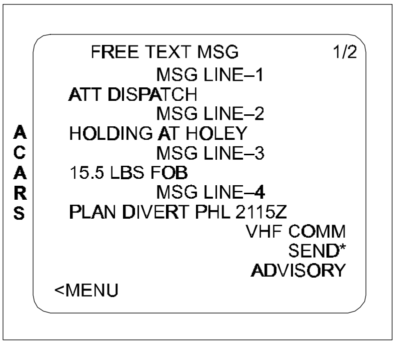
37316122

If your message requires more than four lines of 21 characters, touch the 1/2 icon to display page 2. This provides four more lines.

Presently, all Free Text Messages go to Dispatch; consequently, you must enter the address in the first line of your message. Entry of your Flight Number is not required.

This is an example of a message sent to Dispatch letting them know you are holding over Holey intersection planning to divert to PHL at 2115z.

Note: Always communicate directly with Dispatch prior to diverting.

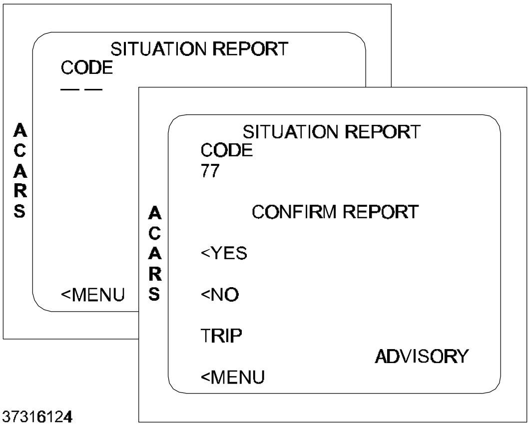


37316123

Situation

<ACARS ③ <MISCELLANEOUS ③ SITUATION

The Situation display activates the SITUATION REPORT for downlinking an emergency report message in case of hijacking.



37316124

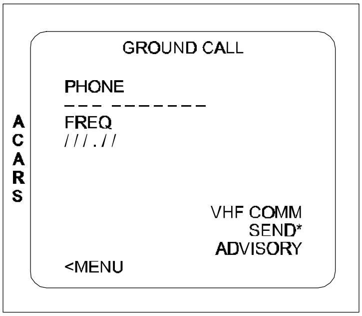
If 77 is entered in the CODE field, the CONFIRM REPORT text, and YES, NO and TRIP prompts will appear.

<YES	Calls up free text page to enter text to be transmitted along with the situation report.
<NO	Does not send the message. Acts similar to pressing the MENU prompt.
<TRIP	Immediately queues the Situation Report for downlink transmission. No message status line for this report.

Ground Call

<ACARS ③ <MISCELLANEOUS ③ <GROUND CALL

Initiates a GROUND CALL downlink message.



37316125

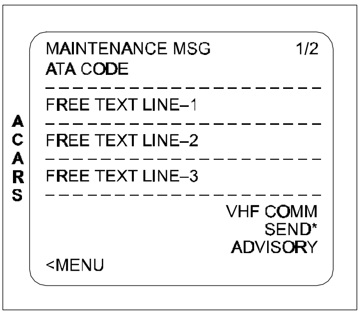
An example might be a need to communicate directly with your dispatcher.

Enter a phone number (up to 10 numbers) or a frequency (up to 5 numbers) and SEND. The dispatcher would then call you on the frequency so specified. You must be within line-of-sight for the GROUND CALL frequency feature.

Maintenance Msg

<ACARS ③ <MISCELLANEOUS ③ <MAINT MESSAGE

The MAINTENANCE MSG display is used for initiating a maintenance discrepancy message for downlink.



37316126

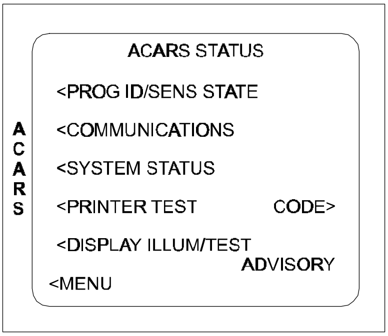
The ATA CODE, optional, will take up to 10 alpha-numeric entries.

If your message requires more than 21 characters of the three available lines, touch the 1/2 icon to display 4 more lines on page 2.2.

ACARS Status

<ACARS ③ <MISCELLANEOUS ③ <ACARS STATUS

The ACARS STATUS menu is used to select a variety of functions related to the ACARS system.

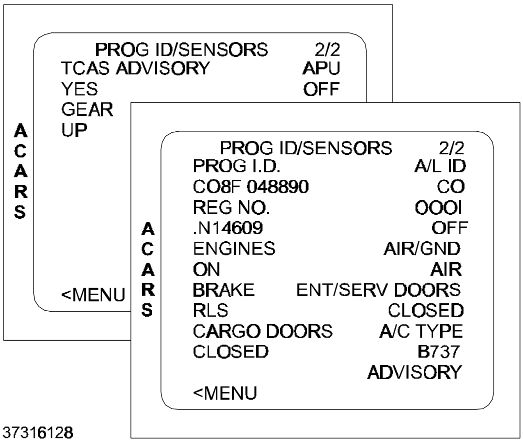


37316127

PROG ID / SENS STATE

<ACARS ③ <MISCELLANEOUS ③ ACARS STATUS ③ <PROG ID / SENS STATE

PROG ID / SENS STATE displays the Program ID, Airline ID, Registration Number and discrete status including current OOOI status.



37316128

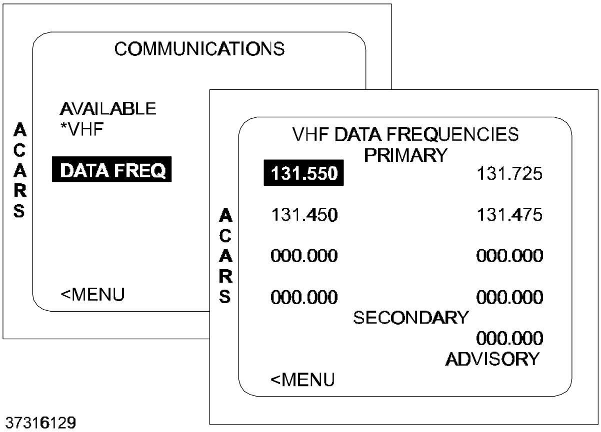
Communications

<ACARS ③ <MISCELLANEOUS ③ ACARS STATUS ③ <COMMUNICATIONS

COMMUNICATIONS displays the Primary Data frequencies and allows entry of a Secondary Data frequency. Manual entry of a Primary frequency is not allowed.

The status area above the VHF key will display **AVAILABLE** if the VHF link is available, **NO COMM** if it is not, and **VOX MODE** when in the VOICE Mode.

Touch DATA FREQ and available ACARS frequencies are displayed. 131.55 is the Primary frequency. Primary frequencies can be changed by touching the desired frequency. During an auto-search, the frequencies will be tried from left to right, the first row, then the second. Six attempts are made anytime a NOCOM advisory appears.



There are two ways for Secondary frequency change:

First, ARINC can auto-tune (example might be congested airspace and the need to unload a frequency);

Second, the pilot may enter a Data frequency. Do not enter a Voice frequency.

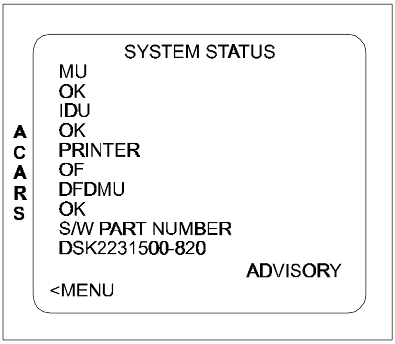
Any Secondary frequency will drop out and the Primary field becomes active after six attempts. Generally takes about two minutes.

131.55	USA / Australia	131.725	Europe
131.45	Japan	131.475	Canada

Systems Status

<ACARS ③ <MISCELLANEOUS ③ <ACARS STATUS ③ <SYSTEM STATUS

SYSTEM STATUS is used to verify operation of MU, IDU, DFDMU, and PRINTER.



37316130

OK	No current failures
ERROR	Current fault exists
NO DATA	No data is being received.

The System Status page can also be called up from the Fail> advisory.

Printer Test

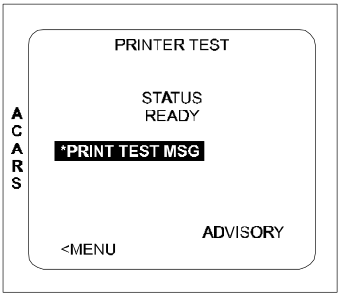
<ACARS ③ <MISCELLANEOUS ③ <ACARS STATUS ③ <PRINTER TEST

PRINTER TEST displays printer STATUS and allows PRINT TEST MSG printout.

The STATUS of the printer is indicate by one of the following:

READY	INIT	BUFOVR	PAPER
BUSY	ERROR	INOPER	NVD (no status)

Select PRINT TEST MSG to send a test format to the printer. Observe the printout to verify printer operation.



37316131

Code

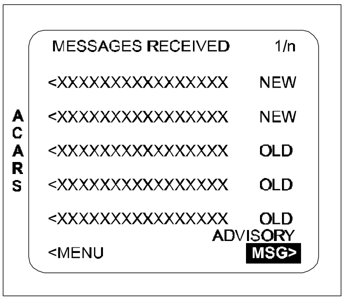
<ACARS ③ <MISCELLANEOUS ③ <ACARS STATUS ③ <CODE

CODE is for Maintenance use only to monitor APU cycles and run time.

Messages

To select the MESSAGES display, press:

<ACARS ③ <MESSAGES
or
<ACARS ③ <PRE FLIGHT ③ <MESSAGES
or
<ACARS ③ <IN FLIGHT ③ <MESSAGES

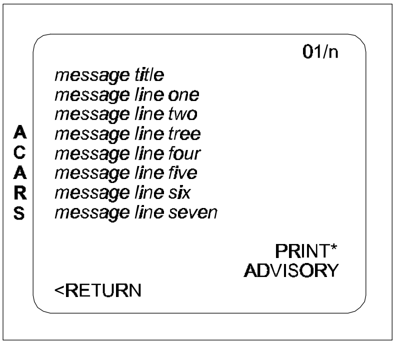


37316132

The MESSAGES RECEIVED display lists the titles of all messages received, with the most recent message listed first. Eight message titles can be listed on each of two display pages.

The POST FLIGHT REPORT erases all messages.

Messages may be retrieved by selecting either the flashing MSG or corresponding MESSAGE title line on the MESSAGES RECVD menu.

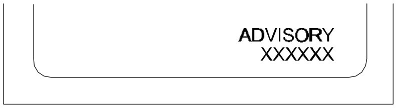


37316133

The Message display is used to provide the text of the message. The title of a message is on line one of the first page only. Each display page contains 8 lines of text and each line may contain up to 21 characters. An entire message may require more than one page, numbered from 1/n (n being the total number of pages.) Touch 1/n to activate the next message page.

Select PRINT to print out the entire message.

Advisory Messages



37316134

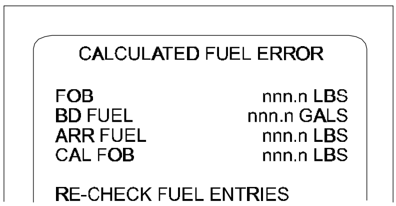
ADVIS A discrepancy exists between entered data and data acquired from external sources. Touch the ADVIS advisory to display the appropriate discrepancy message.

BUSY An uplink voice busy message was received in response to a Ground Call message. Touch the BUSY advisory to cancel it.

DELAY The OFF event is delayed. This advisory turns on 20 minutes after the OUT event if the OFF event has not yet occurred. Touch the DELAY advisory to activate the DELAY display and cancel the advisory.

FAIL Indicates a new ACARS equipment failure has been detected or reported to the MU and not yet been displayed on the SYSTEM STATUS display. Touch the FAIL advisory to activate the SYSTEM STATUS display for verifying the failure and recording in the maintenance log. The response cancels the FAIL advisory.

FUEL A fuel calculation error has been detected. If the calculated value differs by more than ±5% from the FOB field value, the FUEL> advisory will be activated. Touch the FUEL advisory to activate the CALCULATED FUEL ERROR display and cancel the advisory. Activating the FUEL advisory calls up the CALCULATED FUEL ERROR display.



37316135

INT A data field on the INITIALIZATION display has not been entered prior to the Out event. Touch the INIT advisory to activate the INITIALIZATION display for current data entry. The response cancels the INIT advisory.

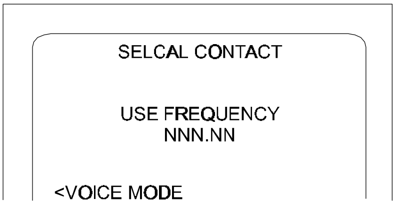
MSG A data message has been received. Touch the MSG advisory to activate the MESSAGE (RECVD) display of the message. The response cancels the advisory unless another message is still awaiting display. If there is more than one message, the oldest is displayed first. A new message will again activate the MSG advisory.

Advisory Messages (continued)

NOCOM Indicates that no air / ground data link is available. Advisory self-terminates when communications link is re-established. No response required.

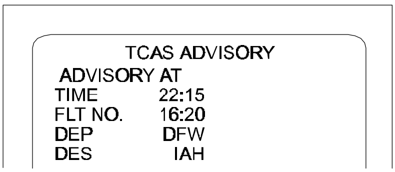
POST The In event has occurred following an On event. This requires that data be entered in the POST FLIGHT display. Touch the POST advisory to activate the POST FLIGHT display and cancel the advisory.

SELCL When illuminated, indicates that data message has been received for establishing a Voice Mode frequency. Touch the SELCL advisory to activate the SELCAL CONTACT display for a Voice Mode frequency and to activate a VOICE MODE display. The response cancels the SELCL advisory.



37316136

TCAS A TCAS RA has occurred and a message has been automatically sent. Touch the TCAS advisory to activate the TCAS ADVISORY display and cancel the advisory. Information only and no data entry is allowed. Resetting the TCAS CB initiates a TCAS ADVISORY message.

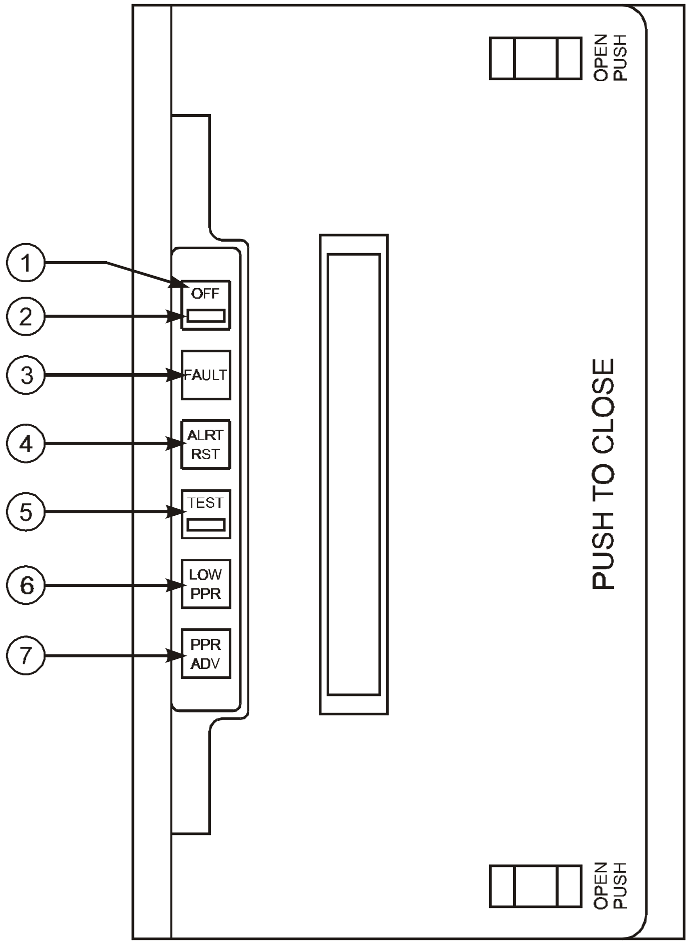


37316137

VOICE VOICE MODE is activated from a VOICE MODE display. When normal, the VOICE advisory indicates the Voice Mode is active and more than 15 seconds remain on the Voice Mode Timer. Touch the normal VOICE advisory to call up to the appropriate Voice Mode display. When VOICE*, indicates that less than 15 seconds remain on the Voice Mode Timer. Touch the VOICE* advisory to reset the timer to two minutes.

INTENTIONALLY LEFT BLANK

3 5 7 8 9 ACARS PRINTER



AFT ELECTRONIC CONTROL PANEL

7376-5019

① OFF Switch

PUSH – Alternately removes and applies power to printer.

PUSH – Extinguishes SELCAL light and resets decoder.

② **OFF** Light

Illuminated (white) – Indicates unit is not powered.

③ **FAULT** Light

Illuminated (white) – Indicates printer paper is out or paper door is open. Also illuminates in the event of printer failure.

④ Alert Reset (ALRT RST) Switch

PUSH – Resets aural / visual printer alert functions.

⑤ TEST Switch

PUSH – Causes printer to accomplish a self-test and print a test pattern.

⑥ Low Paper (**LOW PPR**) Light

Illuminated (white) – Indicates printer paper is low.

⑦ Paper Advance (PPR ADV) Switch

PUSH – Advances paper while switch is held.

Note: The flight crew is responsible for installing the printer paper.

7 8 9 ACARS OPERATION

INTRODUCTION

With ACARS (**A**ircraft **C**ommunications **A**ddressing and **R**eporting **S**ystem), the aircraft fleet becomes part of the airline data processing and information network. From Out / Off / On / In information, to duty free sales processing, the efficiency of airline operations is enhanced with ACARS, Collins ACARS is the industry leader in data link development to meet the needs of the airline industry.

The original intent of ACARS was to eliminate the need to transmit routine information by voice. Once the technology became available, the question of how else can we utilize aircraft-to-ground data processing has resulted in a growing list of applications for airlines.

The system is simply a VHF radio and control, a management unit or data processor, and a ACARS control. This ACARS control is a multi-input control-display unit (MCDU). Communication is accomplished with digital data bursts (which are millisecond transmissions) between the aircraft and computer networks on the ground. Information can be downlinked or uplinked automatically or manually with minimal flight crew action.

ORGANIZATION

The DLM-900 is a partitioned system to allow for rapid application development and certification. For this reason, it is divided into three main applications - the AOC (contains customer-specific Airline Operational Control functions), the ATS (contains standard Air Traffic Services functions), and the Technical (contains link maintenance and other system functions). Although this partitioning is made to be as transparent as possible, it can not be completely hidden. Therefore, this guide is organized with the intent of providing a logical flow while keeping the contents of each application together. The pilot should keep this in mind while looking for a description of a particular function or display page.

EVENT ALERTS AND DELAY REPORTING

ACARS is often used to report any divergence between the expected and the real flight leg events. It is also used to alert the crew to a particular event or condition. The following events and delays are defined for the Continental ACARS system:

Initialization

The INIT active advisory is used by the system to alert the crew that the new flight leg needs to be initialized in ACARS. This advisory may be activated by any of the following conditions:

1. At the start of a new flight leg, any field on either INITIALIZE page has not been filled. The first time the INITIALIZE page is exited with at least one unfilled field, the chime and light will be activated along with the INIT advisory.
2. A request for a Flight Initialization uplink has been sent and two minutes have elapsed without receiving a response.
3. A Flight Initialization uplink is received.

This advisory will not be displayed while the INITIALIZE page is being viewed on any MCDU. When selected, this advisory will cause the INITIALIZE page 1 of 2 to be displayed.

Fuel Discrepancy

The FUEL active advisory is activated when, after flight initialization information has been entered, the system has determined that there is a discrepancy of at least +/- 5% between the calculated and actual fuel on board. When this advisory is selected, the CALC FUEL ERROR page is displayed, showing the values used in calculating the discrepancy.

Takeoff Delay

The takeoff delay occurs when 20 minutes have elapsed since the OUT event, and the OFF event has not yet occurred. At this time, the DELAY active advisory is displayed and, when selected, causes the TAKEOFF DELAY page to be displayed. On this page, the crew may enter appropriate information and send a Takeoff Delay downlink message.

Miscellaneous Delays

Other delays may be reported by the crew by using the DELAYS pages. These three pages allow the crew to enter a delay code and number of minutes for a delay in the OUT to OFF event, the OFF to ON event, or the ON to IN event. This information is stored and automatically downlinked as a part of the In Report message that is downlinked at the end of the flight leg.

Return to Gate

The Return to Gate event occurs when, with the aircraft in the OUT state, any door is opened. Refer to the “0001 Flight Phase States” section for more information.

Reset Flight Leg

The Reset Flight Leg event occurs when, after a Return to Gate event, the flight is canceled or delayed indefinitely. Refer to the “0001 Flight Phase States” section for more information.

Return to Field

The Return to Field event occurs when, after takeoff, the crew determines the need to return to the field from which they had departed. When this occurs, the RETURN TO FIELD page may be used by the crew to send a Return to Field downlink. A Request Gate Assignment message is always automatically appended to the Return to Field message for convenience.

TCAS Resolution Advisory

In the event of a TCAS Resolution Advisory, a TCAS Advisory downlink message is automatically downlinked by the ACARS system. When this occurs, the TCAS active advisory is displayed. When time allows, the crew may select this advisory to view and/or print the TCAS ADVISORY page which displays the information sent in the downlink.

In Range

The In Range "event" is determined by the ACARS system to be 45 minutes prior to ETA if the estimated time enroute (ETE) is greater than 55 minutes. If the ETE is less than 55 minutes, the In Range event is determined to be 10 minutes after the OFF time. In either case, the In Range event will never occur less than 10 minutes after takeoff. When this event occurs, the IN RANGE active advisory is displayed and the chime and light are activated. Selection of the IN RANGE advisory causes the IN RANGE page to be displayed from which the crew may send an In Range Report message. A Request Gate Assignment message is always automatically appended to the In Range Report message for convenience.

Post-Flight

At the IN event, the POST active advisory will be displayed, reminding the crew that a post-flight In Report must be sent. When the POST advisory is selected, the POST-FLIGHT page is displayed, allowing the crew to enter appropriate information and send the In Report downlink. If this report is not sent by the crew within ten minutes following the IN event, the In Report will be sent automatically by the system, and will contain default information that identifies it as being sent automatically.

CONDITION AND MONITORING ADVISORIES

Active Advisories

Active advisories signal the crew that either a condition requires attention or that a function is available. Typically a crew action extinguishes the advisory. Three categories are available. TECHNICAL advisories have the highest priority, followed by ATS, and then AOC advisories.

Two options exist for extinguishing advisories. First, when the advisory is selected; second, when an action has been performed.

Active advisories are defined from highest to lowest priority in the sections that follow.

Technical

CONFIG:

Set	Either the aircraft registration number, or the 2-character airline ID is not available.
Clear	Both values are available.
Selection	The OVERRIDES page is displayed.

DATALOAD:

Set	A data loader with dataload disk inserted is connected to the MU.
Clear	The DATALOAD page is displayed.
Selection	The DATALOAD page is displayed.

SELCAL:

Set	A SELCAL uplink message is received.
Clear	The SELCAL page is displayed, or VHF is in voice mode.
Selection	The SELCAL page is displayed.

ATS

DEP CLX:

Set	A departure clearance report uplink message is being held with a status of NEW, OPEN, or ACCEPTED.
Clear	When DEPART CLX REVIEW page is being displayed or no Departure Clearance Report message is being held with a status of NEW, OPEN, or ACCEPTED.
Selection	The DEPART CLX REV page is displayed.

OCEAN CLX:

Set	An oceanic clearance report uplink message is being held with a status of NEW, OPEN, or ACCEPTED.
Clear	When OCEANIC CLX REVIEW page is being displayed or no Oceanic Clearance Report message is being held with a status of NEW, OPEN, or ACCEPTED.
Selection	The OCEAN CLX REV page is displayed.

ATS MSG:

Set	A flight system report uplink message is being held with a status of NEW or OPEN.
Clear	When FLT SYS REVIEW page is being displayed or when no Flight System message is being held with a status of NEW or OPEN.
Selection	The FLT SYS REVIEW page is displayed.

ATIS:

Set	An ATIS report uplink message is being held with a status of NEW or OPEN.
Clear	When ATIS REVIEW page is being displayed or when no ATIS Report message is being held with a status of NEW or OPEN.
Selection	The ATIS REV page is displayed.

TWIP:

Set	A TWIP report uplink message is being held with a status of NEW or OPEN.
Clear	When the TWIP REVIEW page is being displayed or when no TWIP Report message is being held with a status of NEW or OPEN.
Selection	The TWIP REV page is displayed.

AOC

MSG:

Set	An uplink display message has been received and has a status of "NEW."
Clear	No display message exists with a status of "NEW."
Selection	MESSAGE RCVD page is displayed showing the oldest free text message with a view status of "NEW."

INIT:

Set	The OUT event has occurred and the INITIALIZE pages have not been completed, or an auto initialization uplink has been received, or two minutes after an Auto Initialize Request message has been downlinked if an Auto Initialize Response uplink has not yet been received.
Clear	The advisory is selected, or the initialization information is complete, or the flight phase state goes to OFF.
Selection	INITIALIZE page 1 of 2 is displayed.

FUEL:

Set	When a fuel error of +/- 5% is calculated.
Clear	Upon selection or when condition no longer exists.
Selection	Displays the CALC FUEL ERROR page.

DELAY:

Set	When 20 minutes have elapsed since the OUT event, and the OFF event has not yet occurred.
Clear	Upon selection or at the OFF event.
Selection	Displays the TAKEOFF DELAY page.

IN RANGE:

Set	At (ETA - 45 minutes) if in OFF state for at least 10 minutes. At (OFF + 10) if estimated flight time is less than 55 minutes.
Clear	Upon selection.
Selection	Displays the IN RANGE RPT page.

TCAS:

Set	When a TCAS ADVISORY message has been queued for downlink.
Clear	Upon selection.
Selection	Displays the TCAS ADVISORY page.

POST:

Set	At the IN event if it follows an ON event.
Clear	Upon selection or at Start-of -Flight.
Selection	The POST-FLIGHT page is displayed.

Inactive Advisories

Inactive advisories are informational in nature. Typically these advisories are extinguished when either the triggering condition no longer exists or a timer expiration has occurred. Three categories are available. TECHNICAL advisories have the highest priority, followed by ATS, and then AOC. There are no ATS or AOC inactive advisories defined at this time.

Technical

The following TECHNICAL advisories are listed by priority.

UTC UPDATED:

Set	The UTC has been updated via uplink.
Clear	A 10 second timer has expired.

VOICE MODE:

Set	The system is in voice mode.
Clear	The system is in data mode.

NO COMM:

Set	No media (VHF, SATCOM, or HF) is available for downlinking a message.
Clear	Either the VHF, SATCOM, or HF medium is available for downlinking a message.

VHF IN PROG:

Set	The system has sent a downlink message via VHF.
Clear	No downlink messages in progress.

SATCOM IN PROG:

Set	The system has sent a downlink message via SATCOM.
Clear	No downlink messages in progress.

HF IN PROG:

Set	The system has sent a downlink message via HF.
Clear	No downlink messages in progress.

Relay Contacts

The MU supplies two relay sets that are connected to visual and/or aural annunciators, usually recognized as a chime (bell) and a light. The relays may be triggered by any of the following:

Technical

1. Manual selection via the RELAYS page.
2. Detection that system configuration data is incomplete.
3. Reception of a SELCAL uplink message.
4. Detection of connection to a dataloader.
5. Successful completion of a VHF link test.

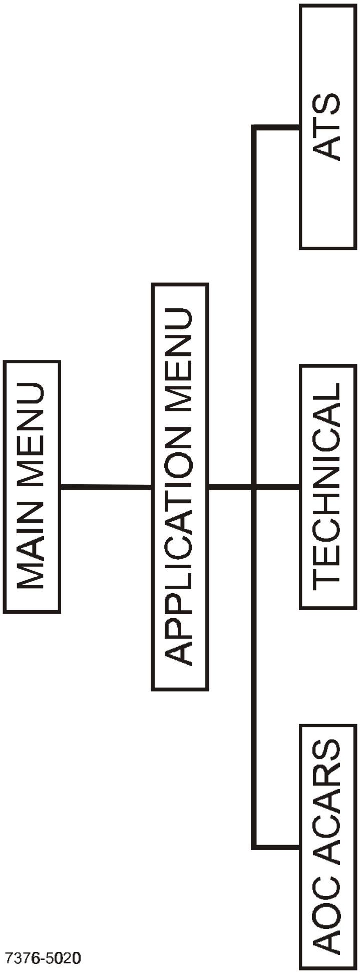
ATS

1. When a Departure Clearance message is received.
2. When an Oceanic Clearance message is received.

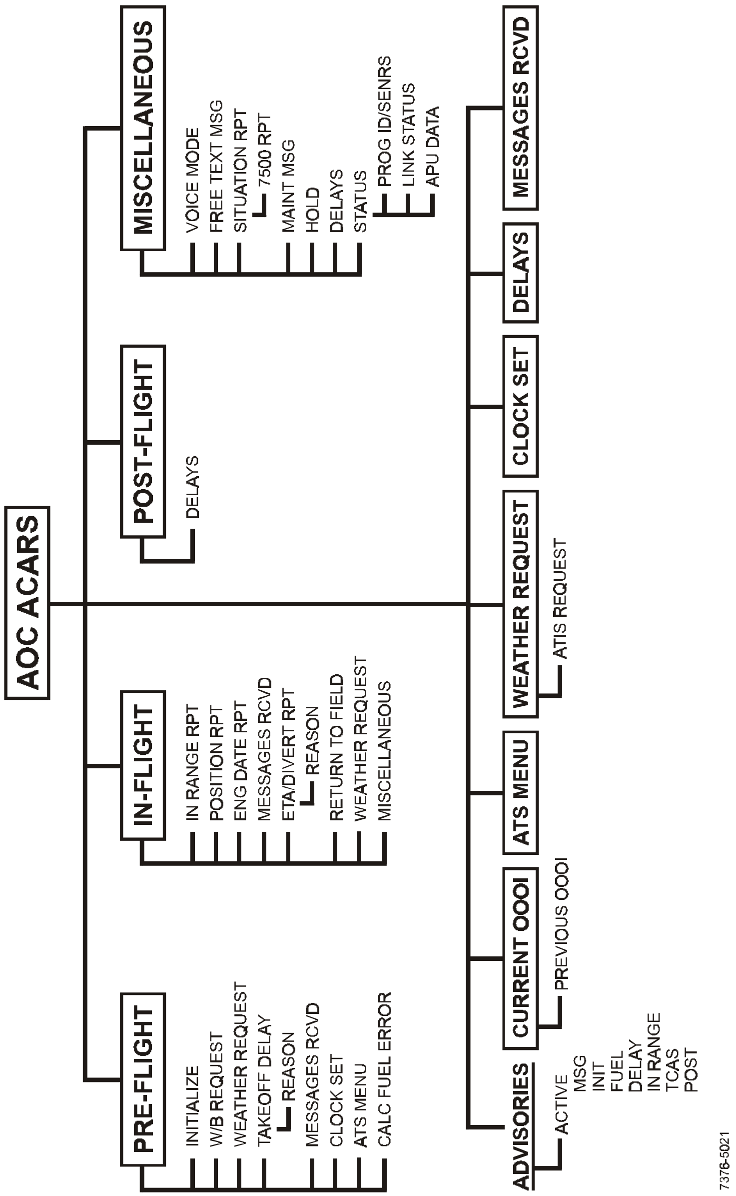
AOC

1. An uplink Display Message containing a bell character is received (MSG advisory is activated).
2. The INITIALIZE page is exited for the first time after the Start-of-Flight with any data field unfilled (INIT advisory is activated).
3. The IN RANGE advisory is activated.

ACARS – SYSTEM MENU TREE (APPLICATION)



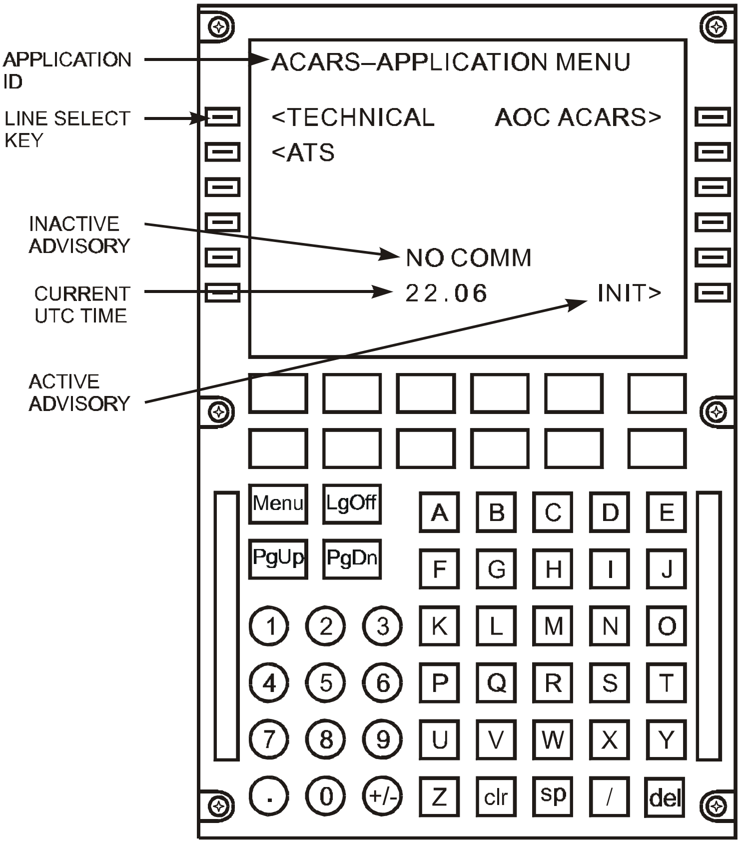
ACARS – SYSTEM MENU TREE (AOC)



SELECTING THE ACARS FUNCTION

Select MENU button on MCDU keyboard to access the MCDU menu. Select line key next to ACARS - resulting display is ACARS - APPLICATION MENU. The ACARS - APPLICATION MENU has three parts; ATS, TECHNICAL, and AOC.

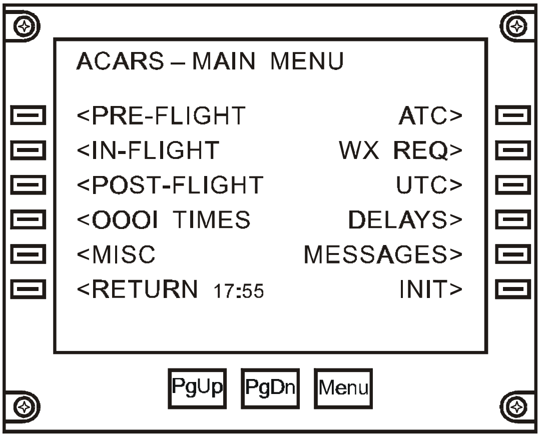
Several operational functions of the MCDU are shown in the ACARS - APPLICATION MENU below. The keyboard will not be shown for any of the subsequent display pages.



7376-5022

MAIN MENU

The MAIN MENU page is the initial AOC application page. It provides ten page selects.

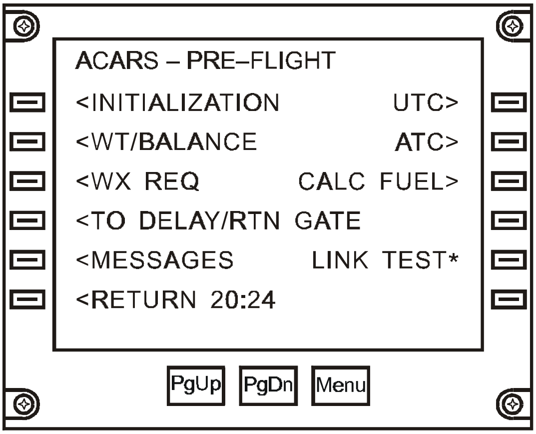


7376-5023

PRE-FLIGHT	Selection displays the PRE-FLIGHT menu page.
IN-FLIGHT	Selection displays the IN-FLIGHT menu page.
POST-FLIGHT	Selection displays the POST-FLIGHT page.
0001 TIMES	Selection displays the CURRENT 0001 page.
MISC	Selection displays the MISCELLANEOUS menu page.
ATC	Selection displays the ATS MENU page (see ATS Application Section).
WX REQ	Selection displays the WEATHER REQUEST page.
UTC	Selection displays the CLOCK SET page (see Technical Application Section).
DELAYS	Selection displays the DELAYS page.
MESSAGES	Selection displays the MESSAGES RCVD menu page.

Pre-Flight

The PRE-FLIGHT menu page provides eight flight phase dependent page selects. This page is accessible from the MAIN MENU.



7376-5080

INITIALIZATION	Selection displays INITIALIZE page.
WT/BALANCE	Selection displays W/B REQUEST page.
WX REQ	Selection displays WEATHER REQUEST page.
TO DELAY/ RTN GATE	Selection displays the TAKEOFF DELAY page.
MESSAGES	Selection displays the MESSAGES RCVD menu page.
UTC	Selection displays the CLOCK SET page (see the Technical Application Section).
ATC	Selection displays the ATS MENU page (see ATS Application Section).
CALC FUEL	Selection displays the CALC FUEL ERROR page.
LINK TEST	Runs VHF Link Test from LINK STATUS page (see Technical Application Section). Link test is successful if NO COMM advisory is not displayed within approximately one minute.

Initialize

The INITIALIZE pages allow the operator to enter / review flight initialization information and/or downlink an Auto Init Request message. This page is accessible from the PRE-FLIGHT menu and, when activated, via the INIT advisory.

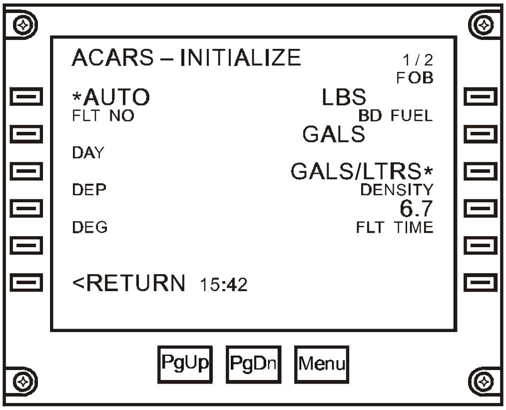
Selecting the AUTO key results in downlinking the Flight Initialization Request message. Upon receipt of the uplink Flight Initialization message, the INIT advisory is activated if the Initialize page is not being displayed. When the advisory is selected, this page is displayed with the data contained in the uplink. The uplink contains flight number, date, departure station, destination station, and estimated flight time. The uplinked data will overwrite any manually entered data. Subsequent manually entered data will then overwrite any uplinked or previous manually entered data.

If all required fields are not filled prior to the Start-of-Flight event, the INIT advisory will be activated. Start-Of-Flight is defined as either 1) the first time the INITIALIZE page is displayed after End-Of-Flight; or 2) the OUT event, whichever occurs first. At Start-of-Flight, if any field has not been entered on this page, the chime will sound the first time this page is left.

Initialization data is locked after takeoff and can be modified, manually or by uplink, only while in the BEGIN (IN) or OUT states. Manual entries of FOB will be cleared to dashes at the OFF event. At End-of-Flight, all data on this page will be cleared.

The contents of page 2/2 are determined by aircraft type. Two-engine aircraft will only display OIL 1 and OIL 2 fields, while three-engine aircraft will display an additional OIL 3 field.

Note: The FOB and BD fuel fields on page 1 and the OIL fields on page 2 are not filled by an Auto Initialization uplink. With the exception of FOB, which may be filled with data from an FMC, these fields must be entered manually.



7376-5024

AUTO — Selection queues an Automatic Flight Initialization Request message to be downlinked.

FILT NO — Flight number. Format: 4 alpha / numeric characters.

DAY — Flight scheduled departure date. Format: nn (1 - 2 numeric characters where 1 < = nn < = 31).

DEP — Flight departure (origination) station. Format: 3 - 4 alpha characters. Default: Displays DEP STA as received from broadcast bus, if available.

DES — Flight destination station. Format: 3 - 4 alpha characters. Default: Displays DES STA as received from broadcast, if available.

FOB — Current fuel on board. Format: nnn[.]n (1 - 4 numeric characters, decimal is optional.) Default: Displays FOB as received from broadcast bus, if available.

BD FUEL — Boarded (uplifted) fuel quantity (manual entry). Format: 1 - 5 numeric characters. Default: Field defaults to “GALS.” May be toggled to “LTRS” by GALS/LTRS* key.

Note: Entry causes recalculation of fuel error.

GALS/LTRS — Selection toggles units in BD FUEL between default “GALS” and “LTRS.”

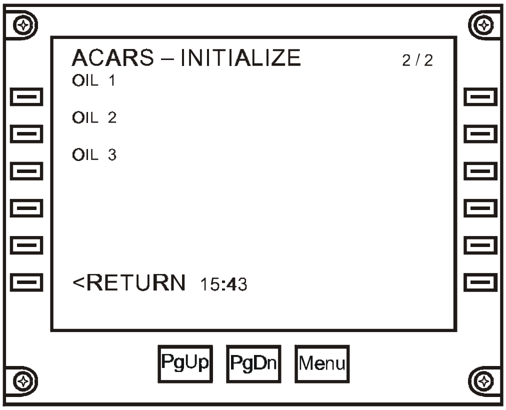
Note: Entry causes recalculation of fuel error.

DENSITY Fuel density. Format: n[.]n (1 - 2 numeric characters, decimal is optional.) Default: 6.7 (GALS) or 1.8 (LTRS).

Note: This is the density in lb/gal or lb/ltr depending on BD FUEL units. Entry causes recalculation of fuel error.

FLT TIME Estimated flight time enroute. Format: hhmm (1 - 4 numeric characters where mm < = 59)

Note: At OFF event, flight time is added to OFF time to determine default system ETA.



7376-5025

OIL 1 Engine 1 oil quantity. Format: 1 – 2 numeric characters

OIL 2 Engine 2 oil quantity. Format: 1 – 2 numeric characters

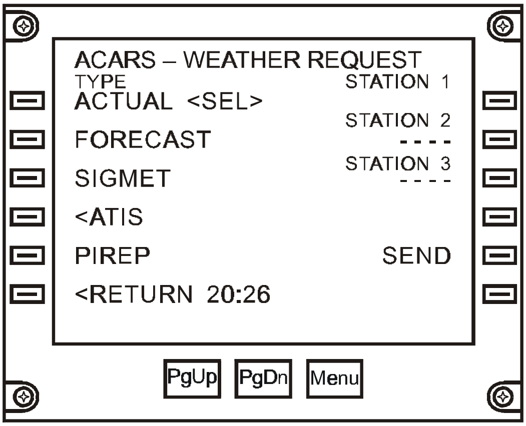
Weather Request

The WEATHER REQUEST page allows the operator to downlink a Weather Request message. This page is accessible from the MAIN menu, the PRE-FLIGHT menu, and the IN-FLIGHT menu.

Any or all of the weather report types may be selected for the station(s) entered. A selected report type is indicated by a <SEL> which may be toggled by the appropriate line key selection.

The ATIS selection provides access to the ATIS REQUEST page (see the ATS Application Section).

This page is not cleared after sending, allowing the operator to check the chosen weather periodically without having to reenter the desired stations.



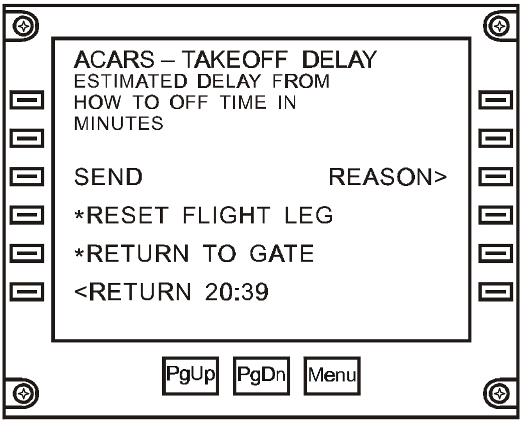
7376-5026

ACTUAL	Selection toggles <SEL> for current weather at station(s).
FORECAST	Selection toggles <SEL> for weather forecast at station(s).
SIGMET	Selection toggles <SEL> for SIGMET report at station(s).
ATIS	Selection displays the ATIS RO page (see ATS Application Section) where ATIS reports may be requested for a single station.
PIREP	Selection toggles <SEL> for PIREP at station(s).

STATION 1	Default or manual entry of 1st station for which selected reports are to be requested. Format: 3 - 4 alpha characters. Default: Current destination station.
STATION 2	Manual entry of 2nd station for which selected reports are to be requested. Format: 3 - 4 alpha characters.
STATION 3	Manual entry of 3rd station for which selected reports are to be requested. Format: 3 - 4 alpha characters.
SEND	When at least one report type is selected and at least one station is filled. SEND becomes large font and selection queues a Weather Request message for downlinking.

Takeoff Delay

The TAKEOFF DELAY page allows the operator to enter / review takeoff delay information and downlink a Takeoff Delay Report. This page is accessible from the PRE-FLIGHT menu and, when available, via the DELAY active advisory. If TAKEOFF DELAY is selected while in the air or before the OUT time is posted, the text "FUNCTION AVAILABLE ONLY ON GROUND AFTER OUT TIME IS POSTED" will replace the normal contents of this page.



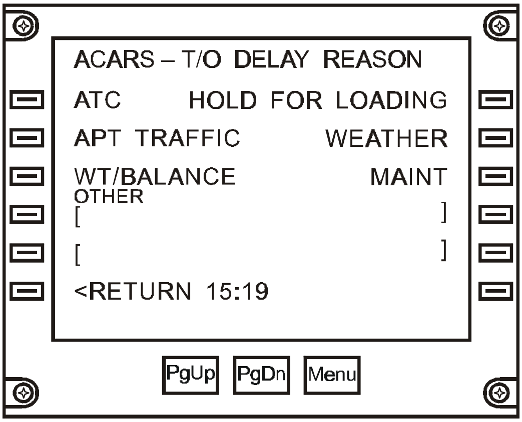
7376-5027

Delay time	Estimated time in minutes until expected OFF event. Format: 1 - 3 numeric characters.
SEND	If a delay time is entered, SEND becomes large font and selection queues a Takeoff Delay message for downlinking.
RESET FLIGHT LEG	Selection resets the flight leg from OUT (RETURN IN) to BEGIN. To be used when the aircraft has gone OUT but will not continue with a complete flight leg. (See 0001 Flight Phase State Section for more information.) <u>Note</u>: This prompt is only visible and functional when in the OUT (RETURN IN) state and a door has been opened to cause a Return To Gate message to be downlinked. This function should be used when maintenance taxis an aircraft from remote parking to the gate to begin a flight.

RETURN TO GATE	Functions as a SEND select. Selection queues a Return To Gate message and Request Gate Assignment message for downlinking.
REASON	Selection displays the T/O DELAY REASON page. This page returns a selected reason to be part of the Takeoff Delay message.

Takeoff Delay Reason

The T/O DELAY REASON page allows the operator to optionally specify one of six predefined reasons and/or a free text reason for the takeoff delay, to be included with the Takeoff Delay message. This page is accessible via the REASON select on the TAKEOFF DELAY page.

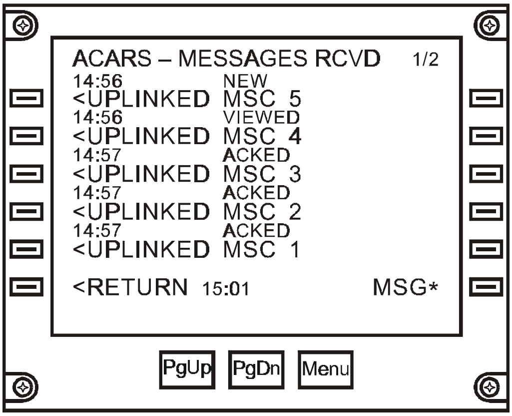


7376-5028

ATC, APT TRAFFIC, WT/BALANCE, HOLD FOR LOADING, WEATHER, MAINT	Reason for takeoff delay. <u>Note</u>: Selection causes the reason to be included in the TAKEOFF DELAY downlink message when sent from the TAKEOFF DELAY page. If free text has been entered in OTHER, it will be appended to the selected reason. The TAKEOFF DELAY page is then immediately redisplayed.
OTHER	Free text reason for the takeoff delay. <u>Note</u>: Free text entry followed by selection of RETURN (6L) or one of the other reasons saves the reason for downlink and returns the display to the TAKEOFF DELAY page. Format: Up to 24 characters / line for 2 lines
RETURN	Saves OTHER reason and returns display to the TAKEOFF DELAY page.

Message Rcvd Menu

The MESSAGES RCVD page allows the operator to review the titles of all uplink display messages and select an individual message for viewing. This page is accessible from the MAIN MENU, the PRE-FLIGHT menu, the IN-FLIGHT menu or, when activated, via the MSG advisory.



7376-5029

Each message is represented by the following fields:

Name	Format	
time stamp	HH:MM	Time message was received.
status	'NEW'	Message has not been viewed / acked.
	'VIEWED'	First page of message has been viewed.
	'ACKED'	Message has been acked.
title	The first 16 characters of the message.	

When a key corresponding to a message title is selected (1 L - 5L), the MESSAGES RCVD review page is displayed containing the selected message for review.

The uplink display messages will be stored in a queue. The first 16 characters of each message are the message title, which will be displayed on the message menu and on the first line of the first page when the message is displayed. The queue will be able to store up to a maximum of 20 messages or 64 transmission blocks. When this limit is exceeded the incoming message is put at the top of the queue and the oldest message(s) is deleted to make room for the new message. The queue is cleared at the End-of-Flight event.

When the final block of a message is received, the MSG advisory will be activated. If an incomplete message is received the MSG advisory will be activated and the text “MESSAGE INCOMPLETE” will be appended to the uplink message text.

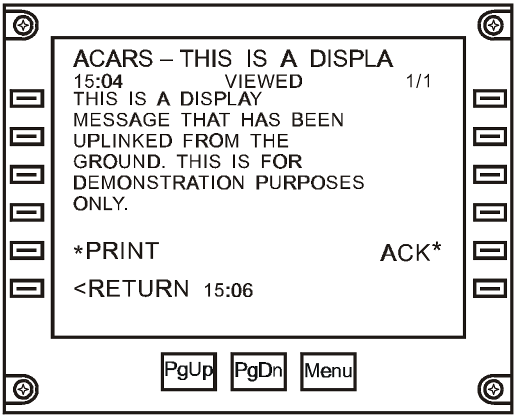
Message Rcvd Review

The MESSAGES RCVD review page allows the operator to view an uplink display message. The title of this page will be the title of the message being viewed. This page is accessible from the MESSAGES RCVD menu page.

The total number of pages is dependent on the message size.

When a message is first viewed on this page, the view status is set to 'VIEWED.'

Selecting ACK* downlinks a Crew Acknowledgment message, disables the ACK select, and sets the view status to 'ACKED.' The ACK* select is only displayed with messages that have a status of 'NEW' or 'VIEWED.'

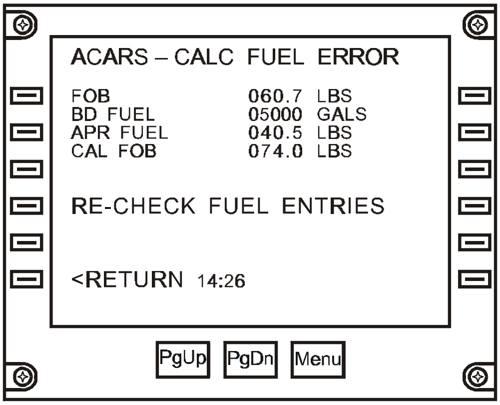


7376-5030

PRINT — Select is available when a printer is connected and reporting its status as OK. Selection sends the message to the printer, and disables the select for five seconds.

Calc Fuel Error

The CALC FUEL ERROR page allows verification of fuel quantity. This page is displayed when the FUEL advisory has been activated and is selected, or via the CALC FUEL select on the PRE-FLIGHT page. All fields on this page are display only. No entry is allowed.



7376-5031

When the BD FUEL field on the INITIALIZE page has been entered, the MU will perform the following calculation:

(ARR FUEL) + (BD FUEL * DENSITY) = CAL FOB

The FUEL advisory is activated when the calculated FOB differs by more than +/- 5% from the value in the FOB field (INITIALIZE page).

ARR FUEL (arrival fuel) is captured at the IN event of the previous flight leg. BD FUEL is a required entry on the INITIALIZE page, and will be displayed on this page as GALS or LTRS, as selected on the INITIALIZE page. DENSITY is defaulted to 6.7 lb/gal (which may be over written with another value or changed to lb/ltr on the INITIALIZE page). The default density for lb/ltr is 1.8 which may be overwritten. The fuel error is recalculated whenever a manual change is made to fuel on board, boarded fuel, units, or density on the INITIALIZE page.

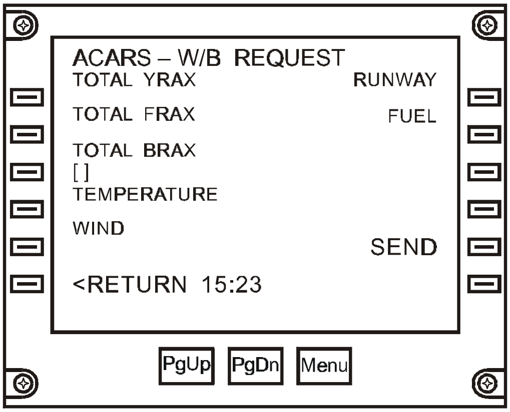
ARR FUEL (arrival fuel) is captured at the IN event of the previous flight leg. BD FUEL is a required entry on the INITIALIZE page, and will be displayed on this page as GALS or LTRS, as selected on the INITIALIZE page. DENSITY is defaulted to 6.7 lb/gal (which may be overwritten with another value or changed to lb/ltr on the INITIALIZE page). The default density for lb/ltr is 1.8 which may be overwritten. The fuel error is recalculated whenever a manual change is made to fuel on board, boarded fuel, units, or density on the INITIALIZE page.

If the CAL FOB differs by more than +/- 5% from the FOB value on the INITIALIZE page, the text "RE-CHECK FUEL ENTRIES" is displayed on line four of this page.

If CALC FUEL is selected before all parameters are available, the text "INITIALIZATION HAS NOT BEEN COMPLETED" will replace the normal contents of this page. If no ARR FUEL is available, the text "ARRIVAL FUEL IS NOT AVAILABLE" will replace the normal contents of this page.

W/B Request

The W/B REQUEST page allows the operator to enter weight and balance information and downlink a Weight / Balance Request message. This page is accessible from the PRE-FLIGHT menu. This feature is not used at Continental Airlines.



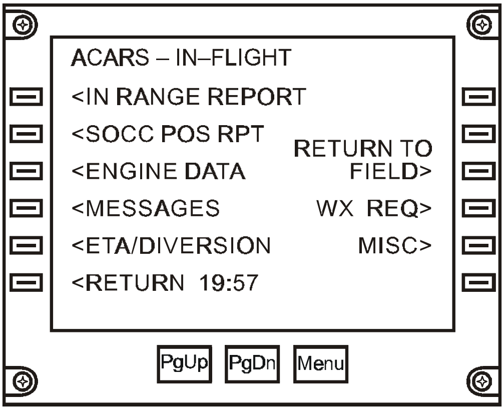
7376-5032

TOTAL YPAX	Number of coach class passengers. Format: 1 - 3 numeric characters.
TOTAL FPAX	Number of first class passengers. Format: 1 - 2 numeric characters.
TOTAL BPAX	Number of business class passengers. Format: 1 - 2 numeric characters.
TEMPERATURE	Temperature in degrees C or F. Format: [x]nn[a] where "xnn" is 1 - 3 numeric characters. Accepts "-" as first character. "[a]" is either a "C" or "F". Default: "C" if no type is entered.
WIND	Wind direction. Format: 1 - 4 numeric characters
RUNWAY	Takeoff runway number. Format: nna where "nn" is 1 - 2 numeric characters and 1 < = nn< = 36, and "a" is L, R, or C.

FUEL	Current fuel on board. Format: nnn[.]n (1 - 4 numeric characters decimal is optional.) Default: Fuel on board from broadcast bus, if available.
SEND	When all mandatory fields have been entered, SEND becomes large font and selection queues the W/B Request message for downlinking.

In-Flight

The IN-FLIGHT page provides eight page selects. This page is accessible from the MAIN MENU.

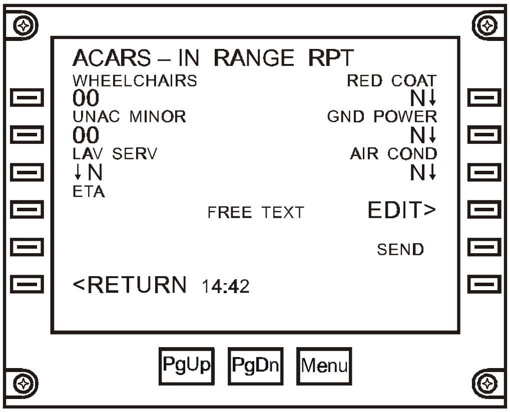


7376-5033

IN RANGE REPORT	Selection displays IN RANGE RPT page.
SOCC POS RPT	Selection displays POSITION RPT page.
ENGINE DATA	Selection displays ENG DATA RPT page.
MESSAGES	Selection displays MESSAGES RCVD Menu page.
ETA/DIVERSION	Selection displays ETA/DIVERT RPT page.
RETURN TO FIELD	Selection displays RETURN TO FIELD page.
WX REQ	Selection displays the WEATHER REQUEST page.
MISC	Selection displays the MISCELLANEOUS page.

In Range Report

The IN RANGE R PT page allows the operator to enter / review in-range information and downlink an In Range Report message. This page is accessible from the IN-FLIGHT menu or by selection of the IN RANGE advisory when activated. If IN RANGE is selected while the aircraft is on the ground, the text "IN FLIGHT FUNCTION ONLY" will replace the normal contents of this page.



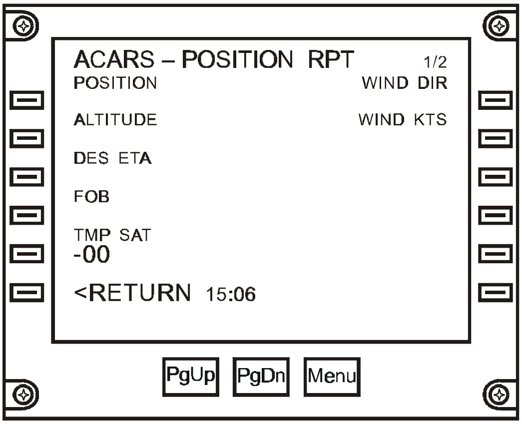
7376-5034

WHEELCHAIRS	Number of wheelchairs required upon arrival. Format: 1 - 2 numeric characters. Default: 00
UNAC MINOR	Number of unaccompanied minors aboard. Format: 1 - 2 numeric characters. Default: 00
LAV SERV	Request for lavatory service upon arrival. Format: "N," "Y"
ETA	Estimated time of arrival. Format: hhmm (1 - 4 numeric characters) Default: Current system ETA. Note: Sets system ETA.
CLEAR TEXT	Select available when free text has been entered through EDIT select. Selection clears all free text.
RED COAT	Request for red coat upon arrival. Format: "N," "Y"
GROUND POWER	Request for ground power upon arrival. Format: "N," "Y"

AIR COND	Request for air conditioning service upon arrival. Format: "N," "Y"
EDIT	Selection displays the Edit Free Text page. Allows entry of up to 16 lines of 24 character / line free text.
SEND	When ETA is filled, SEND becomes large font and selection queues the In Range Report message for downlinking.

Position Report

The POSITION REPORT pages allow the operator to enter / review position / weather information and downlink a Position Report message. This page is accessible while in flight from the IN-FLIGHT menu. If POSITION REPORT is selected while the aircraft is on the ground, the text "IN FLIGHT FUNCTION ONLY" will replace the normal contents of this page. This report is only sent to the airline (SOCC) Systems Operations Control Center not ATC facilities.



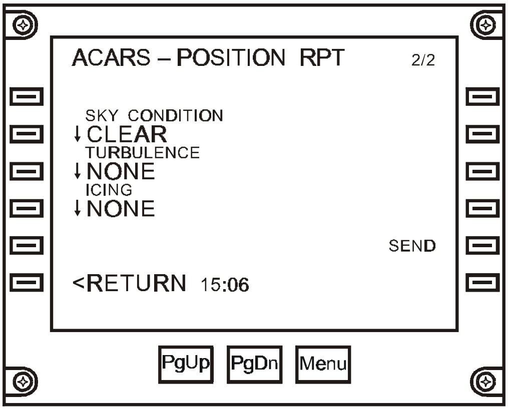
7376-5035

POSITION	Present position (Latitude / Longitude, Waypoint, or Navaid ID). Format: Up to 15 characters of free text.
ALTITUDE	Present altitude. Format: 1 – 3 numeric characters
DES ETA	Destination ETA. Format: hhmm (1 - 4 numeric characters) Default: Current system ETA. Note: Sets system ETA..
FOB	Current fuel on board. Format: nnn[.]n (1 - 4 numeric characters, decimal is optional). Default: Latest FOB from broadcast bus, if available.

TMP SAT — Static air temperature. Format: [a]nn where [a] is either blank or and nn is 1 - 2 numeric characters. Default: -00 Note: Default entry is negative value without requiring "-" entry. "+" must be entered to fill with positive value.

WIND DIR — Wind direction in degrees. Format: nnn where 000 < = nnn < = 360

WIND KTS — Wind speed in kts. Format: 1 – 3 numeric characters



7376-5036

SKY CONDITION — Present sky condition. Format: "**CLEAR**," "IN CLOUDS," "ON TOP," "BETWEEN LAYERS."

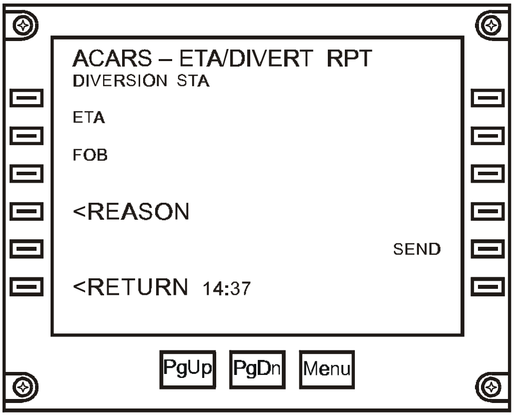
TURBULENCE — Present turbulence condition. Format: "**NONE**," "LIGHT," "MODERATE," "SEVERE."

ICING — Present icing condition. Format: "**NONE**," "LIGHT," "MODERATE," "HEAVY."

SEND — When all required fields are filled, SEND becomes large font and selection queues Position Report message for downlinking.

ETA/Divert RPT

The ETA / DIVERT RPT page allows the operator to enter / review ETA / destination information and downlink an ETA / Diversion message. This page is accessible from the IN-FLIGHT menu while airborne only. If ETA / DIVERT is selected while the aircraft is on the ground, the text "IN FLIGHT FUNCTION ONLY" will replace the normal contents of this page.

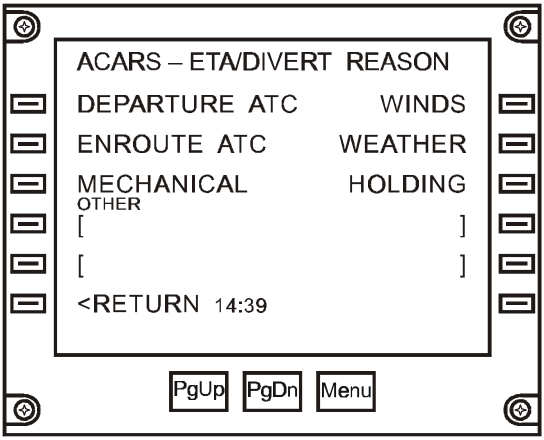


7376-5037

DIVERSION STA	New destination station. SEND causes this to be the destination station throughout the system. Format: 3 – 4 alpha characters.
ETA	Estimated time of arrival. SEND causes this to be the ETA throughout the system. Format: hhmm (1 - 4 numeric characters). Default: Displays calculated ETA (OFF time + Flight Time) if available..
FOB	Fuel on board. Format: nnn[.]n (1 – 4 numeric characters, decimal is optional). Note: Manual entry only.
REASON	Selection displays the ETA / DIVERT REASON page.
SEND	When all mandatory fields are filled, selection queues ETA / Diversion Report message for downlinking.

ETA/Divert Reason

The ETA / DIVERT REASON page allows the operator to select one of six predefined reasons or enter a free text reason for the ETA / Destination change. The selected reason is then returned to the ETA / DIVERT RPT page. This page is accessible from the ETA / DIVERT RPT page.

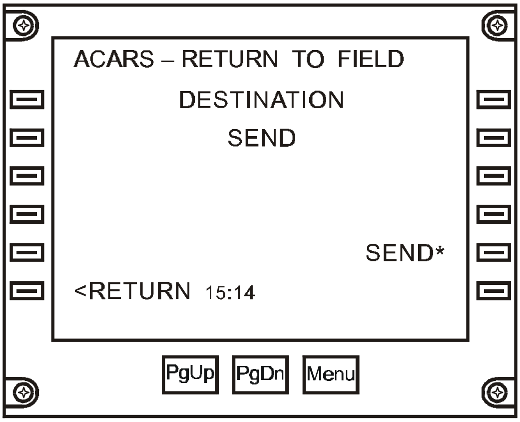


7376-5038

DEPARTURE ATC, ENROUTE ATC, MECHANICAL, WINDS, WEATHER, HOLDING	Reason for ETA / Destination change. Note: Selection causes the reason to be included in the ETA / Diversion downlink when sent from the ETA / DIVERT RPT page which is then redisplayed. If free text has been entered in OTHER, it will be appended to the selected reason.
OTHER	Free text reason for ETA / Destination change. Note: Free text entry followed by selection of RETURN or one of the other reasons, saves the reason for downlink and returns the display to the ETA / DIVERT RPT page. Format: zzz..z (up to 24 characters / line for 2 lines).
RETURN	Saves OTHER reason and returns display to the ETA / DIVERT RPT page.

Return To Field

The RETURN TO FIELD page allows the operator to downlink a Return to Field message. This page is accessible from the IN-FLIGHT menu only while airborne, If RETURN TO FIELD is selected while the aircraft is on the ground, the text "IN FLIGHT FUNCTION ONLY" will replace the normal contents of this page.

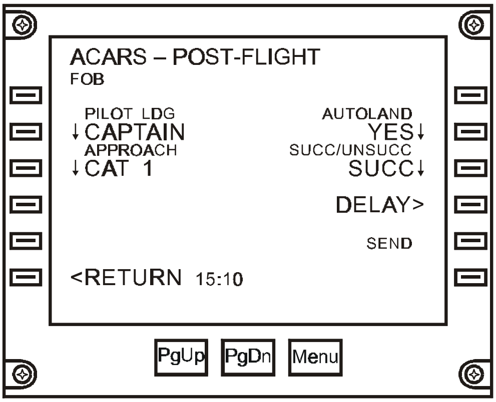


7376-5039

Station	Destination station for return-to-field. Displays the departure station from the flight initialization.
SEND	Selection queues the Return to Field Report message and Request Gate Assignment message for downlinking.

Post Flight

The POST FLIGHT page allows the operator to enter / review approach and landing information after the IN event and downlink an In Report message. This page is accessible from the MAIN MENU or via the POST advisory. If POST-FLIGHT is selected before the IN event, the text "FUNCTION AVAILABLE AFTER IN EVENT" will replace the normal contents of this page.

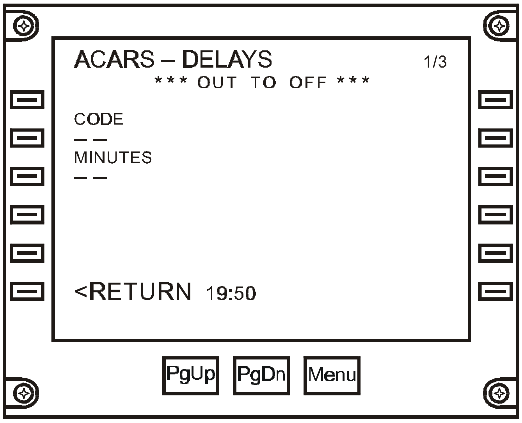


7376-5040

FOB	Current fuel on board. Format: nnn[.]n (1 - 4 numeric characters, decimal is optional.) Default: Latest FOB from broadcast bus, if available.
PILOT LDG	Pilot that performed the landing. Format: **"<u>CAPTAIN</u>"**, "1ST OFFICER" – "IRO"
APPROACH	Type of approach used. Format: **"<u>CAT 1</u>"**, "CAT 2", "CAT 3"
AUTOLAND	Selection toggles whether Autoland was used. Format: **"<u>No</u>"**, "YES"
SUCC/UNSUCC	Selection toggles whether Autoland was a success. This selection and heading are only displayed when Autoland is toggled to "YES". Format: **"<u>SUCC</u>"**, "UNSUCC"
DELAY	Selection displays the DELAYS page 1 of 3.
SEND	When FOB is filled, SEND becomes large font and selection queues the In Report message for downlinking.

Delays

The DELAYS page allows the operator to enter delay information that indicates the type and duration of the delay. The information can be entered for delays in the transition from OUT to OFF, OFF to ON, or ON to IN depending on the page selected (1 through 3). This information is then automatically downlinked at post-flight in a Delay Code message. This page is accessible from the MAIN MENU page, the MISCELLANEOUS page, and the POST-FLIGHT menu.



7376-5041

CODE — Delay code indicates type of delay. Format: 1 - 2 numeric characters. Note: Entry is optional. Dashes fill field if no valid entry is made.

MINUTES — Duration of delay. Format: 1 – 3 numeric characters. Note: Entry is optional. Dashes fill field if no valid entry is made.

0001 Flight Phase States

A typical flight leg starts in the IN state. This state represents the real world situation where the aircraft is sitting at the gate with its doors open and its parking brake set.

After the aircraft is loaded, the doors are closed and the parking brake is released. This results in a flight phase state change to OUT. At this time, the OUT time is logged and an Out Report message is automatically downlinked.

In a normal flight leg, the aircraft would then taxi to the runway and takeoff. At takeoff, when the strut sensor (air / ground sensor) shows “air,” the flight phase state changes to OFF. At this time, the OFF time is logged and an Off Report message is automatically downlinked.

The OFF state continues until the aircraft lands and the strut sensor shows “ground.” This results in a flight phase state change to ON. At this time, the ON time is logged and an On Report message is automatically downlinked.

After taxiing to the gate, the brake is set and a door is opened (or vice versa). The flight phase state changes to IN when a door is opened. The IN time is logged as the earlier of the last brake set time or the first door open time.

After the IN event, a new flight leg is started when the INITIALIZE page is first viewed. If the aircraft goes to the OUT state before the INITIALIZE page is viewed, the OUT event causes the transition to a new flight leg. It is at this “start-of-flight” event that the flight data from the previous flight is cleared, and any uplink message logs are cleared in preparation for the new flight.

Two other special conditions will occasionally occur. The first condition occurs when an aircraft is in the OUT state and, for whatever reason, a door must be opened. At this time, a Return To Gate message is automatically downlinked, including the time the door was opened. When all doors are once again closed and the brake is released, another Out Report message is automatically downlinked showing this new OUT time. The original OUT time, however, is saved and displayed as the true OUT time in the ACARS system. If the flight must be canceled, the *RESET FLIGHT LEG select on the TAKEOFF DELAY page may be used to reset the system to the IN state. Use of this RESET FLIGHT LEG function causes a Reset Flight message to be automatically downlinked.

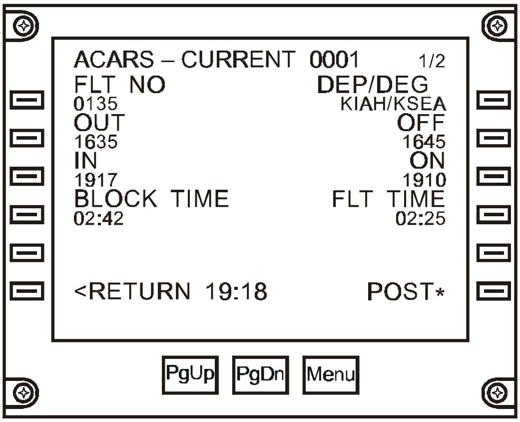
The second special condition is the touch-and-go. A touch-and-go will cause an On Report to be automatically downlinked, followed shortly by an Off Report when the aircraft lifts off.

0001

The CURRENT 0001 page allows the operator to review 0001 information for the current (page 1) and previous (page 2 “PREVIOUS 0001”) flight legs. This page is accessible from the MAIN MENU page.

The current / previous flight leg information is reset at the End of Flight event.

No manual entry is allowed on this page. Any field for which information is not available is filled with dashes.

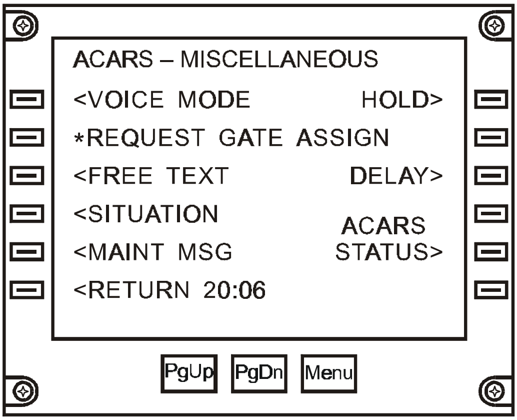


7376-5042

FLT NO	Flight number from INITIALIZATION page.
OUT	Out event time.
IN	In event time.
BLOCK TIME	Total block time = IN time - OUT time.
DEP/DES	Departure and Destination stations from the INITIALIZATION page.
OFF	Off event time.
ON	On event time.
FLT TIME	Total flight time = ON TIME – OFF TIME.

Miscellaneous

The MISCELLANEOUS page provides eight miscellaneous page selects and the "Request Gate Assign" function. This page is accessible from the MAIN MENU.

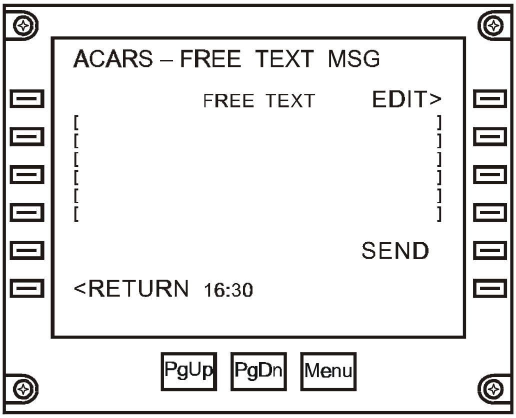


7376-5043

VOICE MODE	Selection displays the SELCAL page (see Technical Application Section).
REQUEST GATE ASSIGN	Selection queues a Request Gate Assignment message for downlinking. This operates identically to the SEND select.
FREE TEXT	Selection displays the FREE TEXT MSG page.
SITUATION	Selection displays the SITUATION RPT page.
MAINT MSG	Selection displays the MAINT MSG page.
HOLD	Selection displays the ENTER / LEAVE HOLD page.
DELAY	Selection displays the DELAYS page.
ACARS STATUS	Selection displays the STATUS page.

Free Text Msg

The FREE TEXT MSG page allows the operator to enter and downlink a Free Text message. The message can consist of up to 16 lines of 24 characters each. This page is accessible from the MISCELLANEOUS menu.

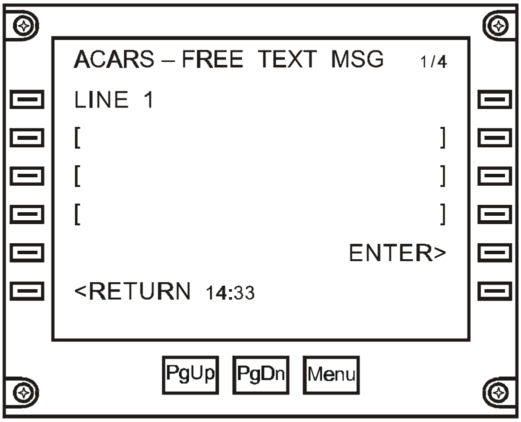


7376-5044

Free Text	Display only (first 6 lines of text as entered in EDIT).
EDIT	Selection displays Edit Free Text page. Allows entry of up to 16 lines of 24 character / line free text.
CLEAR TEXT	Select available when free text is present. Selection clears all free text.
SEND	If text on any line has been returned from the EDIT FREE TEXT page(s), SEND becomes large font and selection queues the Free Text message for downlinking.

Edit Free Text

The edit free text page allows the operator to edit / review / accept free text. This page is accessible via the EDIT select on the FREE TEXT MSG, IN RANGE RPT, and MAINT MSG pages. These pages allow 16 lines of free text, therefore having four edit pages available. The page title is determined by the calling page.



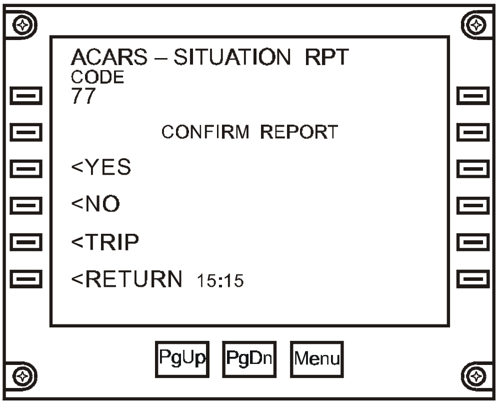
7376-5045

Free Text (Lines 1 through 4)	Four Lines of free text. Format: 1 to 24 free text characters per line
ENTER	Select is only available if free text has been changed. Selection returns text to calling page.

Situation Report

The SITUATION REPORT page allows the operator to enter information about an emergency situation and downlink an Emergency Report message. This page is accessible from the MISCELLANEOUS menu.

An emergency code is used to determine the contents and actions of this page. Until a code is entered, the page will only consist of the system default fields (title, “RETURN”, and advisory) and the “CODE” field. When 77 is entered as the code, the “CONFIRM REPORT”, “YES”, “NO”, and “TRIP” fields will appear. When 75 is entered as the code, the 7500 RPT page is displayed allowing the operator to downlink a 7500 Report. If any other code is entered, the display will act as if RETURN had been selected.

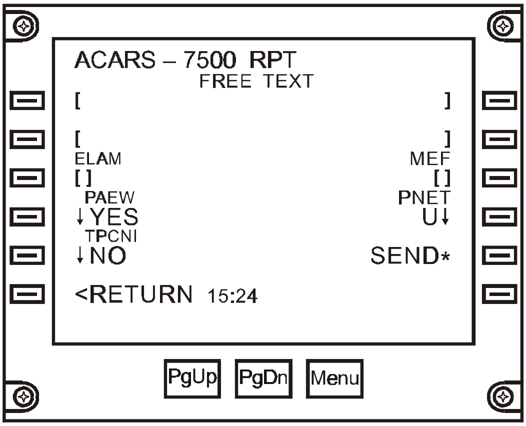


7376-5046

CODE	Determines the contents and actions of this page as noted above. Format: 75 or 77
YES	Selection displays the FREE TEXT MSG page which allows the entry of free text to be appended to the Situation Report message. Selection of the SEND key from the FREE TEXT MSG page will queue the Situation Report message for downlinking and return display to the MISCELLANEOUS menu page.
NO	Selection causes the display to act as if RETURN had been selected.
TRIP	Selection immediately queues the Situation Report message for downlinking and returns display to the MISCELLANEOUS menu page.

7500 RPT

The 7500 RPT page allows the operator to enter emergency information and downlink an Emergency Report. This page is accessed only by entering a code 75 on the SITUATION REPORT page.

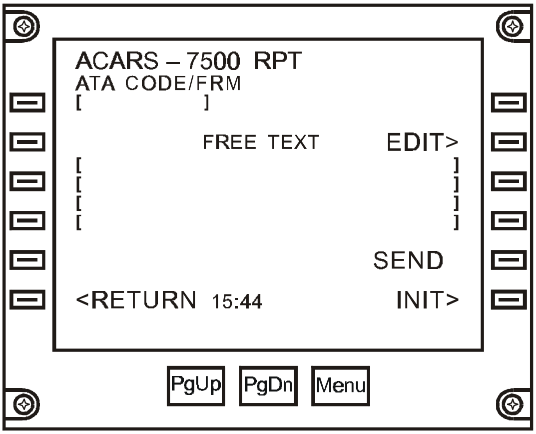


7376-5047

FREE TEXT	Accepts entry of two lines of free text to be included in the Emergency Report downlink. Format: Two lines of up to 24 characters each.
ELAM	Number of males. Format: 1 – 2 numeric characters.
PAEW	Are weapons being used? Format: **"<u>YES</u>"**, "NO"
TPCNI	Are they on the flight deck? Format: **"<u>NO</u>"**, "YES"
MEF	Number of females. Format: 1 – 2 numeric characters.
PMET	What is temperament? Format: "**U**"nknown, "**C**"alm, "**I**"ntense
SEND	Selection queues a 7500 Report message for downlinking.

Maintenance Msg

The MAINT MSG page allows the operator to enter maintenance information and downlink a Maintenance Message. This page is accessible from the MISCELLANE0US menu. DLOP (Data Link Operational Problems), NDOP (Nav Database Operational Problems) are written and sent on this page.

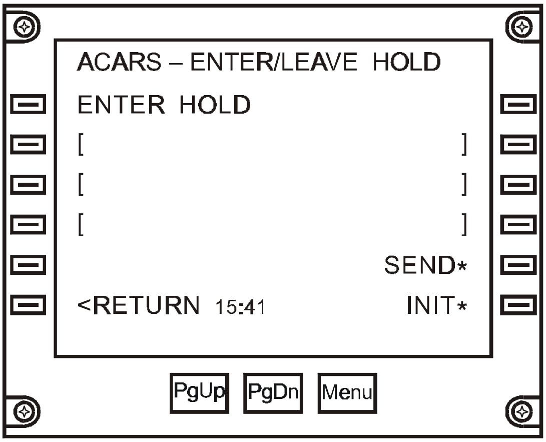


7376-5048

ATA CODE/FRM	Air Transport Association equipment code. Format: 1 - 10 alpha / numeric characters.
Free Text	Display Only. Format: zzz..z (up to 24 characters / line for 4 lines).
CLEAR TEXT	Select available when free text has been entered through EDIT select. Selection clears all free text.
EDIT	Selection displays the Edit Free Text page. Allows entry of up to 16 lines of 24 character / line free text.
SEND	If any entry has been made by the operator, SEND becomes large font and selection queues the Maintenance Message for downlinking.

Hold

The ENTER / LEAVE HOLD page allows the operator to create and send an Enter / Leave Hold message when the aircraft is entering or leaving a hold condition. This page is accessible from the MISCELLANEOUS menu.

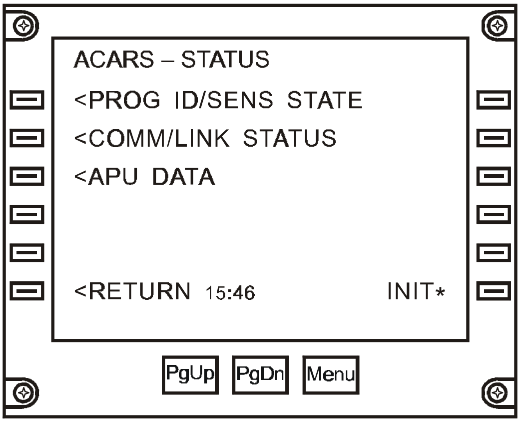


7376-5049

ENTER HOLD/ LEAVE HOLD	Automatically toggles between ENTER HOLD and LEAVE HOLD to indicate which transition the aircraft is in. This determines which type of message is queued when SEND is selected. State will be reset to ENTER HOLD after End-of-Flight. If an Enter Hold message is downlinked, the state will become LEAVE HOLD. If a Leave Hold message is downlinked, the state will return to ENTER HOLD. Format: "ENTER HOLD" or "LEAVE HOLD"
Free Text	Allows the operator to specify up to three lines of free text to be added to the message. Format: zzz ... z (up to 24 characters / line for 3 lines).
SEND	Selection queues an Enter / Leave Hold message for downlinking.

Status

The STATUS page provides three page selects that give access to status information on the 0001 sensors, communication links, and the APU. This page is accessible from the MISCELLANEOUS menu.



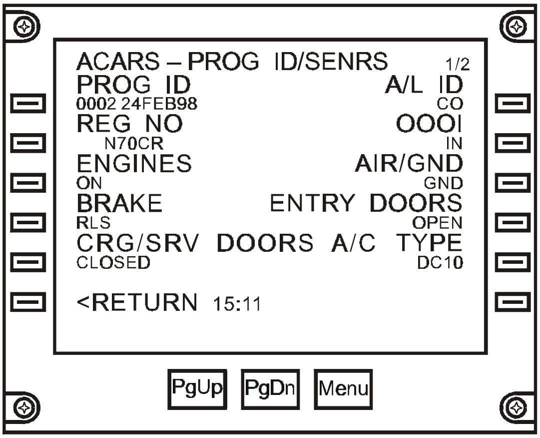
7376-5050

PROG ID / SENS STATE	Selection displays the PROG ID / SENRS page.
COMM/LINK STATUS	Selection displays the LINK STATUS page (see Technical Application Section).
APU DATA	Selection displays the APU DATA page.

Prog ID/Senrs

The PROG ID / SENRS page allows the operator to review software version, airline, aircraft, and 0001 sensor information. The fields on this page are display only. No manual entry is allowed. This page is accessible from the STATUS page.

Note: This page is to be used for testing and maintenance purposes only. Some sensors as shown on these pages may not be connected and therefore may not register the correct state.



7376-5051

PROG ID — Displays program version number and generation date.

REG NO — Displays aircraft registration number as received from program pins.

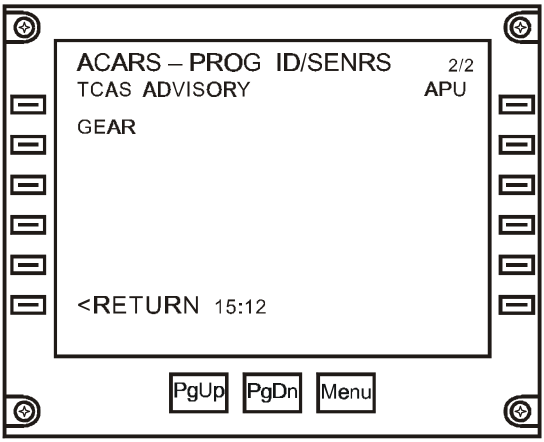
ENGINES — Displays the state of the engine sensors. "ON" if any engine is on, "OFF" if all engines are off.

BRAKE — Displays the state of the parking brake sensor. "SET" if brake is set, "RLS" if brake is released.

CRG / SRV DOORS — Displays the state of the service, cargo, and EE doors sensors. "OPEN" if any is open, "CLOSED" if all are closed.

A/L ID — Displays the current Airline ID.

0001	Displays the current 0001 state. Format: "OUT", "OFF", "ON", "IN"
AIR / GND	Displays the state of the strut sensor. "AIR" if airborne, "GND" if on the ground.
ENTRY DOORS	Displays the state of the entry doors sensors. "OPEN" if any are open, "CLOSED" if all are closed.
A/C TYPE	Displays the current aircraft type as read from the program pins.



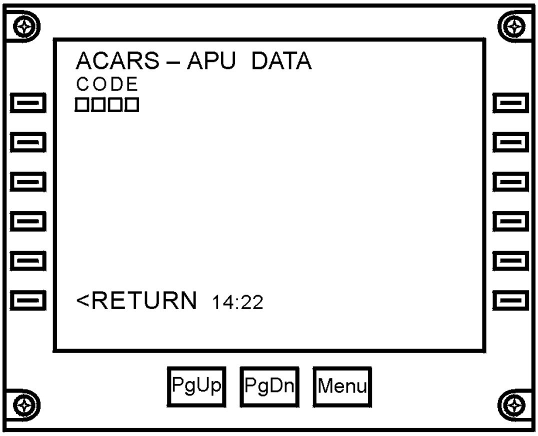
7376-5052

TCAS ADVISORY	Displays the state of the TCAS advisory discrete. "ON" if on, "OFF" if off.
GEAR	Displays the state of the landing gear sensor. "UP" if retracted, "DOWN" if extended.
APU	Displays the state of the APU sensor. "ON" if on, "OFF" if off.

APU Data

The APU DATA page allows the operator to review cycle and run time information for the APU and reset these to zero when the APU is changed out. This page is accessible from the STATUS page.

An access code is used to determine the contents and actions of this page. Until the correct code is entered, the page will only consist of the system default fields (title, “RETURN”, and “ADVISORY”) and the “CODE” field. When the proper access code is entered, the “*APU CHANGED”, “APU CYCLES nnn”, and “APU RUN TIME hhhmm” fields will appear. If any other code is entered, the display will act as it RETURN had been selected.

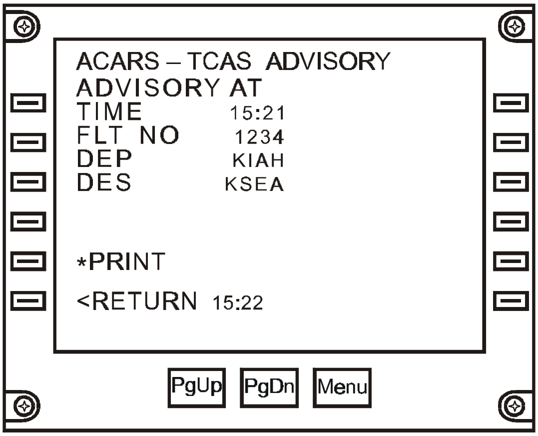


7376-5053

CODE — Determines the contents and actions of this page as noted above. Format: nnnn

TCAS Advisory

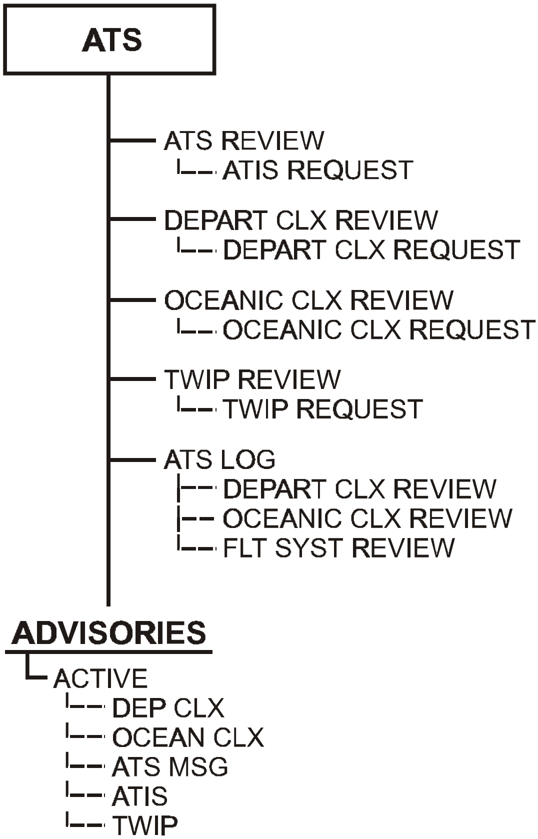
The TCAS ADVISORY page allows the operator to review information from the automatic TCAS ADVISORY downlink message. This page is for review only "-" no entry is allowed. This page is accessible via the TCAS active advisory.



7376-5054

TIME	UTC time the message was queued for downlink.
FLT NO	Flight number.
DEP	Departure station.
DES	Destination station.
PRINT	Selection prints contents of this page. <u>Note</u>: Select is available only when a printer is connected and reporting its status as okay.

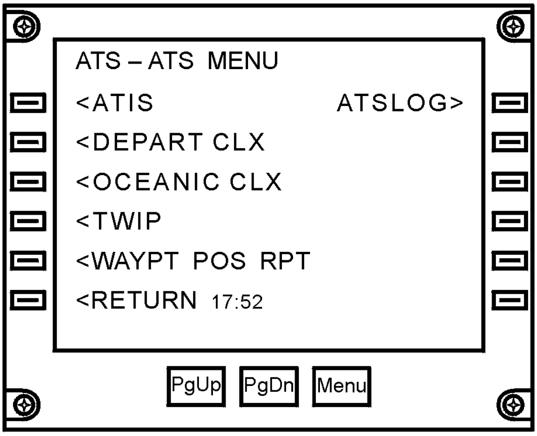
ACARS – System Menu Tree (ATS)



7376-5055

ATS Menu

The ATS MENU page provides access to the Air Traffic Services pages. This page is accessible from the Application Menu display.

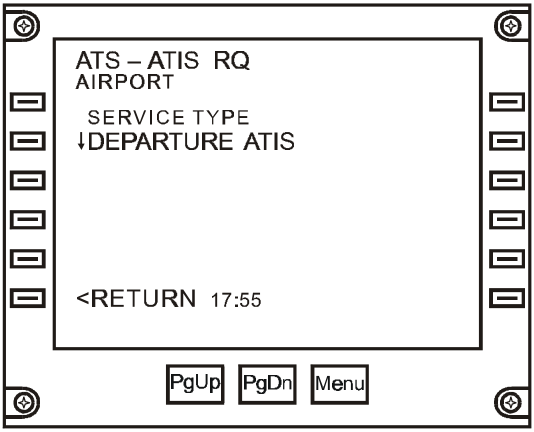


7376-5056

ATIS	If an ATIS Report - ARINC format is available, selection displays the ATIS REVIEW page. Otherwise, the ATIS RQ page is displayed.
DEPART CLX	If a Departure Clearance Report is available, selection displays the DEPART CLX REVIEW page. Otherwise, the DEPART CLX RQ page is displayed.
OCEANIC CLX	If an Oceanic Clearance Report is available, selection displays the OCEANIC CLX REVIEW page. Otherwise, the OCEANIC CLX RQ page is displayed.
TWIP	If a TWIP Report is available, selection displays the TWIP REVIEW page. Otherwise, the TWIP RQ page is displayed.
ATS LOG	Selection displays the ATS LOG page.

ATIS RQ

The ATIS RQ page allows the operator to send an ATIS Request message. This page is accessible from ATS MENU page.



7376-5057

AIRPORT	Airport of interest. Four character ICAO airport codes except for three Japan three character IATA codes. Format: Four alpha / numeric characters or one of the following three character codes NSJ, WSJ, SSJ. Default: Departure station before OFF event. Destination station after OFF event.
SERVICE TYPE	ATIS report type. Range: DEPARTURE ATIS, ENROUTE INFO SERVICE, ARRIVAL ATIS. Default: DEPARTURE ATIS if state is IN or OUT. ARRIVAL ATIS if state is OFF or ON.
REPORTING MODE	Select is available only when SERVICE TYPE is ARRIVAL ATIS. Selection allows user to specify a downlink message that will start or stop auto-updates. Range: SINGLE REPORT, START AUTO-UPDATES, STOP AUTO-UPDATES.
SEND	Selection available only if the AIRPORT field is filled. Selection queues appropriate ATIS Request message for downlinking. Specific downlink format is dependent on field values as described below.

ATIS Request - ARINC Format

Automatically selected when none of the above service providers and types of service are determined. ARRIVAL (with automatic update), DEPARTURE, and ENROUTE INFO SERVICE will be available for SERVICE TYPE field.

Note: Some types of service may not be available in certain locations and service may require subscription.

Default data is available for all fields. Manually entered data is not cleared after the message has been sent. All data will be automatically cleared at the start of a new flight leg and just after the transition to the “OFF” 0001 state.

Data entry determines service provider and types of service available according to the following rules:

ATIS Request - Japanese Format

Automatically selected when AIRPORT entry is four alpha characters and the first character is ‘R’. ARRIVAL / DEPARTURE will be the SERVICE TYPE, and no other selections will be available.

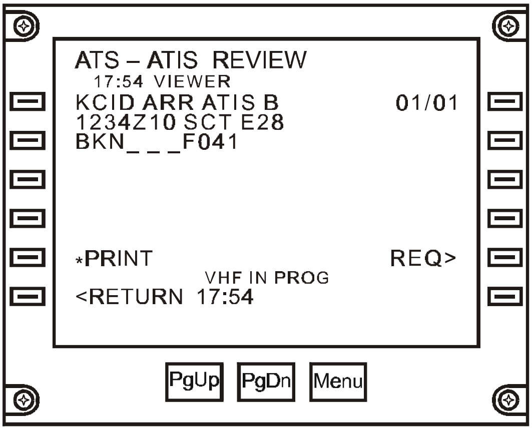
AEIS Request - Japanese Format

Automatically selected when AIRPORT entry is either ‘NSJ’, ‘WSJ’, or ‘SSJ’. ENROUTE INFO SERVICE will be the SERVICE TYPE, and no other selections will be available.

ATIS Review

The ATIS REVIEW page allows the operator to view the latest ATIS Report uplink message. This page is accessible as shown on the ATS MENU page and, when available, via the ATIS active advisory.

The total number of pages is dependent on the message size.



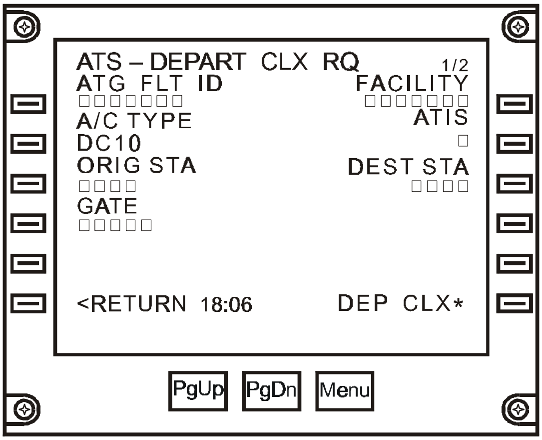
7376-5058

Time	UTC time when message was received.
Status	Message status. Range: NEW Message has not been viewed. OPEN At least one page of the message has been displayed. VIEWED All pages of the message have been displayed.
Text	ATIS Report uplink message text.
REQ	Selection displays ATIS RQ page.
PRINT	Selection queues ATIS Message to be printed.

Depart CLX RQ

The DEPART CLX RQ pages allow the operator to send a Departure Clearance Request message. This page is accessible from the ATS MENU.

Default data may be available for all fields except GATE and FREE TEXT. Default data is updated on this page whenever it changes. Manually entered data is cleared after the message has been sent. All data is automatically cleared at the start of a new flight leg.



7376-5059

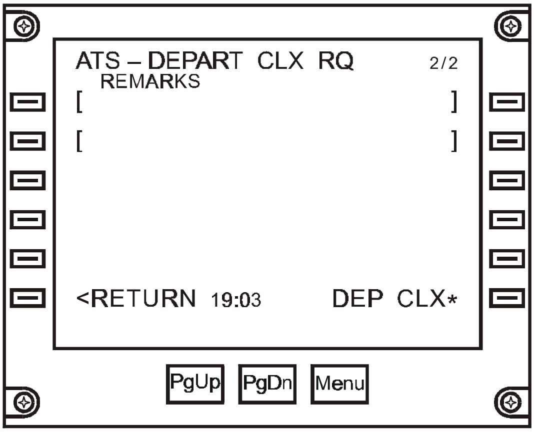
ATS FLT ID — ATS flight identifier. A default flight ID will be provided and is ‘COA’ followed by the flight number. This is a ‘best guess’ only and may not be the correct flight ID as assigned by ATS. The crew should always double-check that this ID is correct and enter a corrected ID if necessary. Format: 2 - 7 alpha / numeric characters.

FACILITY — Teletype address of ATC facility servicing predeparture clearance request or 4 character ICAO airport code. Default data may be available. Format: 4 or 7 alpha / numeric characters.

A/C TYPE — Aircraft type. Default data may be available. Format: 2 - 4 alpha / numeric characters.

ATIS	Current ATIS designation. Default data may be available if an ATIS Report uplink has been received and viewed. Format: 1 alpha character.
ORIG STA	Departure airport. Four character ICAO airport code. Default data may be available. Format: 4 alpha characters.
DEST STA	Destination airport. Four character ICAO airport code. Default data may be available. Format: 4 alpha characters.
GATE	Current gate position of the aircraft. Format: 1 - 5 alpha / numeric characters.
SEND*	Select is only available if all required fields are filled. Selection queues Departure Clearance Request message for downlinking.

This page is accessible from the DEPART CLX RQ ½ page.



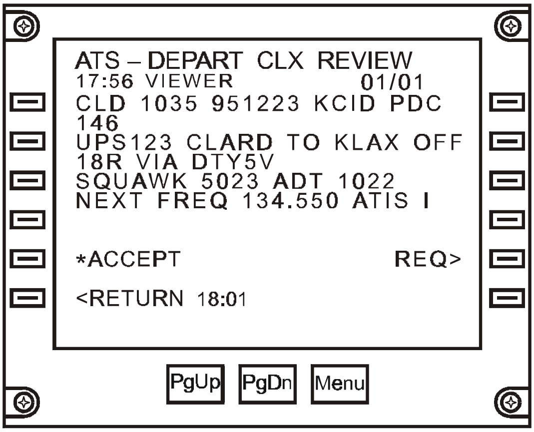
7376-5060

REMARKS	Free text. Format: 1 - 24 characters of free text / line (2 lines).

Depart CLX Review

The DEPART CLX REVIEW page allows the operator to view / accept the selected Departure Clearance Report message. This page is accessible from the ATS MENU and, when available, via the DEP CLX active advisory.

The total number of pages is dependent on the message size.

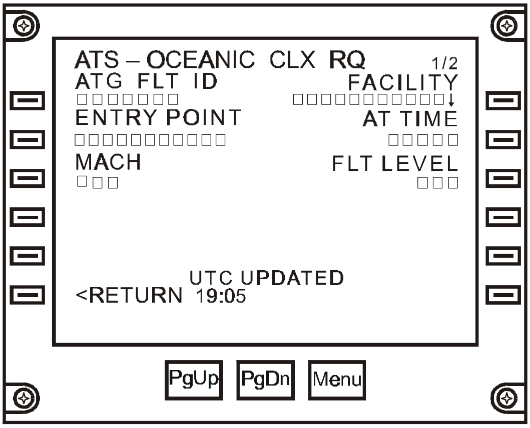


7376-5061

Time	UTC time when message was received.
Status	Message status. Range: NEW Clearance has not been viewed. OPEN At least one page of the clearance has been displayed. VIEWED All pages of the clearance have been displayed. ACCEPTED Clearance has been accepted.
Text	Displays Departure Clearance Uplink Message text.
ACCEPT/PRINT	This select cycles through two modes as follows: *ACCEPT Select is available only if displayed Departure Clearance Report message has OPEN status (i.e., not previously accepted). Selection queues Departure Clearance Readback Message for downlinking, marks message status as ACCEPTED, and cycles to PRINT. *PRINT Select is available if message status is ACCEPTED and a printer is connected and functional. Selection queues Departure Clearance Message for printing.
REQ	Selection displays DEPART CLX RQ page.

Oceanic CLX RQ

The OCEANIC CLX RQ pages allow the operator to send an Oceanic Clearance Report message. This page is accessible from the ATS MENU.



7376-5062

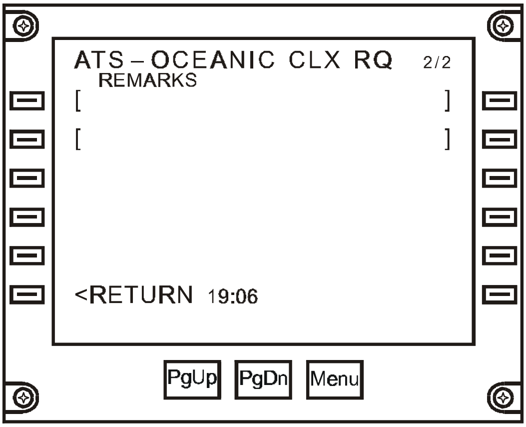
ATS FLT ID — ATS flight identifier. A default flight ID will be provided and is 'COA' followed by the flight number. This is a 'best guess' only and may not be the correct flight ID as assigned by ATS. The crew should always double-check that this ID is correct and enter a corrected ID if necessary. Format: 2 – 7 alpha / numeric characters.

FACILITY — Oceanic clearance facility. Range: GANDER, REYKJAVIK, SANTA MARIA, SHANWICK

ENTRY POINT — Oceanic track entry point identifier. Latitude / Longitude value is checked for validity. Format: 1 - 11 alpha / numeric characters. Latitude / Longitude: (N or S) + Lat (1, 2 or 4 numeric) + (E or W) + Long (1, 2, 3, or 5 numeric) or Lat (1, 2 or 4 numeric) + (N or S) + Long (1, 2, 3, or 5 numeric) + (E or W) <u>Note</u>: The Latitude must be less than 90 degrees. The longitude must be less than 180 degrees. Named Reporting Point: Navaid ID / Waypoint - 3 - 5 alpha characters.

AT TIME — Estimated time of arrival at entry fix. Format: HH:MM

MACH	Mach number requested for cruise. Format: 2 numeric characters.
FLIGHT LEVEL	Altitude requested at entry fix. Format: 1 - 3 numeric characters.
SEND*	Select is only available if all required fields are filled. Selection queues Oceanic Clearance Request message for downlinking.



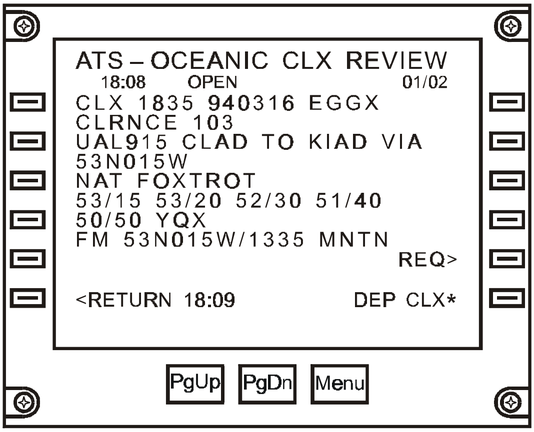
7376-5063

REMARKS	Free text. Format: 1 - 24 characters of free text / line (2 lines).
SEND*	Select is only available if all required fields are filled. Selection queues Oceanic Clearance Request message for downlinking.

Oceanic CLX Review

The OCEANIC CLX REVIEW page allows the operator to view / accept the selected Oceanic Clearance Report message. This page is accessible from the ATIS MENU and, when available, via the OCEAN CLX active advisory.

The total number of pages is dependent on the message size.



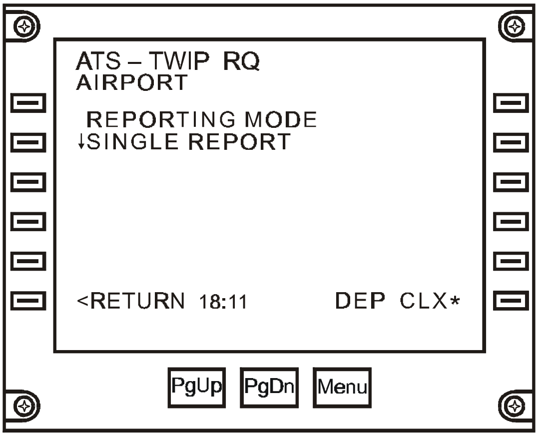
7376-5064

Time	UTC time when message was received.
Status	Message status. Range: NEW Clearance has not been viewed. OPEN At least one page of the clearance has been displayed. VIEWED All pages of the clearance have been displayed. ACCEPTED Clearance has been accepted.
Text	Displays Oceanic Clearance Uplink Message text.
ACCEPT/PRINT	This select cycles through two modes as follows: *ACCEPT Select is available only if displayed Oceanic Clearance Report message has OPEN status (i.e. not previously accepted). Selection queues Oceanic Clearance Readback Message for downlinking, marks message status as ACCEPTED, and cycles to PRINT. *PRINT Select is available if message status is ACCEPTED. Selection queues Oceanic Clearance Message for printing.
REQ	Selection displays OCEANIC CLX RQ page.

TWIP RQ (Not Activated For Continental Airlines)

The TWIP RQ page allows the operator to send a TWIP Request message. This page is accessible from the ATS MENU.

The auto update TWIP request message will inform the ground service provider that TWIP reports should be delivered to the aircraft as they are updated. Selecting / sending the START AUTO-UPDATES reporting mode starts the automatic updates. Selecting / sending the STOP AUTO-UPDATES reporting mode terminates the automatic updates. Not all airports support the automatic update features.



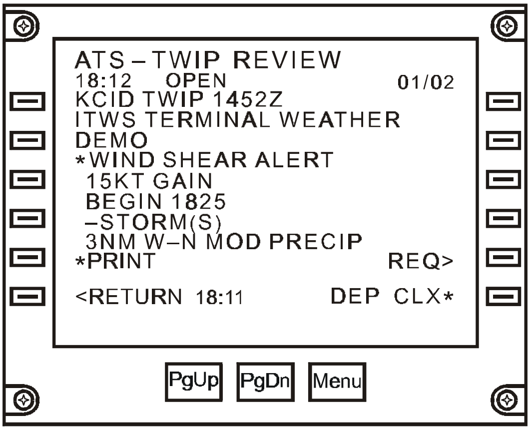
7376-5065

AIRPORT	Airport of interest. Format: 3 - 4 alpha / numeric characters. Default: Departure station before the OFF event. Destination station after the OFF event.
REPORTING MODE	Reporting mode. Range: <u>SINGLE REPORT</u>, START AUTO-UPDATES, STOP AUTO-UPDATES.
SEND*	Selection available only if all required fields are filled. Selection queues appropriate TWIP Request message for downlinking.

TWIP Review

The TWIP REVIEW page allows the operator to view the selected TWIP Report message. This page is accessible from the ATS MENU and, when available, via the TWIP active advisory.

The total number of pages is dependent on the message size.



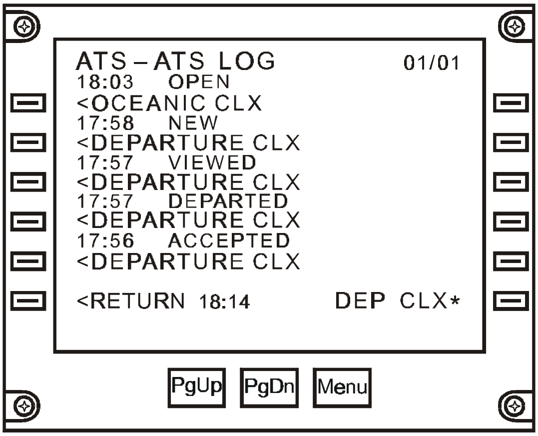
7376-5066

Time	UTC time when message was received.
Status	Message status. Range: NEW Message has not been viewed. OPEN At least one page of the message has been displayed. VIEWED All pages of the message have been displayed.
Text	Displays TWIP Report Uplink Message text.
PRINT	Select is available if printer is connected and functional. Selection queues TWIP Message to be printed.
REQ	Selection displays TWIP RQ page.

ATS Log

The ATS LOG page allows the operator to view a list of uplinked Departure Clearance, Oceanic Clearance, and Flight System messages, and select an individual message for viewing. This page is accessible from the ATS MENU.

Up to 25 messages can be listed on these pages.

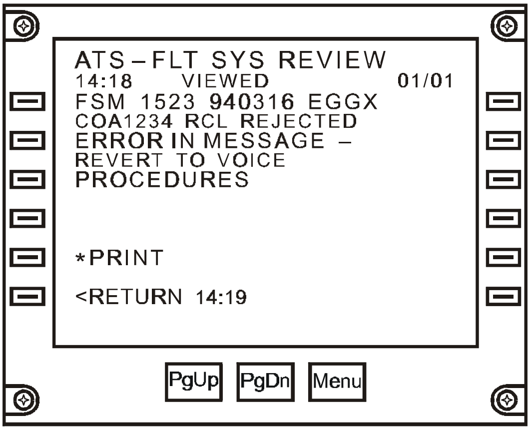


7376-5067

Time Stamp	UTC time when message was received.
View Status	For clearance report messages: NEW Clearance has not been viewed. OPEN At least one page of the clearance has been displayed. VIEWED All pages of the clearance have been displayed. ACCEPTED Clearance has been accepted. For Flight System Messages: NEW Message has not been viewed. OPEN At least one page of the message has been displayed. VIEWED All pages of the message have been displayed.
Message Title	DEPART CLX Departure Clearance Report. OCEANIC CLX Oceanic Clearance Report. FLT SYS MSG Flight System Message. The message title will default to the first 16 characters of the uplink message if any unknown labels or message format errors are found.

FLY SYS Review

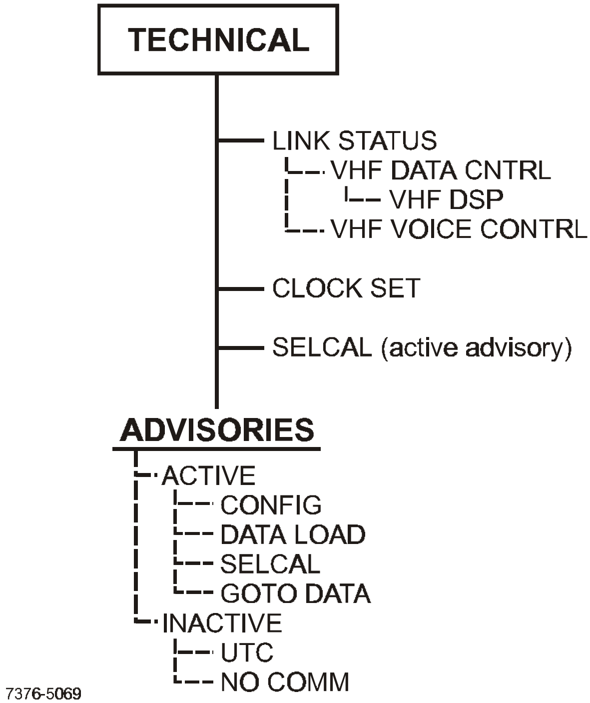
The FLT SYS REVIEW page allows the operator to view / accept an uplinked Flight System Message. This page is accessible from the ATS LOG page if there is a Flight System Message and, when available, via the ATS MSG active advisory.



7376-5068

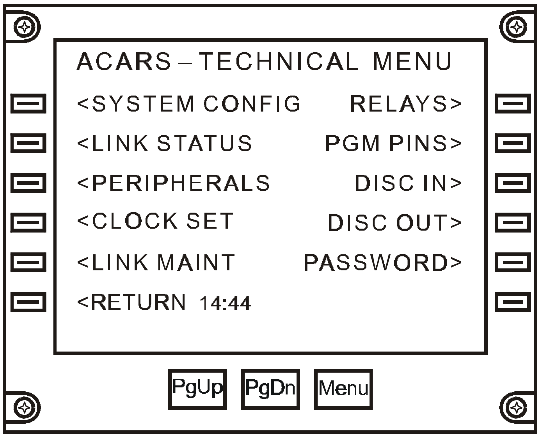
Time	UTC time when message was received.
Status	Message status. Range: NEW Message has not been viewed. OPEN At least one page of the message has been displayed. VIEWED All pages of the message have been displayed.
Text	Displays Flight System uplink message text lines.
PRINT	Selection queues Flight System Message to be printed. This select is available only when a printer is connected and functioning properly.

ACARS – System Menu Tree (Technical)



Technical Menu

The TECHNICAL MENU is the initial Technical application page. This menu provides access to functions such as diagnostics, link maintenance, and other functions not normally accessed during a flight leg.



7376-5070

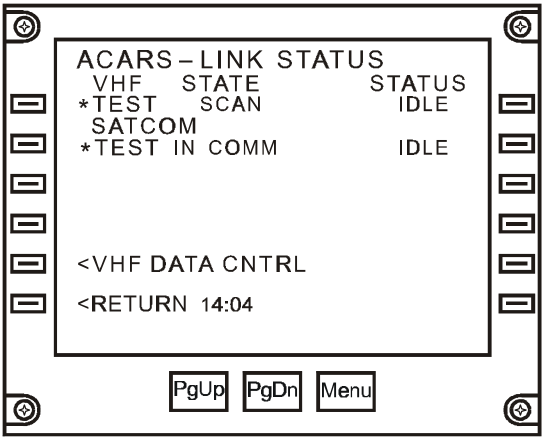
<u>Note</u>: This section only discusses Technical Application pages which are regularly used by the crew. All other pages are normally used only during installation and maintenance. See the Software Requirements Specification for display pages not covered in this section.

LINK STATUS Selection displays the LINK STATUS page.

CLOCK SET Selection displays the CLOCK SET page.

Link Status

The LINK STATUS page provides information about the current status of each existing communication medium as well as the ability to perform a link test for each communication medium. This page is accessible as shown on the TECHNICAL MENU page.



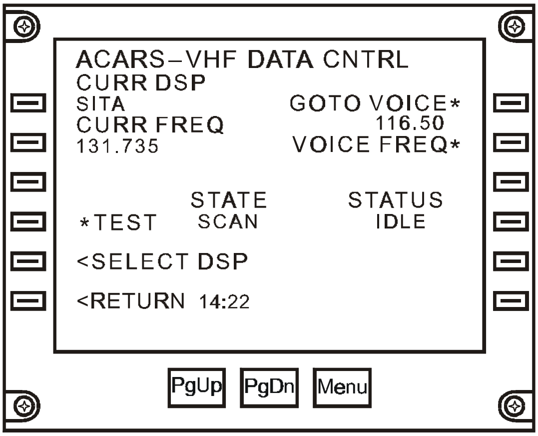
7376-5071

TEST (1 L)	Selection initiates a VHF link test. Test is successful if STATE changes to IN COMM.
TEST (2L)	Select is available when SATCOM is present. Selection initiates a SATCOM link test.
TEST (3L)	Select is available when HF is present. Selection initiates an HF link test.
STATE	Current operational state. Range: VHF VOICE System is in voice mode. SCAN System is searching for a datalink. IN COMM System has established a datalink. AUTOTUNE System has been autotuned to an alternate frequency. Range: SATCOM and HF LOGD ON System is logged on. LOGD OFF System is logged off. IN COMM System has established a datalink. NO RESP System is not responding.

STATUS	Current medium status. Range: IDLE No uplink or downlink messages currently in progress. UP MSG Uplink message reception currently in progress. DOWN MSG Downlink message transmission currently in progress. UP / DOWN UP MSG and DOWN MSG currently in progress.
AAA ... AAA (5L)	The select shows: VHF VOICE CNTRL while in voice mode. VHF DATA CNTRL while in data mode. Selection displays VHF DATA CNTRL or VHF VOICE CNTRL page, respectively.

VHF Data CNTRL

The VHF DATA CNTRL page provides control functions for the VHF communication medium while in data mode. This page is accessible as shown on the LINK STATUS page. This page is replaced by the VHF VOICE CNTRL page if the system switches to voice mode.



7376-5072

CURR DSP — Current VHF Datalink Service Provider identity. Range:

Displayed Text	Description
ARINC-AMER	ARINC Americas
SITA	SITA
SITA-PACIFC	SITA Pacific
SITA-BOEING	SITA at Boeing
AVICOM-JAPN	Japan
CANADIAN	Canada
MASCOM-MAL	Malaysia
TEST (AS)	SITA at Airbus
TEST (MD)	SITA at MD
TEST-BA	ARINC Europe

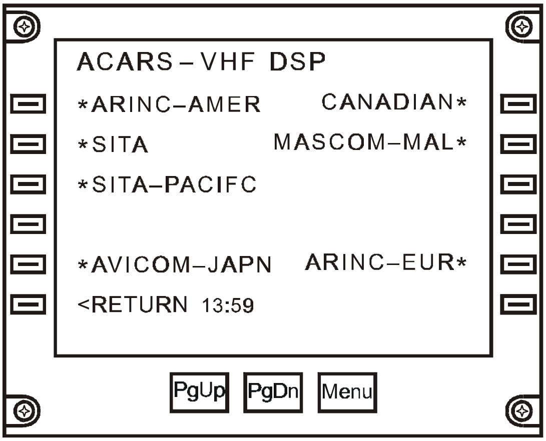
CURR FREQ	Displays current VHF data frequency. Range: 118.00 to 136.97 MHz.
GOTO VOICE	Select is available only when a frequency has been entered in the VOICE FREQ* field. Selection swaps primary and standby frequencies, loads new voice frequency into primary, and requests voice mode. A pause may occur if system is sending / receiving a message.
VOICE FREQ	Changes current VHF voice frequency. Range: 118,00 to 136.97 MHz. FORMAT: 5-digit frequency is entered without the decimal point.
STATE	Current VHF Operational state. Range: VOICE System is in voice mode. SCAN System is searching for a datalink. IN COMM System has established a datalink. AUTOTUNE System has been autotuned to an alternate frequency.
STATUS	Current VHF link status. Range: IDLE No uplink or downlink messages currently in progress. UP MSG Uplink message reception currently in progress. DOWN MSG Downlink message transmission currently in progress. UP / DOWN UP MSG and DOWN MSG currently in progress.
TEST (4L)	Selection initiates a VHF link test.
SELECT DSP	Selection displays VHF DSP page.

VHF DSP

The VHF DSP page provides the operator access to all Datalink Service Providers included in the scan algorithm. This page is accessible as shown on the VHF DATA CNTRL page.

Since setting the DSP list is generally an installation or maintenance function, and ACARS automatically scans this list, it is not generally necessary for the crew to use the functions on this page. During normal operation, the link with an appropriate DSP will be automatically initiated and maintained.

All selections may not be displayed as shown below.



7376-5073

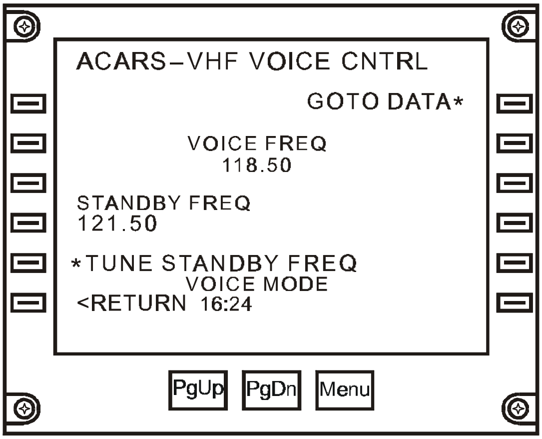
ARINC-AMER	Selection displays the VHF DATA CNTRL page and requests that ARINC-AMER be scanned as soon as possible.
SITA	Selection displays the VHF DATA CNTRL page and requests that SITA be scanned as soon as possible.
SITA-PACIFC	Selection displays the VHF DATA CNTRL page and requests that SITA-PACIFC be scanned as soon as possible.
TEST (BA)	Selection displays the VHF DATA CNTRL page and requests that ARINC Europe scanned, as soon as possible.
AVICOM-JAPN	Selection displays the VHF DATA CNTRL page and requests that AVICOM-JAPN be scanned as soon as possible.

CANADIAN	Selection displays the VHF DATA CNTRL page and requests that CANADIAN be scanned as soon as possible.
MASCOM-MAL	Selection displays the VHF DATA CNTRL page and requests that MASCOM-MAL be scanned as soon as possible.
TEST (AS)	Selection displays the VHF DATA CNTRL page and requests that SITA at Airbus be scanned as soon as possible.
TEST (MD)	Selection displays the VHF DATA CNTRL page and requests that SITA at MD be scanned as soon as possible.
ARINC-EUR	Selection displays the VHF DATA CNTRL page and requests that ARINC-EUR be scanned as soon as possible.

VHF Voice CNTRL

The VHF VOICE CNTRL page provides control functions for the VHF communication medium while In voice mode. This page is accessible from the LINK STATUS page.

This page is replaced by the VHF DATA CNTRL page if the system switches to data mode.



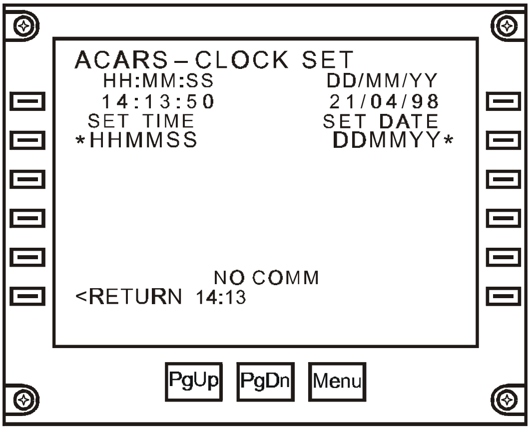
7376-5074

VOICE FREQ	Current tuned frequency.
STANDBY FREQ	Standby voice frequency. Format: 5-digit frequency is entered without the decimal point. Range: 118.00 to 136.97 MHz.
TUNE STANDBY FREQ	Swaps standby and current frequencies. Select is only available if STANDBY FREQ is filled.
GOTO DATA	Selection requests switch to data mode.

Clock Set

The CLOCK SET page provides access to the MU system clock and the ground network system time. This page is accessible as shown on the TECHNICAL MENU.

A clock advisory downlink is queued anytime the internal clock is modified by a period of 60 seconds nominal.



7376-5075

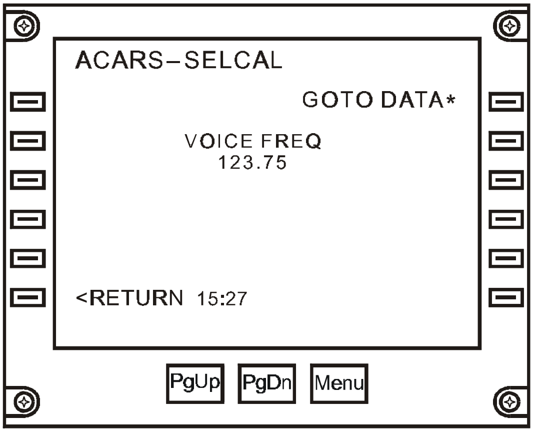
HHMMSS	Selection sets the system clock time. Enter a 6-digit time of the format HHMMSS. Select is only available when the aircraft is in the IN state and ACARS is NO COMM.
DDMMYY	Selection sets the system clock date. Enter a 6-digit date of the format DDMMYY. Select is only available when the aircraft is in the IN state and ACARS is NO COMM.
GROUND REQ	Select is available when system is in communications with the ground. Selection queues a UTC Clock Update Request message. The UTC Clock Update response uplink will synchronize the system time with the ground system time.

SELCAL

This page shows the contents of the SELCAL uplink message. This page is accessible via the SELCAL active advisory.

Reception of a SELCAL uplink with a valid voice frequency causes the primary voice frequency to be swapped into the standby frequency and the uplinked voice frequency to be loaded into the primary voice frequency. A switch into voice mode following the reception of a SELCAL message tunes to the uplinked frequency.

This page is replaced by the VHF VOICE CNTRL page if the system switches to voice mode.



7376-5076

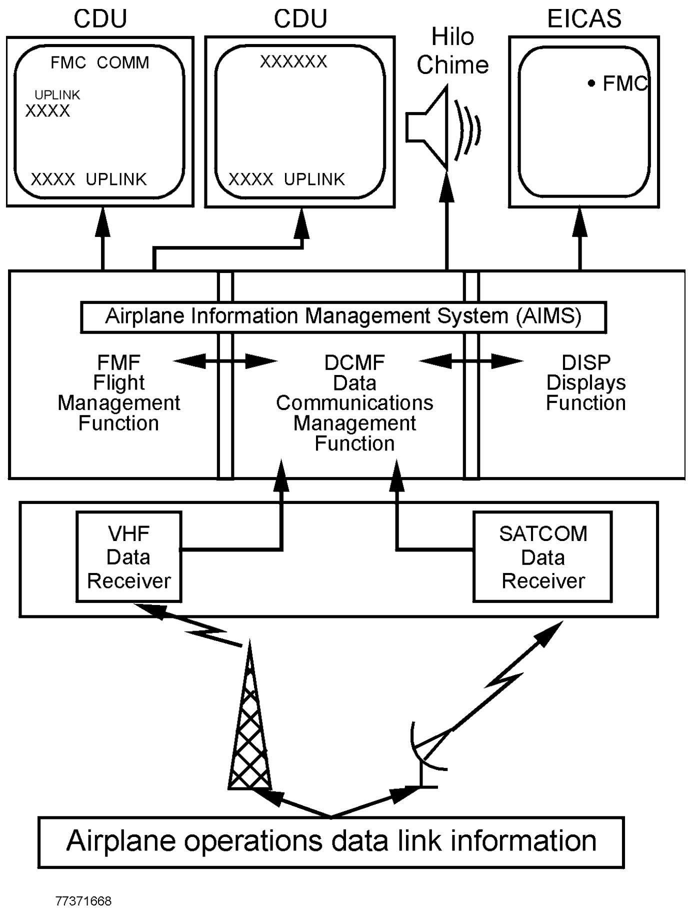
VOICE FREQ Frequency given within uplink message. Range: 118.00 to 136.97 MHz.

GOTO VOICE Selection requests switch to voice mode at the VOICE FREQ shown.

Note: The switch to voice mode is delayed until the system is done sending or receiving data.

7 8 9 DATA LINK

The onboard communication system provides for two-way data link communications between the FMC and airline operations. Information may be downlinked from the FMC either manually or automatically. Information may be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.



COMPANY DATA LINK

Downlinks

Downlinks are data link message transmitted to a ground station. Requests for information and reports of FMC information are two types of downlinks. Requests are manually initiated. Reports can be manually initiated or occur automatically.

Manual Downlinks

Downlink request for data may be initiated by selection of a REQUEST prompt from the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST or RTE DATA pages. Downlink reports of the current route may be accomplished by selection of the REPORT prompt on the RTE page and a position report may be downlinked by selection of the REPORT prompt on the POS REPORT page.

When the communications function is unable to process FMC downlinks, the words FAIL, NO COMM, or VOICE are displayed on the CDU pages in place of the REQUEST and REPORT prompts. The data link status is also displayed on the FMC COMM page. Radios supporting data link operations can be reconfigured by the crew through the MFD COMM function. The status messages are:

- FAIL
  - The AIMs data communications management function is inoperative, or
  - Both the VHF and SATCOM data radios have failed.
- NO COMM
  - The VHF and SATCOM data radios are operational but not available,
  - The VHF data radio has failed and the SATCOM data radio is not available, or
  - The SATCOM data radio has failed and the VHF data radio is not available.
- VOICE
  - All available radios are operating in the VOICE mode.

Reports

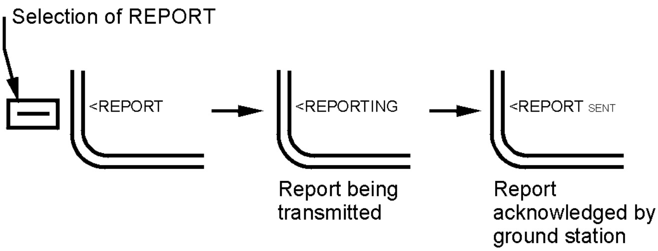
Each page containing a REPORT prompt downlinks a unique report appropriate for that page. The following pages contain report prompts.

77371669

CDU PAGE

Report Pages

Following is a typical sequence of status in response to sending a report.



77371669A

CDU PAGES

Automatic Downlinks

The FMC can be configured by the airline to automatically transmit downlinks of FMC data at predetermined points during the flight or in response to specific information requests from the airline dispatcher. The FMC response in these cases is completely automatic and no crew action is required.

Uplinks

Uplinks are messages transmitted to the aircraft. Most uplinks require manual processing. Two uplinks automatically load data into the FMC and do not require execution.

Uplink processing actions depend on the type of uplink. Processing can be through **ACCEPT / REJECT** or **LOAD / PURGE** prompts, FMC modification **ERASE** prompt or EXEC key, or by accessing the page containing the uplink. Glareshield mounted accept and reject switches perform the same as **ACCEPT / REJECT** prompts.

Data can be uplinked from the airline dispatcher directly to the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST and WIND pages. The uplinks are annunciated to the crew by the FMC EICAS communications alert and a HI-LO chime. The uplink is identified by a CDUK scratchpad message and by the presence of an UPLINK label over the appropriate COMM page prompt.

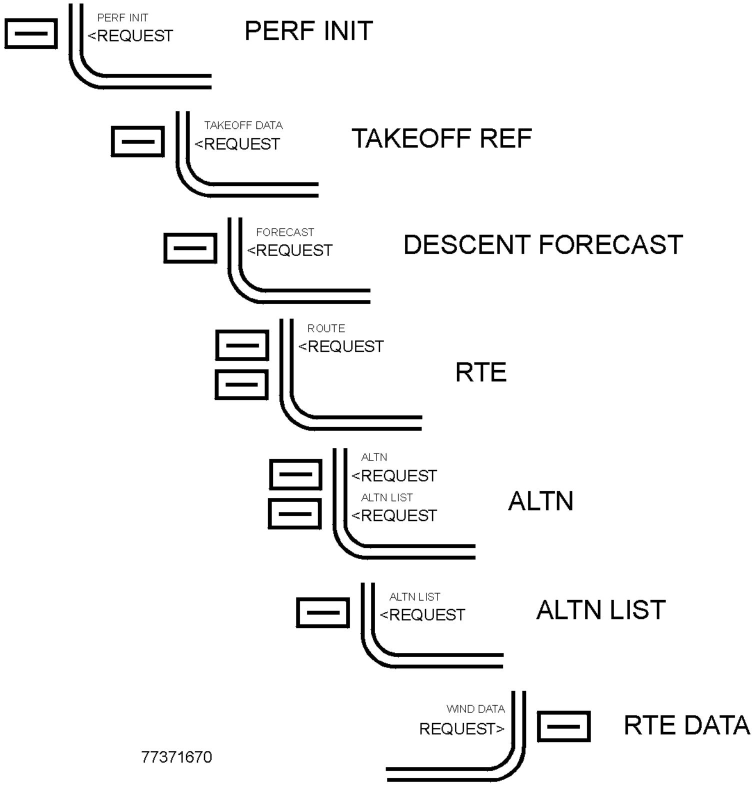
Takeoff uplinks are not annunciated until:

- Gross weight is entered on the PERF INIT page
- A route is activated
- The active route has a departure runway (and intersection, if applicable) matching the TAKEOFF uplinks (up to six takeoff records can be uplinked).

If there is no active route, wind uplinks are not annunciated, and the **<WIND** prompt on the COMM page does not appear.

Requests

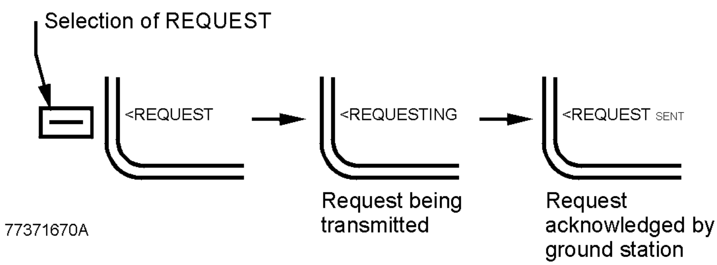
Each page containing a **REQUEST** prompt downlinks a unique requirement for information appropriate for that page. The following pages contain request prompts.



CDU PAGES

Request Status

Following is a typical sequence of status in response to sending a request.



CDU PAGES

FMC Data Link Uplinks (Accept / Reject)

ACCEPT and **REJECT** appear on the PERF INIT, TAKEOFF 1/2, and ALTN pages following receipt of uplink data.

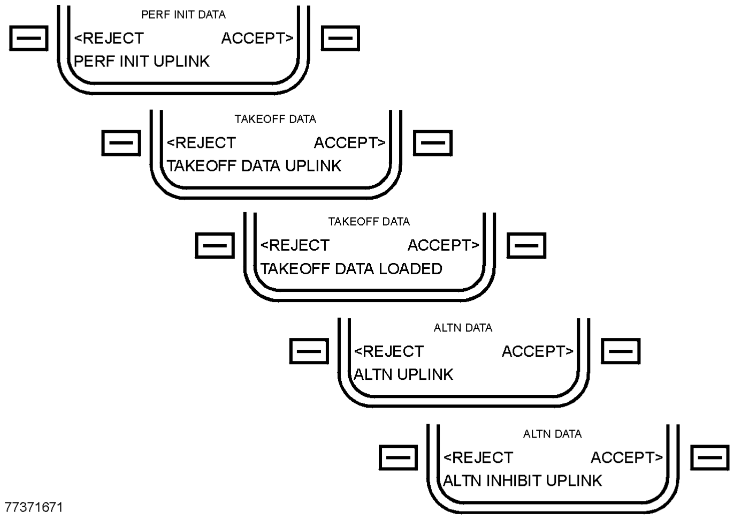
Uplink data is displayed initially in small font for preview.

Selecting **ACCEPT**:

- Displays uplinked data in large font.
- Replaces previous data with uplinked data.
- Returns page display to normal (pre-link) format.
- Clears scratchpad message.
- Transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting **REJECT**:

- Replaces uplinked data with previous data.
- Returns page display to normal (pre-uplink) format.
- Clears scratchpad message.
- Transmits a downlink reject message (if enabled) to inform of rejection.



CDU PAGES

FMC Data Link Uplinks (Load / Purge)

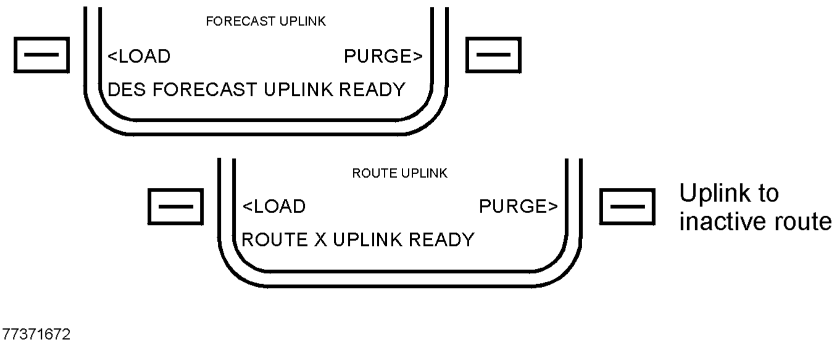
LOAD and **PURGE** appear on the DESCENT FORECAST page following receipt of uplink data. **LOAD** and **PURGE** also appear on the active RTE 1 or RTE 2 page when there is an uplink to the inactive route.

Selecting **LOAD**:

- Loads uplinked data into FMC for viewing.
- Clears scratchpad message.
- Replaces previous data with uplinked data
- Returns page display to normal (pre-uplink) format
- Transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting **PURGE**:

- Replaces uplinked data with previous data.
- Returns page display to normal (pre-uplink) format.
- Clears scratchpad message.
- Transmits a downlink reject message (if enabled) to inform of rejection.



CDU PAGES

FMC Data Link Uplinks (Load / Exec-Erase)

LOAD appears on the RTE and WIND pages following receipt of uplink data.

After the uplinked data is loaded, the **EXEC** light illuminates and the **ERASE** prompt is displayed.

Selecting **LOAD**:

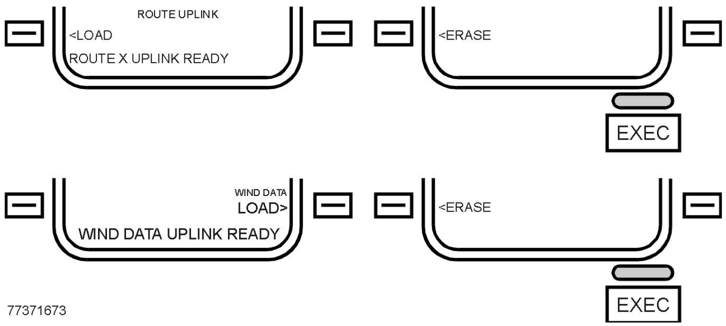
- Loads uplinked data into FMC for viewing.
- Clears scratchpad message.
- Uplinked data modifies previous data.
- Page title displays MOD
- ERASE prompt displays.
- **EXEC** light illuminates.

Pushing the EXEC key:

- Incorporates modified data into active flight plan.
- Returns page display to normal (pre-uplink) format.
- Transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting **ERASE**:

- Removes modified data.
- Returns page display to normal (pre-uplink) format.
- Transmits a downlink reject message (if enabled) to inform of rejection.



CDU PAGES

FMC Data Link Uplinks (Automatic)

FLT NO and ALTN LIST data can be automatically uplinked and loaded. FLT NO automatically loads into the RTE 1/x page and does not require the pilot to ACCEPT, LOAD or EXEC. The list of 20 alternates automatically loads into the ALTN LIST page and does not require the pilot to ACCEPT, LOAD or EXEC.

The scratchpad messages **FLIGHT NUMBER UPLINK** or **ALTN LIST UPLINK** remain in the scratchpad display queue until the appropriate CDU page is selected.

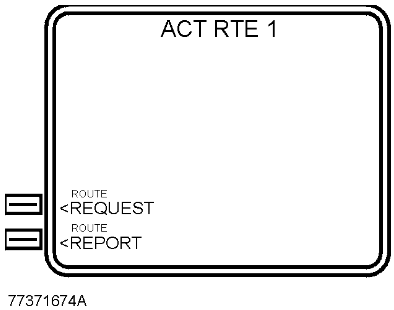
CDU PAGES

Data Link Management

Management of FMC data link requires monitoring of system status on various CDU pages or on the FMC COMM page. Changes to data link system operating modes is accomplished using the COMM function on the display select panel.

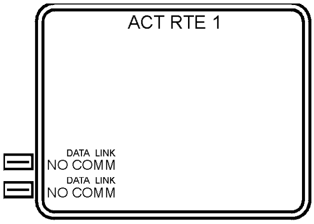
CDU Data Link Status Displays

Normal data link operation is displayed by CDU page REQUEST and REPORT prompt headings indicating the type of request or report.



CDU PAGE

When the data link system is not operating, CDU page prompts change to NO COMM and the headings change to DATA LINK.



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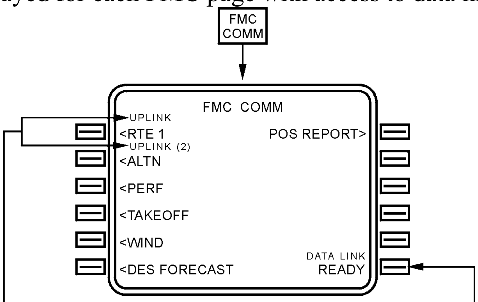
CDU PAGE

FMC Communications Page

General data link status is displayed on the FMC COMM page. Page select prompts are displayed for each FMC page with access to data link information.



UPLINK STATUS

The page line heading displays UPLINK when an uplink message is pending and all preprocessing is complete. Preprocessing of uplinks ensures that all of the necessary data is available for display when the uplink message is selected.

Examples of preprocessing include:

- RTE ALTN, ALTN LIST, PERF, TAKEOFF, and WIND uplinks are held until route activation or modifications are complete.
- Subsequent uplinks of the same type are held until previous uplinks are processed by the pilot.
- TAKEOFF uplink is held until gross weight is entered, a pending PERF uplink is processed, or a takeoff runway is entered.

When both ALTN and ALTN LIST uplinks are pending, (2) is displayed to the right of UPLINK in the line heading.

The EICAS message •FMC is displayed whenever any UPLINK message is pending.

DATA LINK

Displays the data link system status.

System status can be:
- READY
- NO COMM
- VOICE
- FAIL

Page Select Prompts

Selection of any of the following prompts displays the appropriate page:

- RTE X
- ALTN
- PERF
- TAKEOFF
- WIND
- DES FORECAST
- POS REPORT

77371675

FMC COMM

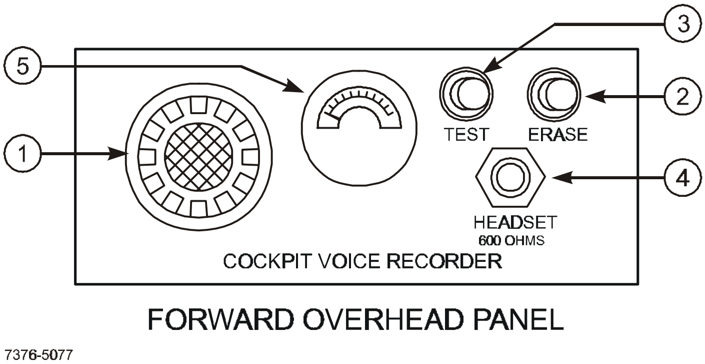
VOICE RECORDER

③ 3 5 The voice recorder uses four independent channels to record flight deck audio on a 30 minute continuous-loop tape. Recordings older than 30 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual audio selector panel output (headset) audio and transmissions for the pilots and first observer.

7 8 The voice recorder uses four independent channels to record flight deck audio for 60 minutes. Recordings older than 60 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ASP output (headset) audio and transmissions for the pilots and first observer.

7 8 9 The voice recorder uses four independent channels to record flight deck audio for 120 minutes. Recordings older than 1200 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ASP output (headset) audio and transmissions for the pilots and first observer.

Voice Recorder Schematic



① Area Microphone

Active anytime 115V AC is applied to aircraft.

② ERASE Switch (red)

Push (2 seconds) –

- All four channels are erased
- Monitor indicator momentarily deflects
- Operative only when aircraft is on ground and parking brake is set.

③ TEST Switch

Push – After a slight delay and no faults are detected:

- Monitor indicator rises into green band
- A tone may be heard through a headset plugged into HEADSET jack.

④ HEADSET Jack

Headset may be plugged into jack to monitor tone transmission during test, or to monitor playback of voice audio.

⑤ Monitor Indicator

Pointer deflection indicates:

- During normal operation – system is recording
- During ERASE – erasure on all four channels (approximately a one second delay)
- During TEST – pointer rises into green band.

FLIGHT RECORDER

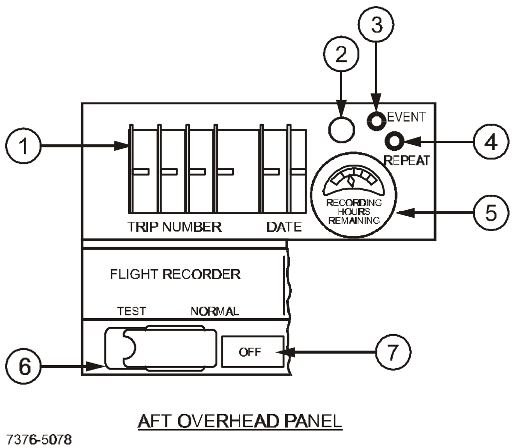
The flight recorder provides a permanent record on tape of selected operational and systems information such as altitude, heading, and airspeed. The recorder is housed in a sealed, fire-resistant container located behind an access door in the aft cabin ceiling.

The pilots manually enter the trip number and date for subsequent transcribing onto the tape.

Operational and systems information is automatically recorded whenever the flight recorder is powered.

Electrical power is provided from transfer bus No. 1 and the battery bus. On the ground, the recorder begins operating as the low oil pressure switch closes during either engine start. Oil pressure switches are bypassed in the air and the flight recorder will be powered (even with both engines shut down) as long as electrical power is available.

③



AFT OVERHEAD PANEL

① Trip And Date Selectors

ROTATE – Sets trip number and date.

② Trip And Date Light (amber)

ILLUMINATED – Trip and date information is being recorded.

- The 15 minute transcribing cycle does not interfere with the recording of other information.

③ EVENT Switch

PRESS – Transcribes a mark on the tape to identify the time of an event.

- Do not use until after the Trip and Date is extinguished.

④ REPEAT Switch

PRESS – Hold until Trip and Date light illuminates.

- Repeats transcription of the trip and date information. Initial application of power initiates transcription.

⑤ Recording Time Remaining Indicator

Not used (reads above 0 at all times).

⑥ FLIGHT RECORDER Test Switch

NORMAL (guarded position)

INFLIGHT – The recorder operates anytime electrical power is available.

ON THE GROUND – Either engine must also be operating.

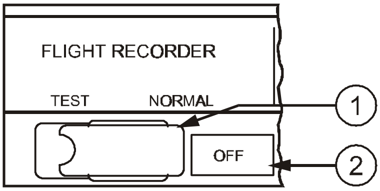
TEST – Bypasses the engine oil pressure switches and the air ground switch to power the flight recorder on the ground.

⑦ **OFF** Light (amber

ILLUMINATED – Indicates that the recorder is not operating or the test is invalid.

- May indicate power failure, loss of input data, or electronic malfunction.

3 5 7 8 9



AFT OVERHEAD PANEL

7376-5079

① FLIGHT RECORDER Test Switch

NORMAL (guarded position)

INFLIGHT – The recorder operates anytime electrical power is available.

ON THE GROUND – Either engine must also be operating.

TEST – Bypasses the engine oil pressure switches and the air ground switch to power the flight recorder on the ground.

② **OFF** Light (amber

ILLUMINATED – Indicates that the recorder is not operating or the test is invalid.

- May indicate power failure, loss of input data, or electronic malfunction.

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/15/02	* 30	11/15/02	* 62	11/15/02
* TOC-2	11/15/02			* 63	11/15/02
* TOC-3	11/15/02	* 31	11/15/02	* 64	11/15/02
* TOC-4	11/15/02	* 32	11/15/02	* 65	11/15/02
		* 33	11/15/02	* 66	11/15/02
* 1	11/15/02	* 34	11/15/02	* 67	11/15/02
* 2	11/15/02	* 35	11/15/02	* 68	11/15/02
* 3	11/15/02	* 36	11/15/02	* 69	11/15/02
* 4	11/15/02	* 37	11/15/02	* 70	11/15/02
* 5	11/15/02	* 38	11/15/02		
* 6	11/15/02	* 39	11/15/02	* 71	11/15/02
* 7	11/15/02	* 40	11/15/02	* 72	11/15/02
* 8	11/15/02			* 73	11/15/02
* 9	11/15/02	* 41	11/15/02	* 74	11/15/02
* 10	11/15/02	* 42	11/15/02	* 75	11/15/02
		* 43	11/15/02	* 76	11/15/02
* 11	11/15/02	* 44	11/15/02	* 77	11/15/02
* 12	11/15/02	* 45	11/15/02	* 78	11/15/02
* 13	11/15/02	* 46	11/15/02	* 79	11/15/02
* 14	11/15/02	* 47	11/15/02	* 80	11/15/02
* 15	11/15/02	* 48	11/15/02		
* 16	11/15/02	* 49	11/15/02	* 81	11/15/02
* 17	11/15/02	* 50	11/15/02	* 82	11/15/02
* 18	11/15/02			* 83	11/15/02
* 19	11/15/02	* 51	11/15/02	* 84	11/15/02
* 20	11/15/02	* 52	11/15/02	* 85	11/15/02
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* 21	11/15/02	* 54	11/15/02	* 87	11/15/02
* 22	11/15/02	* 55	11/15/02	* 88	11/15/02
* 23	11/15/02	* 56	11/15/02	* 89	11/15/02
* 24	11/15/02	* 57	11/15/02	* 90	11/15/02
* 25	11/15/02	* 58	11/15/02		
* 26	11/15/02	* 59	11/15/02	* 91	11/15/02
* 27	11/15/02	* 60	11/15/02	* 92	11/15/02
* 28	11/15/02			* 93	11/15/02
* 29	11/15/02	* 61	11/15/02	* 94	11/15/02

* Asterisk indicates page(s) revised or added by the current revision.

ENGINES & APU

TABLE OF CONTENTS

ENGINES SYSTEM DESCRIPTION

GENERAL

③[3][5] The aircraft are equipped with two CFM56-3 high bypass ratio turbofan engines rated at 20,000 pounds of takeoff thrust.

[7][8][9] The aircraft are powered by two CFM56-7 engines.

[7] Takeoff thrust rating is 24,200 lbs.

[8][9] Takeoff thrust rating is 26,300 lbs.

The engine is dual rotor assembly consisting of a fan rotor (N_1) and a compressor rotor (N_2). The N_1 rotor consists of a single stage fan and a three stage booster section connected by a through shaft to a four-stage low pressure turbine. The N_2 rotor is a nine-stage axial flow compressor connected by a through shaft to a single-stage high pressure turbine. The first four stages of the compressor are variable. The compressor delivers highly compressed air to the annular combustor where the fuel / air mixture is ignited. The resulting high energy gasses drive the turbines, producing the power to turn the fan, the compressor and the accessories. Thrust is the combined forces produced by accelerated fan air and rapidly expanding high velocity combustion gasses. Fan air and combustion gasses exit through separate nozzles at the rear of the engine.

③[3][5] The Main Engine Control (MEC) schedules fuel to provide the thrust called for by the Forward Thrust Lever setting in the flight deck. This fuel flow is further refined electronically by the Power Management Control (PMC) without moving the Forward Thrust Levers.

[7][8][9] The Hydro-Mechanical Unit (HMU) and the Electronic Engine Control (EEC) combine to meet the thrust requirements called for by the forward thrust lever setting. The EEC meters fuel through the HMU for both forward and reverse thrust.

A sliding sleeve, fixed vane thrust reverser system is installed which redirects bypass fan air to aid in stopping the aircraft.

③③⑤ POWER MANAGEMENT CONTROL (PMC)

The thrust control system consists of a hydro-mechanical MEC unit and a PMC unit mounted on each engine. The PMC is an electronic system with limited authority over the MEC.

The PMC uses MEC power lever angle, N_1 speed, inlet temperature and pressure to adjust, or trim, the MEC to obtain the desired N_1 speed. The PMC adjusts fuel flow as a function of thrust lever angle.

The PMC provides a constant thrust climb feature once the thrust lever is set at the beginning of climb. Thus, when thrust is set for the climb, the PMC automatically maintains that thrust throughout the climb profile with no further thrust lever adjustments. If the thrust lever is repositioned, the PMC maintains the setting corresponding to the new thrust lever angle.

The PMC includes failure detection and annunciation modules, which detect PMC failures and provide a signal to the crew. For detectable failure conditons, the PMC schedules a slow N_1 drift over approximately 30 seconds and illuminates the **PMC INOP** light, the **ENG** system annunciator light and the **MASTER CAUTION** lights. For a PMC failure, the PMC can be selected OFF by a switch on the aft overboard panel. The engine speed is then controlled by the hydro-mechanical MEC only. The **PMC INOP** light is suppressed below starter cutout engine speed (46% N2 RPM).

⑦⑧⑨ ELECTRONIC ENGINE CONTROL (EEC)

Each engine has a full authority digital EEC. Each EEC has two independent control channels and automatically switches channel if the operating channel fails. With each engine start or start attempt, the EEC alternates between control channels. The EEC uses thrust lever inputs to automatically control forward and reverse thrust. N_1 is used by the EEC to set thrust in two control modes; normal and alternate. Manual selection of the control mode can be made with the EEC switches on the engine panel.

EEC Normal Mode

In the normal mode, the EEC uses sensed flight conditions and bleed air demand to calculate N_1 values. The EEC compares commanded N_1 to actual N_1 and adjusts fuel flow to change engine speed until actual N_1 equals commanded N_1.

The full rated takeoff thrust for the installed engine is available at a thrust lever position less than the forward stop. Fixed or assumed temperature reduced takeoff thrust ratings are set at thrust lever positions less than full rated takeoff. If the thrust lever is advanced to the forward stop, the EEC limits thrust to the maximum certified thrust rating for current conditions.

EEC Alternate Mode

The EEC can operate in either of two alternate modes, soft or hard. If required signals are not available to operate in the normal mode, the EEC automatically changes to the soft alternate mode. When this occurs, the **ALTN** switch illuminates and the **ON** indication remains visible. In the soft alternate mode, the EEC uses the last valid flight conditions to define engine parameters. Thrust rating shortfalls or exceedences may occur as flight conditions change. The soft alternate mode remains until the hard alternate mode is entered by either retarding the thrust lever to idle or manually selecting ALTN with the EEC switch on the aft overhead panel.

Note: Loss of either DEU results in a loss of signal to both EECs. The EEC **ALTN** lights illuminate and each EEC reverts to the alternate mode to prevent the engines from operating on a single source of data.

When the hard alternate mode is entered, the EEC reverts to the alternate mode thrust schedule. Hard alternate mode thrust is always equal to or greater than normal mode thrust for the same lever position. Maximum certified thrust rating can be exceeded. If the hard alternate mode is entered by reducing the thrust lever to idle while in the soft alternate mode, the **ALTN** switch remains illuminated and the **ON** indication remains visible. When ALTN is selected manually, the **ON** indication is blanked.

Structural Limit Protection

The EEC provides N_1 and N_2 redline overspeed protection in both normal and alternate modes. The EGT limit must be observed by the crew because the EEC does not provide EGT redline exceedence protection.

③ 3 5 IDLE RPM

There are two engine idle speeds, low idle and high idle.

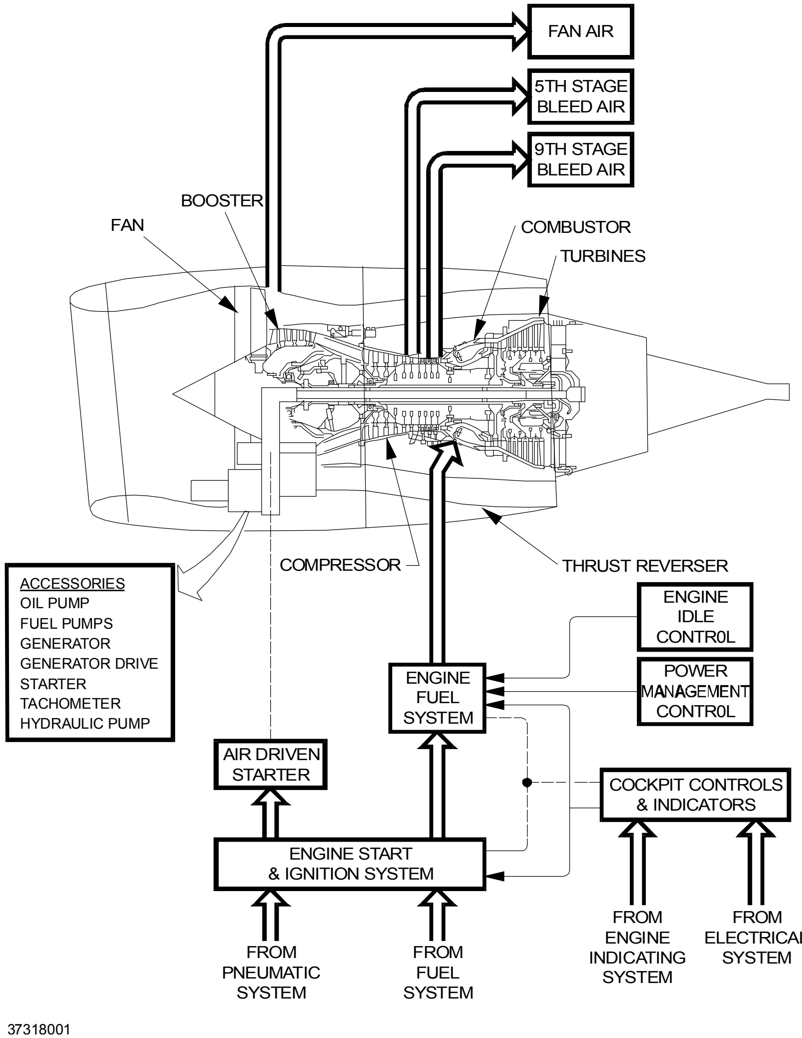
The minimum engine speed for all flight phases is high idle, which varies with flight conditions. As temperature and airspeed decrease, high idle speed also decreases. The average high idle setting is approximately 32% N_1.

To reduce braking activity, engine idle speed is reduced to low idle, approximately 22% N_1, four seconds after touchdown. The four second delay is provided to enhance engine speed acceleration for reverse thrust.

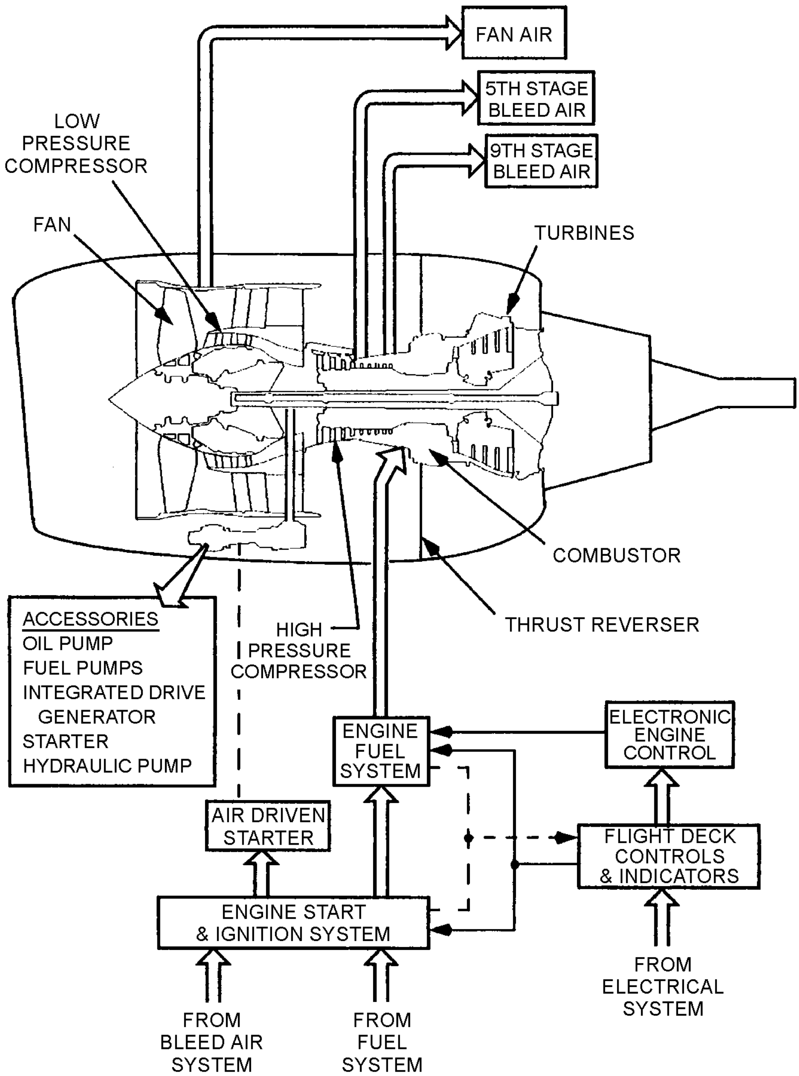
7 8 9 IDLE OPERATION

The EEC automatically selects approach idle, flight minimum idle, and ground minimum idle. Ground minimum idle is selected for ground operations and flight minimum idle is selected for most phases of flight. Approach idle is selected in flight if flaps are in landing configuration or engine anti-ice is ON for either engine. Approach idle improves engine acceleration time for go-around. Approach idle is maintained until after touchdown, when ground minimum idle is selected. In flight, if a fault prevents the EEC from receiving flap or anti-ice signals, approach idle schedule begins below 15,000 feet MSL.

③⑶⑸ POWER PLANT SYSTEM SCHEMATIC



7 8 9 POWER PLANT SYSTEM SCHEMATIC



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ENGINE FUEL SYSTEM

③③⑤ Fuel is delivered to the engines at pressures and flow rates required to obtain desired engine thrust. Fuel leaves the fuel tank and enters through the main engine fuel shutoff valve. The engine fuel shutoff valve is electrically controlled by the Engine Start Lever and the Engine Fire Warning Switch. When the engine fuel shutoff valve is closed, the **FUEL VALVE CLOSED** light located on the forward overhead panel illuminates dim.

Fuel passes from the first stage of the engine driven fuel pump through a fuel / oil heat exchanger to a filter. Provisions are made to bypass the heat exchanger or the filter in the event of failure or blockage. Illumination of the **FILTER BYPASS** light indicates an impending bypass of the fuel filter due to contamination.

The second stage of the fuel pump provides high pressure fuel to the MEC. As the fuel leaves the second stage, a portion of the fuel is diverted to run the hydro-mechanical portion of the MEC. This fuel is filtered again and then routed through the fuel heater a second time. The fuel heater uses engine oil to heat the fuel of the MEC for anti-icing purposes.

The MEC in conjunction with the PMC uses thrust lever angle, fan inlet pressure and temperature, N_1 RPM and N_2 RPM to meter the correct amount of fuel to the combustor. Fuel flows from the MEC through the MEC fuel shutoff valve. The MEC shutoff valve is mechanically controlled by the Engine Start Lever. A fuel flow transmitter measures the rate of fuel flow from the MEC.

⑦⑧⑨ Fuel is delivered under pressure from fuel pumps located in the fuel tanks. The fuel flows through a fuel spar shutoff valve located at the engine mounting wing stations. The fuel passes through the first stage engine fuel pump where pressure is increased.

It then passes through two fuel / oil heat exchangers where IDG oil and main engine oil heat the fuel. A fuel filter then removes contaminants. Fuel automatically bypasses the filter if the filter becomes saturated. Before the fuel bypass occurs, the fuel **FILTER BYPASS** alert illuminates on the upper display unit. The second stage engine fuel pump adds more pressure before the fuel reaches the Hydro-Mechanical Unit (HMU). To meet thrust requirements, the EEC meters fuel through the HMU.

The spar fuel shutoff valve and engine fuel shutoff valve allow fuel flow to the engine when both valves are open. The valves are open when the engine fire warning switch is in and the start lever is in IDLE. Both valves close when either the start lever is in CUTOFF or the engine fire warning switch is out. **SPAR VALVE CLOSED** and **ENG VALVE CLOSED** lights located on the overhead panel indicate valve position.

Fuel flow is measured after passing through the engine fuel shutoff valve and is displayed on the upper display unit. Fuel flow information is also provided to the FMS.

ENGINE OIL SYSTEM

③ 3 5 Oil from the individual engine tank is circulated under pressure, through the engine to lubricate the engine bearings and accessory gearbox. Oil quantity is displayed on the Oil Quantity Indicator located on the center instrument panel.

The oil system is pressurized by the engine driven oil pump. The oil leaves the oil pump, passes through an oil filter, and continues to the engine bearings and gearbox. Sensors for the oil pressure indicator and the **LOW OIL PRESSURE** light are located downstream of the oil filter, prior to engine lubrication.

The oil is returned to the oil tank by means of engine driven scavenge pumps. From the scavenge pumps the oil passes through a scavenge filter. Should the filter become saturated with contaminants, oil automatically bypasses the filter. Prior to the oil bypassing the filter, the **OIL FILTER BYPASS** light, located on the center instrument panel, illuminates.

Scavenge oil temperature is sensed as the oil returns to the oil tank, and is displayed on the Oil Temperature Indicator located on the center instrument panel. The oil then passes through the fuel / oil heat exchanger where it is cooled by engine fuel to maintain proper oil temperature prior to returning to the oil tank.

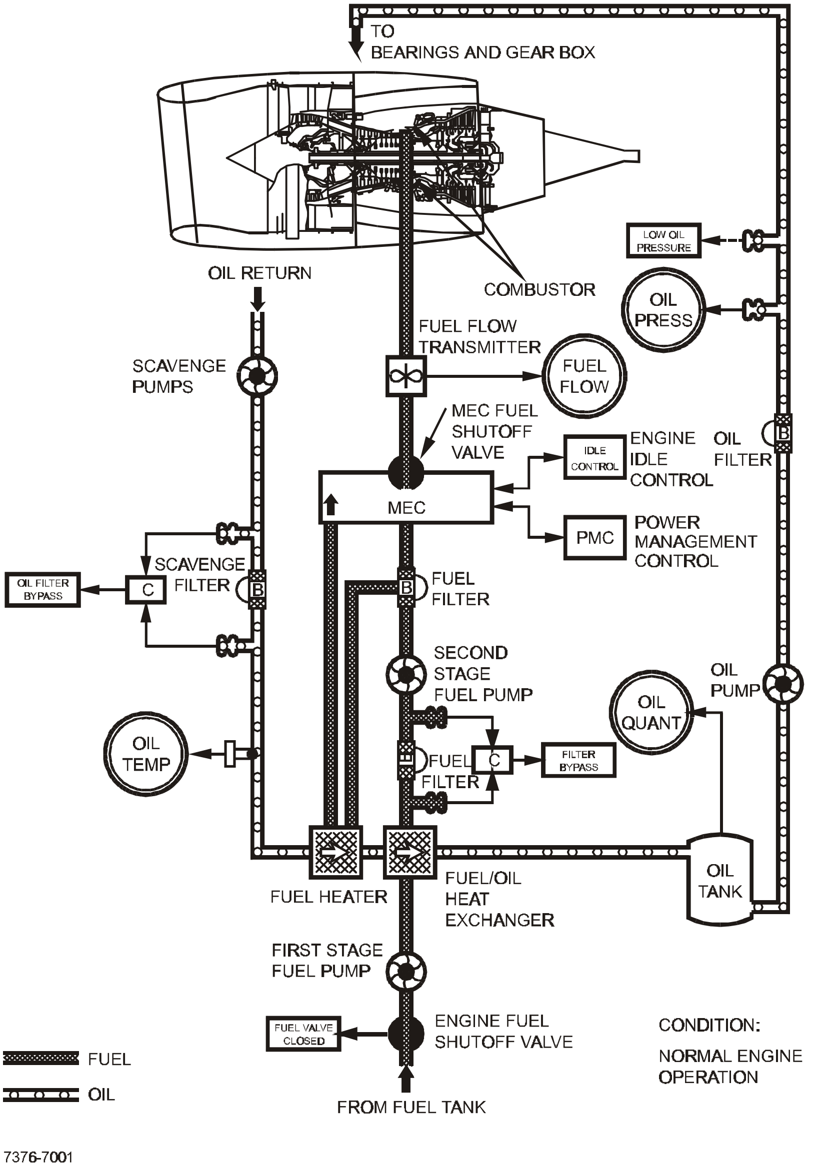
7 8 9 Oil from the individual engine tank is circulated under pressure, through the engine to lubricate the engine bearings and accessory gearbox. The oil quantity indicator, oil temperature indicator, oil pressure indicator and **LOW OIL PRESSURE** alert are all located on the upper display unit.

The oil system is pressurized by the engine driven oil pump. Oil from the pump goes to the engine bearings and gearbox. Sensors for the oil temperature indicator, oil pressure indicator and **LOW OIL PRESSURE** alert are located downstream of the oil pump prior to engine lubrication.

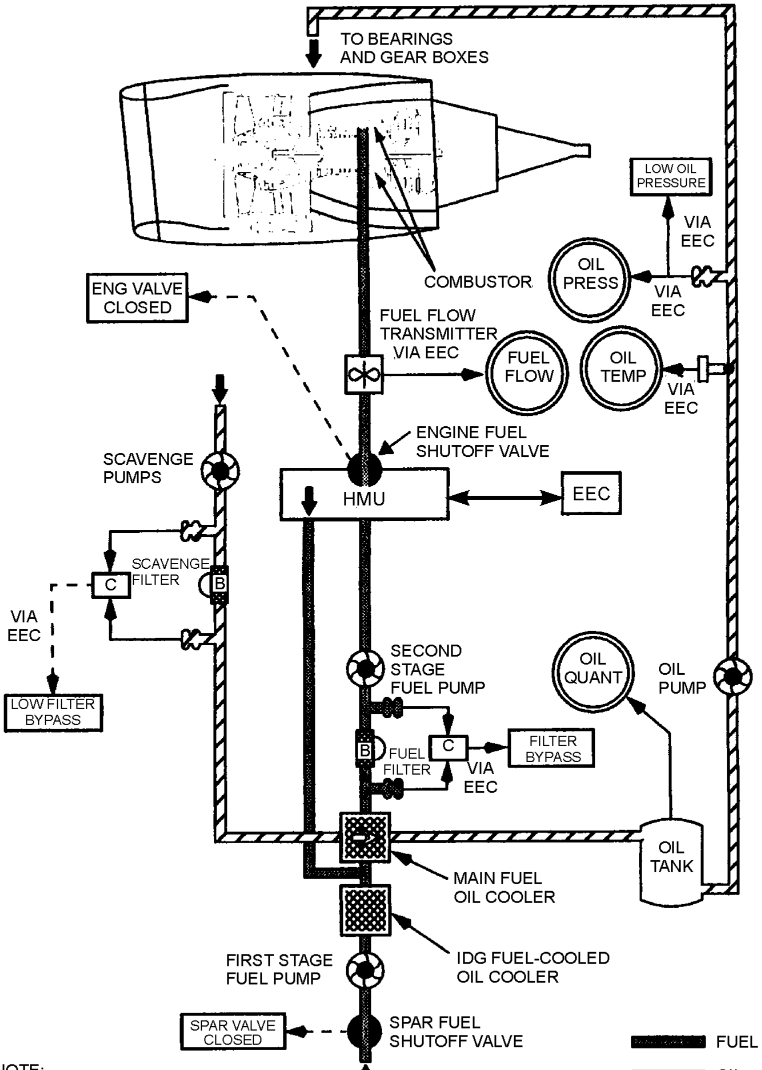
Oil is returned to the oil tank by engine driven scavenge pumps. From the scavenge pumps oil passes through a scavenge filter. If the filter becomes saturated with contaminants, oil automatically bypasses the filter. Prior to the oil bypassing the scavenge filter, the **OIL FILTER BYPASS** alert illuminates on the upper display unit.

Prior to returning to the oil tank, the oil passes through the main engine oil cooler where it is cooled by engine fuel to maintain proper oil temperature.

③ 3 5 ENGINE FUEL AND OIL SYSTEM SCHEMATIC



7 8 9 ENGINE FUEL AND OIL SYSTEM SCHEMATIC



NOTE:
ALL ENGINE OIL AND FUEL INDICATIONS (EXCEPT OIL QUANTITY AND ENGINE VALVE CLOSED) ARE SENSED BY THE EEC, DIGITIZED, AND SENT TO THE CDS.

CONDITION:
OPERATION
NORMAL ENGINE

7376-7028

ENGINE START SYSTEM

Pressurized air, a pneumatic starter, and electrical power are required for starter operation. The engines may be started with air from the APU, from a ground source, or by using engine crossbleed.

③ 3 5 The Engine Start Switch GRD position uses DC power from the battery bus to *command the engine bleed air valve closed, open the starter valve and allow pressure from the pneumatic manifold to rotate the starter. When the starter valve opens, the amber **START VALVE OPEN** light, located on the center instrument panel, illuminates. The starter is a turbine-type air motor which rotates the N_2 compressor through the accessory drive gear system. When the engine has accelerated to 25% N_2 RPM, and with the Engine Start Lever advanced to the IDLE position, which completes the ignition circuit, the MEC supplies fuel to the combustor and the fuel ignites, resulting in an engine start. At cutout speed (46% N_2 RPM), power is interrupted to the start switch-holding solenoid, allowing the Engine Start Switch to return to the OFF position, *the engine bleed air valve to return to the selected position and the starter valve to close.

During an engine shutdown, the start switch holding-solenoid is held in the cutout position until engine speed falls below 30% N_2 RPM. The starter should not be re-engaged until engine speed has decreased below 20% N_2 RPM.

7 8 9 In the GRD position, the engine start switch uses battery power to close the engine bleed air valve and open the start valve to allow pressure to rotate the starter. When the start valve opens, an amber **START VALVE OPEN** alert is provided on the upper display unit. The starter rotates the N_2 compressor through the accessory drive gear system. When the engine accelerates to the recommended value (25% N_2 or max motoring), moving the engine start lever to the IDLE position opens the fuel valves on the wing spar and engine, and causes the EEC to supply fuel (via the HMU) and ignition to the combustor where the fuel ignites. Initial fuel flow indications lag actual fuel flow by approximately two seconds, therefore, during engine start, an EGT rise may occur before fuel flow indication.

At starter cutout speed (approximately 56% N_2), power is removed from the start switch holding solenoid. The engine start switch returns to OFF, the engine bleed air valve returns to the selected position and the start valve closes.

* On all B737 aircraft delivered after November 1988.

Abnormal Start Protection (Ground Starts Only)

[7][8][9] During ground starts, the EEC monitors engine parameters to detect impending hot starts, EGT start limit exceedances, and wet starts. These protection features do not function during inflight starts.

If an impending hot start is detected by a rapid rise in EGT or EGT approaching the start limit, the white box surrounding the EGT digital readout flashes. The flashing white box resets when the start lever is moved to CUTOFF or the engine reaches the idle N_2.

If the EGT exceeds the starting limit, the EGT display, both box and dial, turn red. The EEC automatically turns off the ignition and shuts off fuel to the engine. The alert terminates and the display returns to white when EGT drops below the start limit. Following engine shutdown, the EGT box turns red to remind crew of the exceedance.

A wet start occurs if the EGT does not rise after the start lever is moved to IDLE. If a wet start is detected, the EEC turns off the ignition and shuts off fuel to the engine 15 seconds after the start lever is moved to IDLE.

IGNITION SYSTEM

Two high energy AC systems are provided. With the Engine Start Switch in the GRD position, the starter valve opens, *the engine bleed air valve closes and the selected igniter(s) are energized when the engine start lever is placed to IDLE. The CONT position is used for takeoff and landing, and prior to turning on engine anti-ice. This affords extra protection, through the selected igniter(s) against flameout in the event that birds or ice are ingested, or inlet airflow is suddenly disrupted for any reason during the more critical stages of flight. The FLT position energizes both igniters when the engine start lever is placed to the IDLE position. It is used for air starts and for flight in severe turbulence, moderate to severe icing, and in moderate to heavy precipitation, hail or sleet.

IGN L, powered by the AC transfer bus, provides single high energy ignition to the left igniter. IGN R, powered by the AC standby bus, provides single high energy ignition to the right igniter.

* On all B737-300/-500's delivered after November 1988.

7 8 9 AUTO-RELIGHT

An auto-relight capability is provided for flameout protection. Whenever the EEC detects an engine flameout, both igniters are activated. A flameout is detected when an uncommanded rapid decrease in N_2 occurs, or N_2 is below idle RPM.

INFLIGHT STARTING

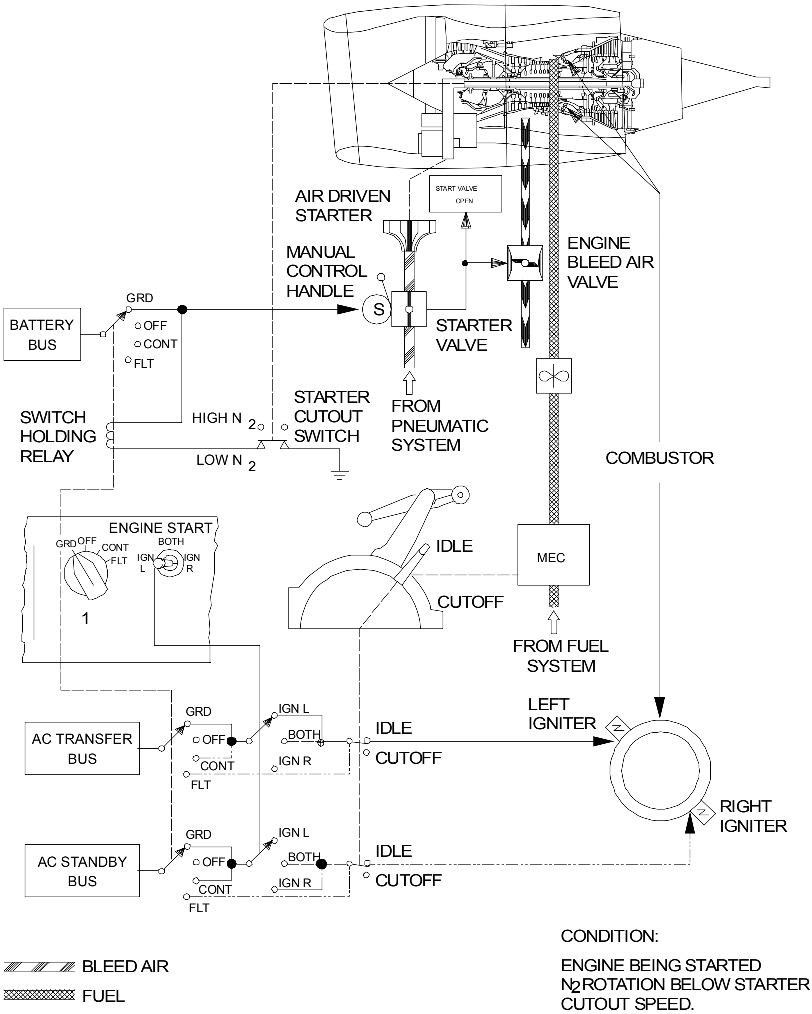
Two methods of starting an engine inflight are available, windmill and crossbleed.

7 8 9 None of the ground start protection features are functional during inflight start.

Note: At low N_2 values, the oil scavenge pump may not provide enough pressure to return oil to the tank, causing a low oil quantity indication. Normal oil quantity should be indicated after start.

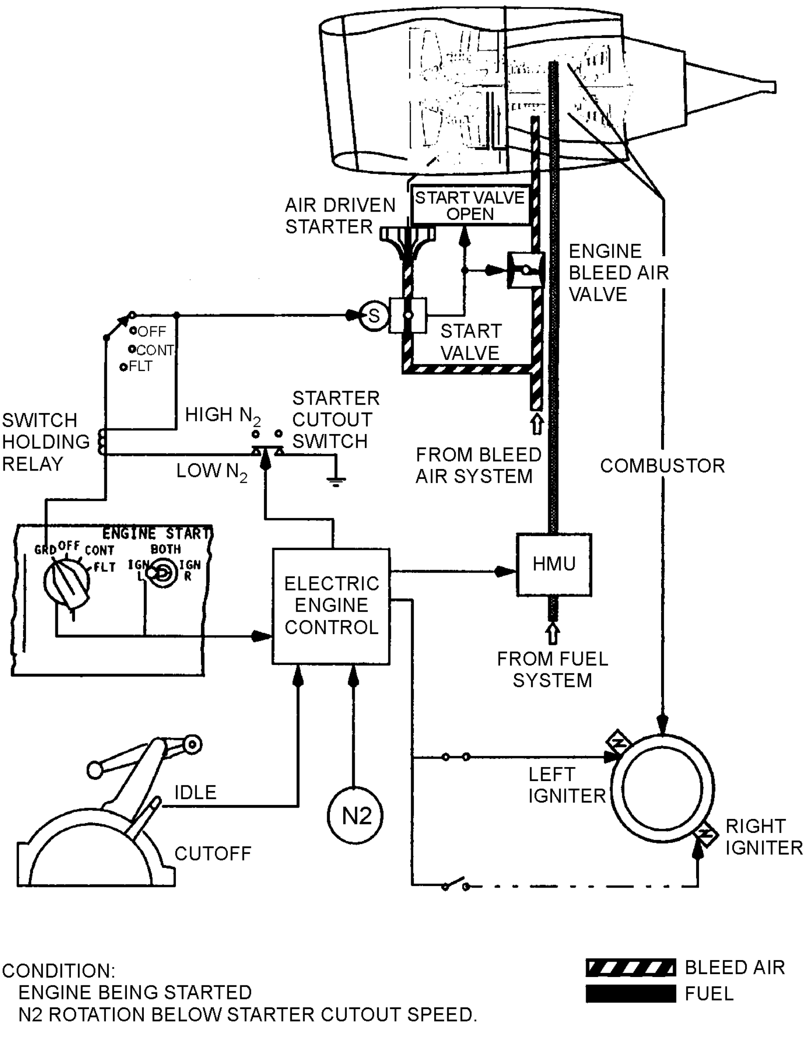
If crossbleed starting is required, the **X-BLD START** indication is displayed above the N_2 dial. This indication is based on aircraft altitude, airspeed and N_2.

③ 3 5 ENGINE START AND IGNITION SYSTEM SCHEMATIC



37318003

7 8 9 ENGINE START AND IGNITION SYSTEM SCHEMATIC



CONDITION:
ENGINE BEING STARTED
N2 ROTATION BELOW STARTER CUTOUT SPEED.

77371804

INTENTIONALLY LEFT BLANK

THRUST REVERSER

Each engine is equipped with a hydraulically operated thrust reverser, consisting of left and right translating sleeves. Aft movement of the reverser sleeves causes blocker doors to deflect fan discharge air forward, through fixed cascade vanes, producing reverse thrust. The thrust reverser is for ground operations only and is used after touchdown to slow the aircraft, reducing stopping distance and brake wear.

Hydraulic pressure for the operation of engine No. 1 and engine No. 2 thrust reversers comes from hydraulic systems A and B, respectively. If hydraulic system A or B fails, alternate operation for the affected thrust reverser is available through the standby hydraulic system. When the standby system is used, the affected thrust reverser will deploy and retract at a slower rate and some thrust asymmetry can be anticipated.

The thrust reverser can be deployed when either radio altimeter senses less than 10 feet altitude, or when the air / ground safety sensor is in the ground mode. Movement of the reverse thrust levers is mechanically restricted until the forward thrust levers are in the IDLE position.

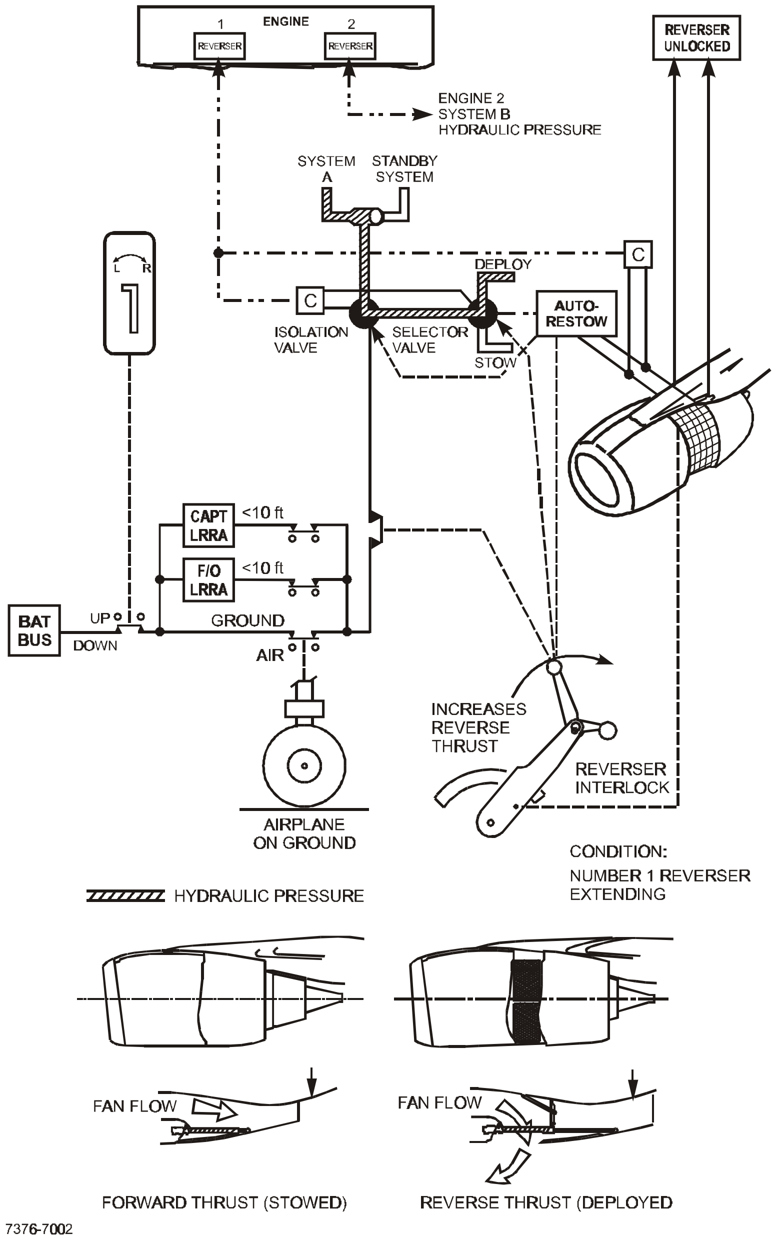
When reverse thrust is selected, an electro-mechanical lock releases, the isolation valve opens and the thrust reverser control valve moves to the deploy position, allowing hydraulic pressure to unlock and deploy the reverser sleeves. An interlock mechanism restricts further movement of the reverse thrust lever until the reverser sleeves have approached the deployed position. When either reverser sleeve moves from the stowed and locked position, the **REVERSER UNLOCKED** light, located on the Center Instrument Panel, illuminates. As the thrust reverser reaches the deployed position, the Reverse Thrust Lever can be raised to detent No. 2. This position provides adequate reverse thrust for normal operations. When necessary, the reverse thrust lever can be pulled beyond detent No. 2, providing maximum reverse thrust.

Downward motion of the Reverse Thrust Lever past detent No. 1 will command the reverser to stow. Once the thrust reverser is commanded closed, the control valve moves to the stow position allowing hydraulic pressure to stow and lock the reverser sleeves. After the thrust reverser is stowed, the electro-mechanical lock engages and the isolation valve closes.

The **REVERSER** light, located on the Aft Overhead Panel, illuminates when the thrust reverser is commanded to stow and extinguishes 10 seconds later when the isolation valve closes. Any time the **REVERSER** light illuminates for more than approximately 12 seconds, a malfunction has occurred and the **MASTER CAUTION** and **ENG SYSTEM** annunciator lights illuminate.

When the reverser sleeves are in the stowed position, an electro-mechanical lock and a hydraulically operated locking actuator inhibit motion of each reverser sleeve until reverser extension is selected. Additionally, an auto-restow circuit compares the actual reverser sleeve position and the commanded reverser position. In the event of incomplete stowage or uncommanded movement of the reverser sleeves toward the deployed position, the auto-restow circuit will open the isolation valve and command the control valve to the stow position directing hydraulic pressure to stow the reverser sleeves. Once the auto-restow circuit is activated, the isolation valve remains open and the control valve is held in the stowed position until the thrust reverser is deployed or until corrective maintenance action is taken.

THRUST REVERSER SCHEMATIC



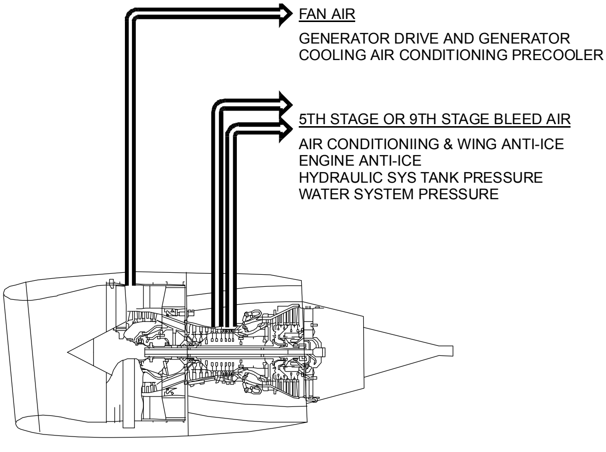
AIR BLEED SYSTEM

Compressor Section

The N_1 compressor, or booster section, produces low temperature, low pressure air and delivers it to the N_2 compressor which produces high temperature, high pressure air. The single stage fan, which is an extension of the first stage of compression, produces very large volumes of bypass air. Each compressor section is driven by its own separate turbine at its own best speed. The high pressure compressor (N_2) is governed by the MEC / EEC while the fan and low pressure compressor (N_1) is driven by its turbine and is free to select the best speed to ensure optimum airflow. This airflow matching feature allows the compressor sections to adjust themselves automatically throughout the operating range of the engine. It also minimizes interstage bleeding preventing stalls and surges, and with the front and rear rotor sections working in harmony, the compression ratio can be increased without decreasing efficiency.

Fan Bypass / Bleed Air

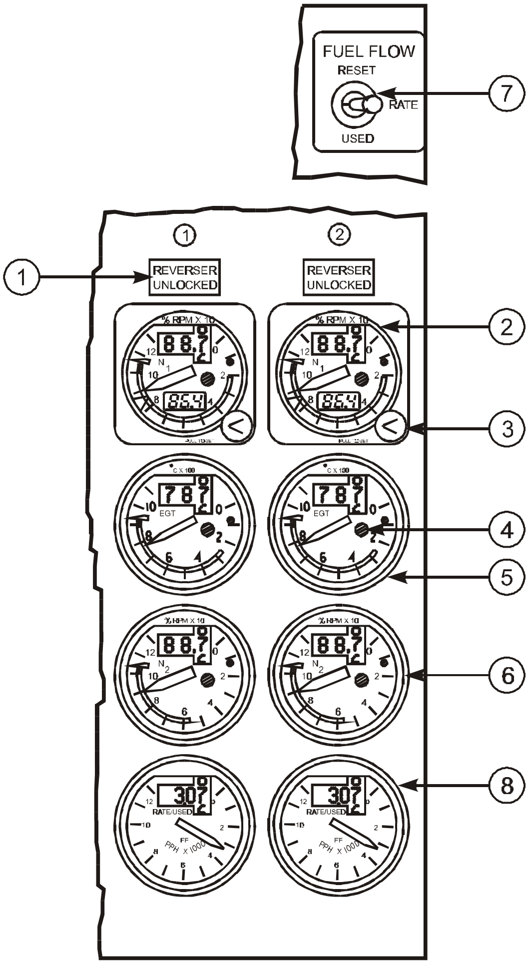
Fan bypass air is used for thrust reversal, generator drive and generator cooling as well as bleed air cooling. Fifth stage bleed air is used for the Environment Control and Anti-Ice systems. However, at low thrust settings, fifth stage air pressure is inadequate, so ninth stage bleed air is used. When fifth stage air pressure becomes adequate, a crossover from ninth to fifth stage air is made.



37318005

AIR BLEED SYSTEM

③③⑤ ENGINE AND FUEL FLOW INDICATORS



CENTER INST PANEL

NOTE: Failure of either Fuel Flow Indicator or transmitter results in the respective digital display blanking and the pointer moving to zero.

7376-7004

① REVERSER UNLOCKED Light (amber)

Illuminated – Indicates the thrust reverser is unlocked.

② N1 RPM Indicator

- Indicates fan speed in percent of RPM.
- Used as the primary thrust setting reference.

③ N_1 Manual Set Knob

Push In – The cursor is set by input signal from the Flight Management Computer (FMC).

- The lower digital display is blank.

Pull Out – Disables the FMC input signal.

Rotate – Sets the desired N_1 RPM in the lower digital display.

- The cursor moves to the corresponding position on the outer scale.

④ Warning Light (red)

Illuminated – Indicates the limit for the engine parameter displayed has been reached or exceeded.

- Remains illuminated until the engine parameter is reduced below the limit.

⑤ Exhaust Gas Temperature (EGT) Indicator

- Indicates turbine exhaust gas temperature in degrees C.

⑥ N2 RPM Indicator

- Indicates high pressure compressor speed in percent of RPM.

⑦ FUEL FLOW Switch (spring loaded to the RATE position)

RESET – Resets the fuel used display on both Fuel Flow Indicators to zero.

RATE – The digital display on both Fuel Flow Indicators shows rate of fuel consumption.

USED – The digital display on both Fuel Flow Indicators shows total fuel consumed per engine since last reset.

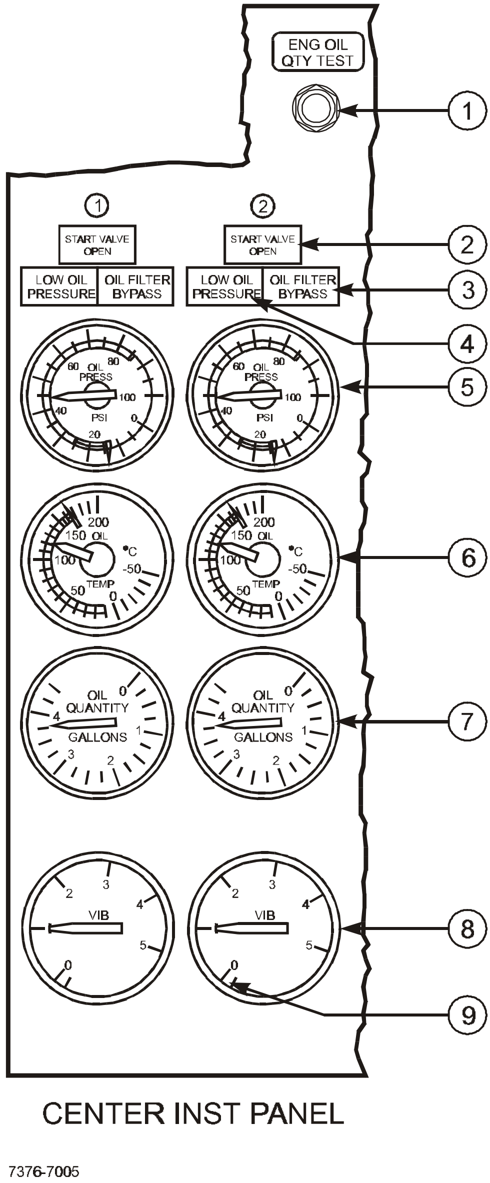
⑧ Fuel Flow (**RATE / USED**) Indicator

Pointer – Indicates the RATE of fuel flow in pounds per hour X 1000 at all times.

Digital Display – With the FUEL FLOW switch in the RATE position, indicates rate of fuel flow in pounds per hour X 1000.

- With the FUEL FLOW switch held in the USED position, indicates the amount of fuel used in pounds X 1000 since last reset.
- With the FUEL FLOW switch held in the RESET position, the fuel USED display returns to zero.

③③⑤ ENGINE OIL AND VIBRATION INDICATORS



① Oil Quantity Test Switch

Press – Oil Quantity Indicators move toward zero during test.

② **START VALVE OPEN** Light (amber)

Illuminated – Indicates the engine starter valve is open and air is being supplied to the air driven starter.

③ **OIL FILTER BYPASS** Light (amber)

Illuminated – Indicates an impending bypass of the scavenge oil filter.

④ **LOW OIL PRESSURE** Light (amber)

Illuminated – Indicates engine oil pressure is at or below the red radial.

⑤ Oil Pressure Indicator

- Indicates engine oil pressure in psi.
- The yellow band is only valid at takeoff thrust.

Note: Oil pressure is unregulated and is primarily a function of engine speed (N_2).

⑥ Oil Temperature Indicator

- Indicates engine oil temperature in degrees C.

⑦ **OIL QUANTITY** Indicator

- Indicates engine oil quantity in gallons.

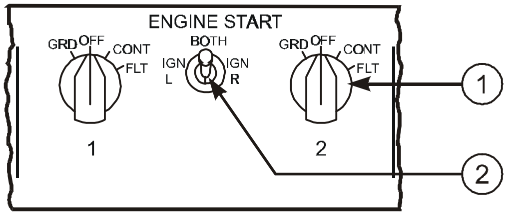
⑧ Airborne Vibration Monitor

- Indicates engine vibration level in the fan section of the engine.

⑨ Off Index Mark (blue)

- Indicator pointer moves to the Off Index Mark if the system is inoperative.

③ 3 5 ENGINE START SWITCHES



FWD OVHD PANEL

7376-7006

① Engine Start Switch

GRD – (solenoid held, spring-loaded to OFF) Opens the starter valve.

- Closes the engine bleed air valve.
- Provides high energy ignition to the selected igniter(s) when the Engine Start Lever is moved from CUTOFF to IDLE.

OFF – No Ignition.

CONT – Provides high energy ignition to the selected igniter(s) with the Engine Start Lever in IDLE.

FLT – Provides high energy ignition to both igniters when the Engine Start Lever is in IDLE.

- The Ignition Select Switch is bypassed when the Engine Start Switch is in FLT.

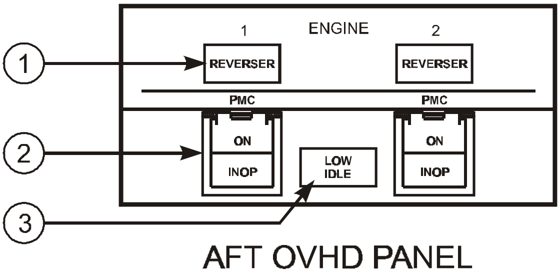
② Ignition Select Switch

IGN L – Selects the left igniter for use on both engines.

BOTH – Selects both igniters for use on both engines.

IGN R – Selects the right igniter for use on both engines.

③ 3 5 ENGINE REVERSER, PMC AND LOW IDLE



7376-7007

① **REVERSER** Light

Illuminated – One or more of the following has occurred:

- The isolation valve or the thrust reverser control valve is not in the commanded position.
- The thrust reverser sleeve position sensors are in disagreement for more than two seconds.
- The auto-restow circuit has been activated.

② Power Management Control (PMC) Switch

ON – (ON in view – white) Indicates the PMC is selected ON.

INOP (INOP in view – amber) Indicates the PMC is inoperative when engine speed is above 46% N_2, or the PMC is selected OFF.

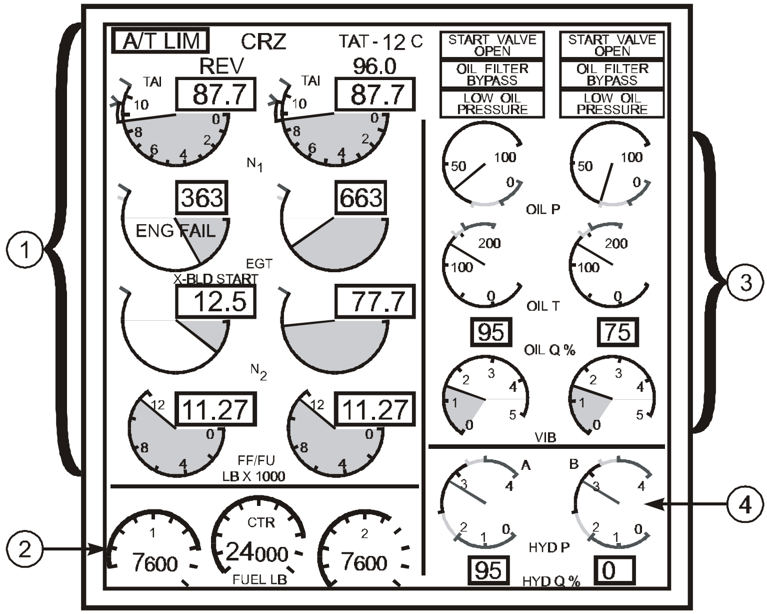
③ **LOW IDLE** Light (amber)

Illuminated – The thrust lever for either engine is near idle and the MEC on either engine is not commanded to maintain high idle RPM inflight.

- The speed of either engine is below 25% N_1 inflight.

If an Engine Start Lever is in CUTOFF, the light is deactivated.

7 8 9 PRIMARY AND SECONDARY ENGINE INDICATIONS



UPPER DISPLAY UNIT

7 8 9

7376-7008

① Primary Engine Indications

② Fuel Quantity Indications

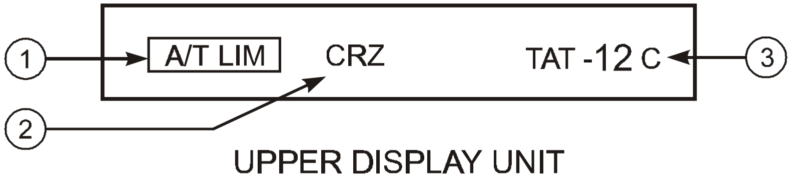
Refer to Section 6.12, Fuel.

③ Secondary Engine Indications

④ Hydraulic Indications

Refer to Section 6.13, Hydraulics.

7 8 9 AUTOTHROTTLE LIMIT, THRUST MODE DISPLAY AND TOTAL AIR TEMPERATURE



7376-7009

① Autothrottle Limit (A/T LIM) Indication

Illuminated (white) – The FMC is not providing the A/T system with N_1 limit values. The A/T is using a degraded N_1 thrust limit from the related EEC.

② Thrust Mode Display

Displayed (green) – The active N_1 limit reference mode.

With N_1 manual select knob on engine display control panel in AUTO, active N_1 limit is displayed by reference N_1 bugs.

Active N_1 limit is normally calculated by FMC.

Thrust mode display annunciations are:

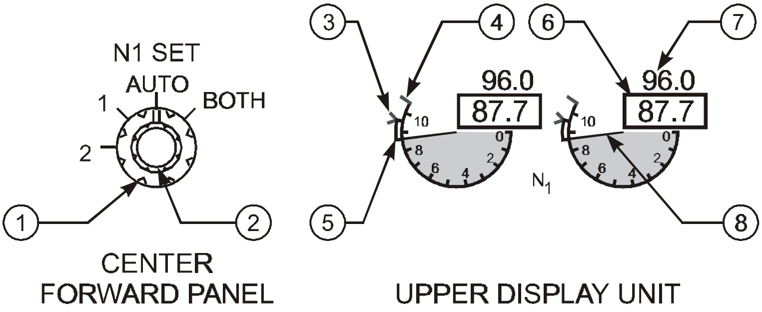
- **R-TO** – reduced takeoff
- **R-CLB** – reduced climb
- **TO** – takeoff
- **CLB** – climb
- **CRZ** – cruise
- **G/A** – go-around
- **CON** – continuous
- ---- FMC not computing thrust limit

Note: **R-TO** does not indicate the type of reduced takeoff. The N_1 limit may be reduced due to the entry of an assumed temperature, a takeoff thrust derate or a combination of both assumed temperature and takeoff thrust derate.

③ Total Air Temperature (TAT) Indication

Displayed (label – cyan, temp – white) – total air temperature (degrees C).

7 8 9 N1 INDICATIONS



7376-7010

① N1 SET Outer Knob

AUTO –

- Both reference N_1 bugs set by FMC based on N_1 Limit page and Takeoff Reference page.
- Displays reference N_1 bugs at active N_1 limit for A/T.

BOTH –

- Both reference N_1 bugs and readouts manually set by turning N1 SET inner knob.
- Has no effect on A/T operation.

1 or 2 –

- Respective N_1 reference bug and readout manually set by turning N1 SET inner knob.
- Has no effect on A/T operation.

② N1 SET Inner Knob (spring-loaded to center)

Rotate – Positions reference bugs N_1 bug(s) and readouts when N1 SET outer knob is set to BOTH, 1, or 2.

③ Reference N_1 Bugs

Displayed (green) – With N1 SET outer knob in AUTO, 1, 2 or BOTH position.

④ N_1 Redlines

Displayed (red) – N_1% RPM operating limit.

⑤ N_1 Command Sectors

Displayed (white) – Momentary difference between actual N_1 and value commaned by thrust lever position.

⑥ N_1 RPM Readouts (digital)

Displayed (white) – Normal operating range.

Displayed (red) –

- Operating limit exceeded.
- On ground after engine shutdown, red box indicates an inflight exceedance has occurred.

⑦ Reference N_1 Readouts

Displayed (green) – Manually set N_1% RPM:

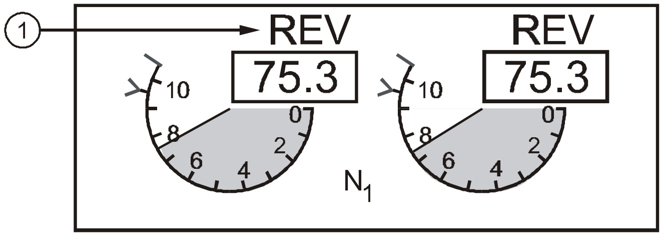
- Set with N1 SET inner knob when N1 SET is in BOTH, 1, or 2 position.
- Blank when N1 SET outer knob in AUTO position.
- ---- When N1 SET outer knob in AUTO and FMC source invalid.

⑧ N_1 RPM Indications

Displays N_1% RPM:

- Displayed (white) – Normal operating range.
- Displayed (red) – Operating limit exceeded.

7 8 9 THRUST REVERSER INDICATIONS



UPPER DISPLAY UNIT

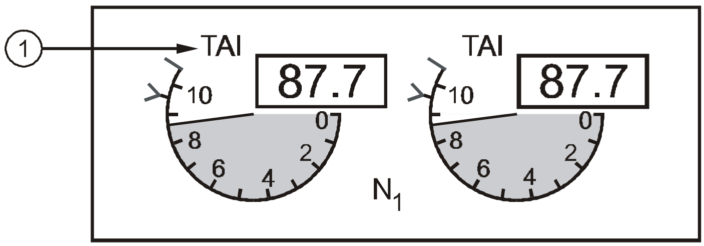
7376-7011

① Thrust Reverser (**REV**) Indications

Displayed (amber) – Thrust reverser is moved from stowed position.

Displayed (green) – Thrust reverser is deployed.

7 8 9 THERMAL ANTI-ICE INDICATION



UPPER DISPLAY UNIT

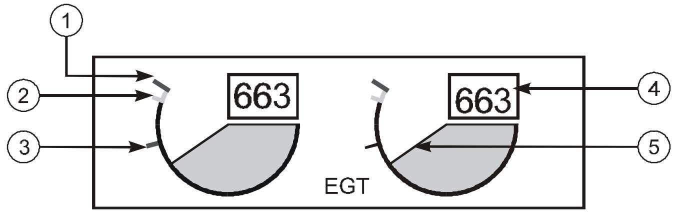
7376-7012

① Thermal Anti-Ice (**TAI**) Indications

Displayed (green) – Cowl anti-ice valve(s) open.

Displayed (amber) – Cowl anti-ice valve is not in position indicated by related engine anti-ice switch.

7 8 9 EGT INDICATIONS



UPPER DISPLAY UNIT

7376-7013

① Exhaust Gas Temperature (EGT) Redlines

Displayed (red) – Maximum takeoff EGT limit.

② Exhaust Gas Temperature (EGT) Amber Bands

Displayed (amber) – Lower end of band displays maximum continuous EGT limit.

③ Exhaust Gas Temperature (EGT) Start Limit Lines

Displayed (red) – N_2 less than 50%.

④ Exhaust Gas Temperature (EGT) Readouts (digital)

Displayed (white) – Normal operating range (degrees C).

7 8

Displayed (amber) – Maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around.

9

Displayed (amber) – Maximum continuous limit exceeded.

- Color change inhibited for up to 5 minutes during takeoff or go-around (normal operation).
- Color change inhibited for up to 10 minutes during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit).

Displayed (red) – Maximum takeoff limit or start limit exceeded.

On ground, after engine shutdown, red box indicates an exceedance has occurred.

EEC senses conditions that may lead to hot start during ground starts (blinking white box).

⑤ Exhaust Gas Temperature (EGT) Indications

Displayed (white) – Normal operating range.

7 8

Displayed (amber) – Maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around.

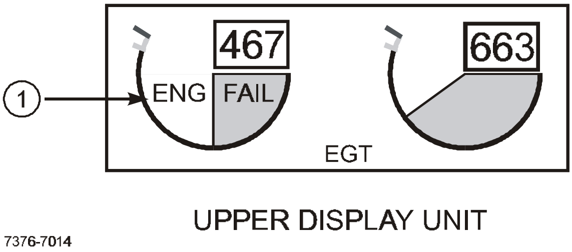
9

Displayed (amber) – Maximum continuous limit exceeded.

- Color change inhibited for up to 5 minutes during takeoff or go-around (normal operation).
- Color change inhibited for up to 10 minutes during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit).

Displayed (red) – Maximum takeoff limit of start limit exceeded.

7 8 9 ENGINE FAIL ALERT



1. Engine Fail (ENG FAIL) Alert

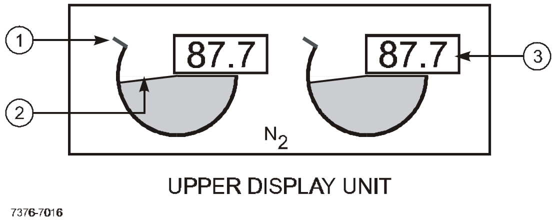
   Displayed (amber) –

   - Engine N_2 below sustainable idle (less than 50%); and
   - Engine start lever in IDLE position.

   Alert remains until –

   - Engine N_2 above sustainable idle (50% or greater); or
   - Start lever moved to CUTOFF; or
   - Engine fire warning switch pulled.

7 8 9 N2 INDICATIONS



① N_2 Redlines

Displayed (red) – N_2% RPM operating limit.

② N_2 RPM Indications

Displays N_2% RPM

- Displayed (white) – Normal operating range.
- Displayed (red) – Operating limit exceeded.

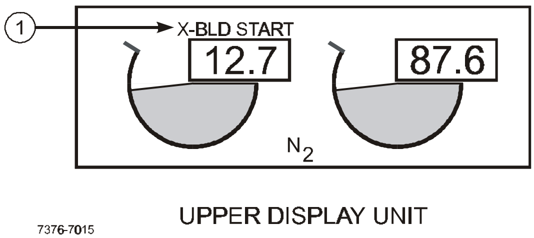
③ N_2 Readouts (digital)

Displayed (white) – Normal operating range.

Displayed (red) –

- Operating limit exceeded.
- On ground, after engine shutdown, red box indicates an inflight exceedance has occurred.

7 8 9 CROSSBLEED START INDICATION

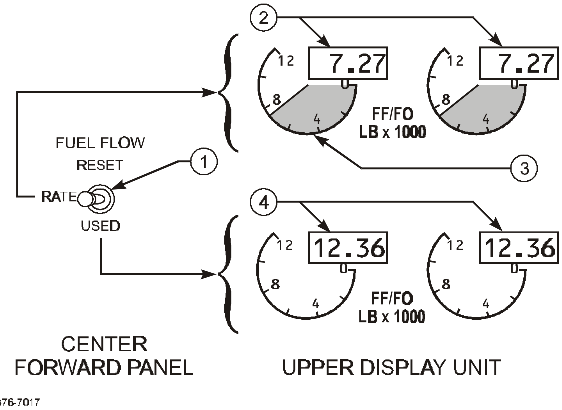


① Crossbleed (**X-BLD**) **START** Indication

Displayed (magenta) – Crossbleed air recommended for inflight start.

Displayed when airspeed is less than required for a windmilling start.

7 8 9 FUEL FLOW / FUEL USED INDICATIONS



① FUEL FLOW Switch (spring-loaded to RATE)

RATE – Displays fuel flow to engine.

USED –

- Pointer and shading are removed.
- Displays fuel used since last reset.
- After 10 seconds, display automatically reverts to fuel flow.

  Note: If switch is activated longer than 30 seconds, fuel used readout is deactivated for remainder of flight.

RESET –

- Pointer and shading are removed.
- Resets fuel used to zero.
- Displays fuel used momentarily, decreases to zero, then displays fuel flow.

② Fuel Flow (FF) Readout (digital)

Displayed (white) – Fuel flow to engine with FUEL FLOW switch in RATE position (pounds per hour x 1000).

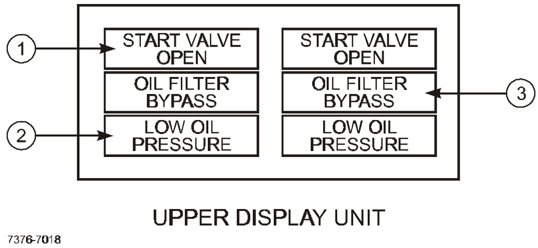
③ Fuel Flow (FF) Dial / Index Markers & Digits (white)

Displayed (white) – Fuel flow to engine with FUEL FLOW switch in RATE position (pounds per hour x 1000).

④ Fuel Used (FU) Readout (digital)

Illuminated (white) – Displayed when FUEL FLOW switch moved to USED or RESET.

7 8 9 CREW ALERTS



① **START VALVE OPEN** Alert

Illuminated (amber) –

- Steady – Respective engine start valve open and air is supplied to starter.
- Blinking – Uncommanded opening of start valve. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for 10 seconds, then alert remains on steady and solid amber boxes are removed. (See Note)

② **LOW OIL PRESSURE** Alert

Illuminated (amber) –

- Steady – Oil pressure at or below red line.
- Blinking – With a condition of low pressure. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for 10 seconds, then alert remains on steady and solid amber boxes are removed. (See Note)

③ **OIL FILTER BYPASS** Alert

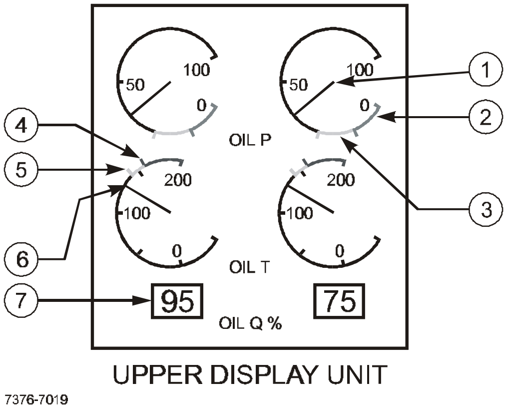
Illuminated (amber) –

- Steady – Indicates an impending bypass of scavenge oil filter.
- Blinking – With an impending bypass. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for 10 seconds, then alert remains on steady and solid amber boxes are removed. (See Note)

Note: Blinking is inhibited:

- During takeoff from 80 knots to 400 feet RA, or 30 seconds after reaching 80 knots, whichever occurs first.
- During landing below 200 feet RA until 30 seconds after touchdown.
- During periods when blinking is inhibited, alerts illuminate steady.

7 8 9 ENGINE OIL INDICATIONS



① Oil Pressure (**OIL P**) Indication

Displays engine oil pressure (psi).

- Displayed (white) – Normal operating range.
- Displayed (amber) – Caution range.
- Displayed (red) – Operating limit reached.

② Low Oil Pressure (**OIL P**) Redline

Displayed (red) – Oil pressure operating limit.

③ Low Oil Pressure (**OIL P**) Amber Band

Displayed (amber) – Low oil pressure caution range beginning at red line:

- Variable depending on N_2% RPM above 65% N_2.
- Amber band not displayed below 65% N_2.

④ High Oil Temperature (**OIL T**) Redline

Displayed (red) – Oil temperature operating limit.

⑤ High Oil Temperature (**OIL T**) Amber Band

Displayed (amber) – Oil temperature caution range.

⑥ Oil Temperature (**OIL T**) Indication

Displays oil temperature (degrees C):

- Displayed (white) – Normal operating range.
- Displayed (amber) – Caution range reached.
- Displayed (red) – Operating limit reached.

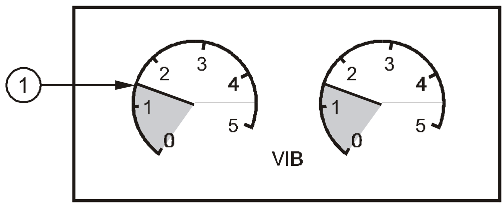
⑦ Oil Quantity (**OIL Q**) % Readout

Displays usable oil quantity as a percentage of full quantity.

Note: Indicated oil quantity may decrease significantly during engine start, takeoff and climb out. If this occurs, engine operation is not impacted and the correct oil quantity should be indicated during level flight.

Note: An oil quantity indication as low as zero is normal if windmilling N_2 RPM is below approximately 8%.

7 8 9 ENGINE VIBRATION INDICATIONS



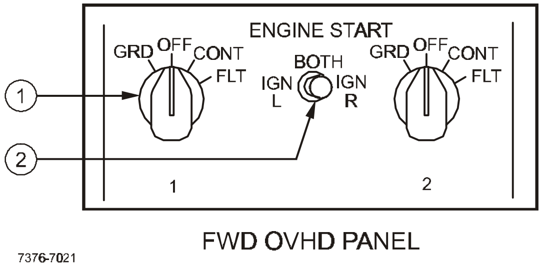
UPPER DISPLAY UNIT

7376-7020

① Vibration (**VIB**) Pointer

Displays (white) – Engine vibration level.

7 8 9 ENGINE START SWITCHES



① ENGINE START Switches

GRD –

- Opens start valve.
- Closes engine bleed valve.
- For ground starts, arms selected igniter(s) to provide ignition when engine start lever is moved to IDLE.
- For inflight starts, arms both igniters to provide ignition when engine start lever is moved to IDLE.
- Releases to OFF at start valve cutout.

OFF –

- Ignition normally off.
- Both igniters are activated when engine start lever is in IDLE and:
  - An uncommanded rapid decrease in N_2 occurs or,
  - N_2 is between 57% and 50 % or,
  - In flight – N_2 is between idle and 5%.

CONT –

- Provides ignition to selected igniters when engine is operating and engine start lever is in IDLE.
- In flight – provides ignition to both igniters when N_2 is below idle and engine start lever is in IDLE.

FLT – Provides ignition to both igniters when engine start lever is in IDLE.

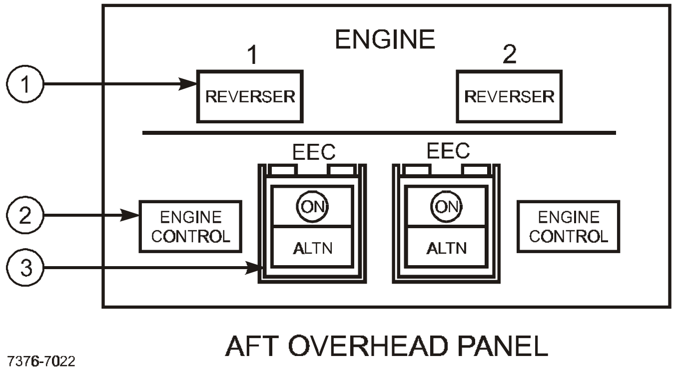
② Ignition Select Switch

IGN L – Selects the left igniter for use on both engines.

BOTH – Selects both igniters for use on both engines.

IGN R – Selects the right igniter for use on both engines.

7 8 9 ENGINE PANEL



① **REVERSER** Lights

Illuminated (amber) – One or more of following has occurred:

- Isolation valve or thrust reverser control valve is not in commanded position.
- One or more thrust reverser sleeves are not in commanded state.
- Auto-restow circuit has been activated.
- A failure has been detected in synchronization shaft lock circuitry.

② **ENGINE CONTROL** Lights

Illuminate (amber) – Engine control system is not dispatchable due to faults in system.

Light operates when:

- Engine is operating and,
- Aircraft on ground and:
  - Below 80 kt prior to takeoff or,
  - Approximately 30 seconds after touchdown.

③ Electronic Engine Control (EEC) Switches

ON – In view (white)

- Indicates normal control mode is selected.
- Engine ratings calculated by EEC from sensed atmospheric conditions and bleed air demand.
- When ON is not in view, the EEC has been manually selected to the alternate mode.

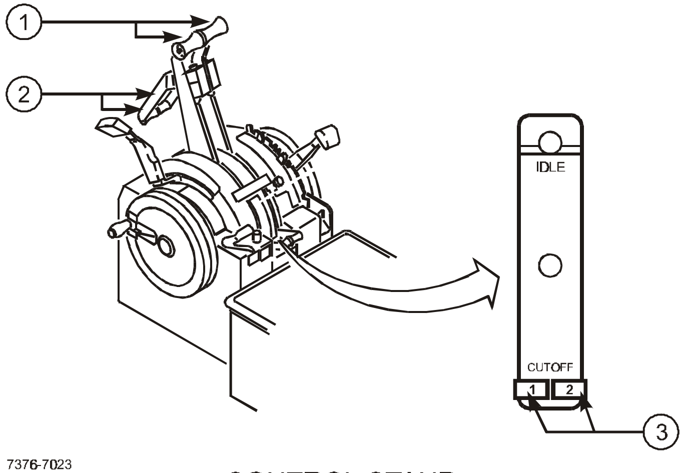
ALTN – In view (amber)

- Indicated EEC has automatically switched to alternate control mode or it has been selected manually.
- EEC provides rated thrust or higher.

Note: Both ON and ALTN may be in view if EEC has automatically switched to soft alternate mode.

Note: EGT limits must be observed in both normal and alternate control modes.

7 8 9 ENGINE CONTROLS



CONTROL STAND

① Forward Thrust Levers –

- Controls engine thrust.
- Cannot be advanced if the reverse thrust lever is in the deployed position.

② Reverse Thrust Levers –

- Controls engine reverse thrust.
- Cannot select reverse thrust unless related forward thrust lever is at IDLE.

Note: Reverse thrust lever is blocked at reverse idle position until related thrust reverser is more than 60% deployed.

Note: Movement of reverse thrust lever into reverse thrust engages locking pawl preventing forward thrust lever from moving. Terminating reverse thrust removes locking pawl and restores forward thrust lever movement ability.

③ Engine Start Levers

IDLE –

③ 3 5

- Energizes the ignition system.
- Electrically opens engine fuel shutoff valve in the wing leading edge, outboard of the pylon.
- Mechanically opens the Main Engine Control (MEC) shutoff valve.

7 8 9

- Energizes ignition system through EEC.
- Electrically opens spar fuel shutoff valve in the wing leading edge, outboard of the pylon.
- Electrically opens engine-mounted fuel shutoff valve via the EEC.

CUTOFF –

③ 3 5

- Closes the engine fuel shutoff valve in the wing and the MEC shutoff valve.
- Ignition system is de-energized.

7 8 9

- Closes both spar and engine fuel shutoff valves.
- De-energizes ignition system.

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APU SYSTEM DESCRIPTION

GENERAL

The Auxiliary Power Unit (APU) is a self-contained, gas turbine engine installed within a fireproof, sound-reducing compartment located in the tail of the aircraft. The APU supplies bleed air for the engine starting or air conditioning / heating. An AC generator provides an auxiliary AC power source. Exhaust gases are dumped overboard through a sound reducing, air cooled exhaust duct.

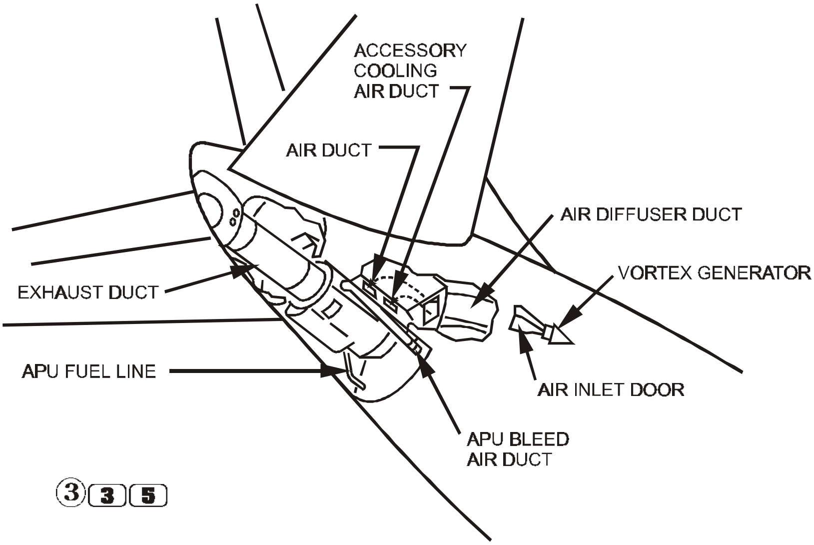
③ 3 5

Air for cooling and compression is routed to the APU through a diffuser duct from an automatically operated door located on the right side of the fuselage. Electrical power from the aircraft battery and fuel from the No.1 tank are used to start and operate the APU. The battery switch must be on for all APU starts and for all ground operations. Positioning the battery switch to OFF, while the aircraft is on the ground, will cause an automatic shutdown. In flight, positioning the battery switch to OFF after APU start causes no automatic shutdown.

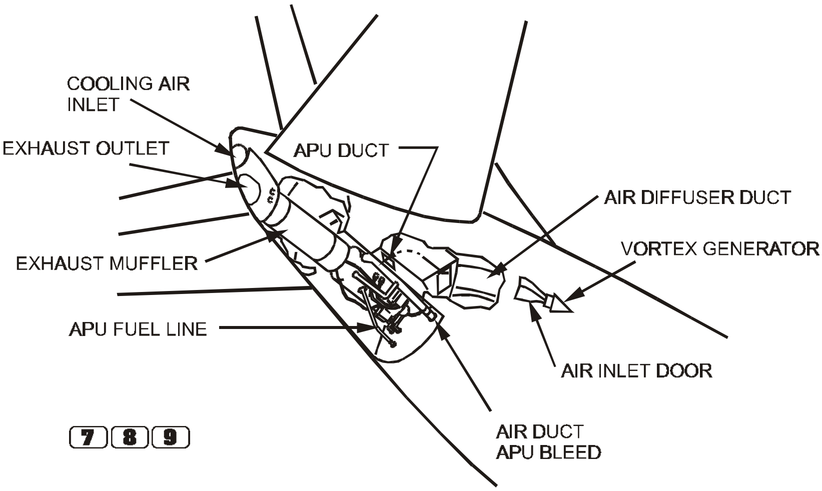
7 8 9

Air for compression routes to the APU through an automatically operated air inlet door located on the right side of the fuselage. Air for APU cooling enters through a cooling air inlet above the APU exhaust outlet. This air circulates through the APU compartment, passes through the oil cooler and vents through the exhaust outlet.

Electrical power from No. 1 transfer bus or the aircraft battery and fuel from the left manifold are used to start the APU. With AC power available, the starter / generator uses AC power to start the APU. With no AC power the starter / generator uses battery power to start the APU. The start / generator only uses very high voltage 3 phase AC power therefore, the AC or DC sources must be converted to be compatible with the starter / generator. The battery switch must be on for all APU operations (start, ground, flight). Moving the battery switch to OFF (ground or flight) causes an automatic shutdown because of power loss to the Electronic Control Unit (ECU).



③ 3 5



7 8 9

7376-7024

APU OPERATION

Engine speed and Exhaust Gas Temperature (EGT) are automatically controlled by the fuel control unit. Control air input is provided to the fuel control unit through a solenoid-operated three-way control valve. This enables the fuel control unit to maintain the required ratio of fuel flow to control air pressure.

The control air pressure is changed by the combined acceleration / load control thermostat in response to EGT changes. When electrical load and bleed air extraction combine to raise the EGT above acceptable levels, the bleed air valve will modulate toward the closed position. In the event of an overtemperature, the bleed air valve will close rapidly but the APU will continue to run without initiating an auto shutdown.

③ 3 5

APU starts and operates up to its maximum altitude of 35,000 ft. The APU can supply bleed air for a single air conditioning pack on the ground or in flight.

Both generator busses can be powered from the APU generator on the ground but only one generator bus may be powered in flight.

One electrical bus and one air conditioning pack may be powered up to 10,000 ft.

One electrical bus or one air conditioning pack may be powered from 10,000 ft. to 17,000 ft. One electrical bus only may be powered from 17,000 ft. to 35,000 ft.

7 8 9

The APU starts and operates up to the aircraft maximum certified altitude of 41,000 ft. The APU supplies bleed air for both air conditioning packs on the ground and one pack in flight. Both transfer busses can be powered on the ground or in flight.

Both electrical power and bleed air are supplied up to a maximum altitude of 10,000 ft. Bleed air alone can be supplied up to 17,000 ft. Electrical power alone can be supplied up to 41,000 ft.

APU START

The automatic start sequence begins by moving the APU switch momentarily to START from the OFF position. This initiates opening of the air inlet door. When the APU inlet door reaches the full open position the start sequence begins. After the APU reaches the proper speed, ignition and fuel are provided. When the APU is ready to accept a bleed air or electrical load the **APU GEN OFF BUS** light illuminates.

If the APU does not reach the proper speed with the proper acceleration rate within the time limit of the starter, the start cycle automatically terminates.
③ 3 5 The start cycle may take as long as 135 seconds. If the start fails or the **APU GEN OFF BUS** light fails to illuinate by the end of the start cycle, a system failure has occurred and the **OVERSPEED** light illumiantes.
7 8 9 The start cycle could take as long as 120 seconds. If the start fails or the **APU GEN OFF BUS** light fails to illuminate by the end of the start cycle, a system failure has occurred and the **FAULT** light illuminates.

Operate the APU for <u>one full minute</u> before using it as a bleed air source. This one-minute stabilization is needed to <u>extend</u> the service life of the APU.

APU FUEL

Fuel to start and operate the APU comes from the left side of the fuel manifold when the AC fuel pumps are operating. If the AC fuel pumps are not operating, fuel is suction fed from the No. 1 tank. During APU operation, fuel is automatically heated to prevent icing.

With the APU operating and AC electrical power on the aircraft busses, operate at least one fuel boost pump to supply fuel under pressure to the APU.

APU SHUTDOWN

③ 3 5 Operate the APU for one full minute with no bleed air prior to shutdown. This cooling period is needed to extend the service life of the APU.

7 8 9 When the APU switch is moved to OFF, a 60-second time delay is met automatically. Moving the APU switch to OFF trips the APU generator, closes the APU bleed air valve and extinguishes the **APU GEN OFF BUS** light. An immediate shutdown can also be accomplished by pulling the APU fire switch.

APU COMPONENTS

③③⑤ Automatic protection for EGT exceedance, overspeed, high oil temperature, low oil pressure, and other system faults is provided by a three way control valve, speed switches, pressure switches, and fuel control unit.

⑦⑧⑨ An Electronic Control Unit (ECU) monitors and controls the APU. Automatic shutdown protection is provided for overspeed conditions, low oil pressure, high oil temperature, APU fire, fuel control unit failure, EGT exceedance, and other system faults monitored by the ECU. The ECU automatically controls APU speed through the electronic fuel control. If speed or EGT exceed acceptable levels with the APU providing electrical load only, some electrical load is shed. When electrical load and air extraction raise the EGT above acceptable levels during engine starting, electrical load shedding occurs prior to reducing bleed air. When electrical load and air extraction raise the EGT above acceptable levels other than during engine starting, the inlet guide vanes move toward a closed position, reducing bleed air extraction while maintaining electrical load.

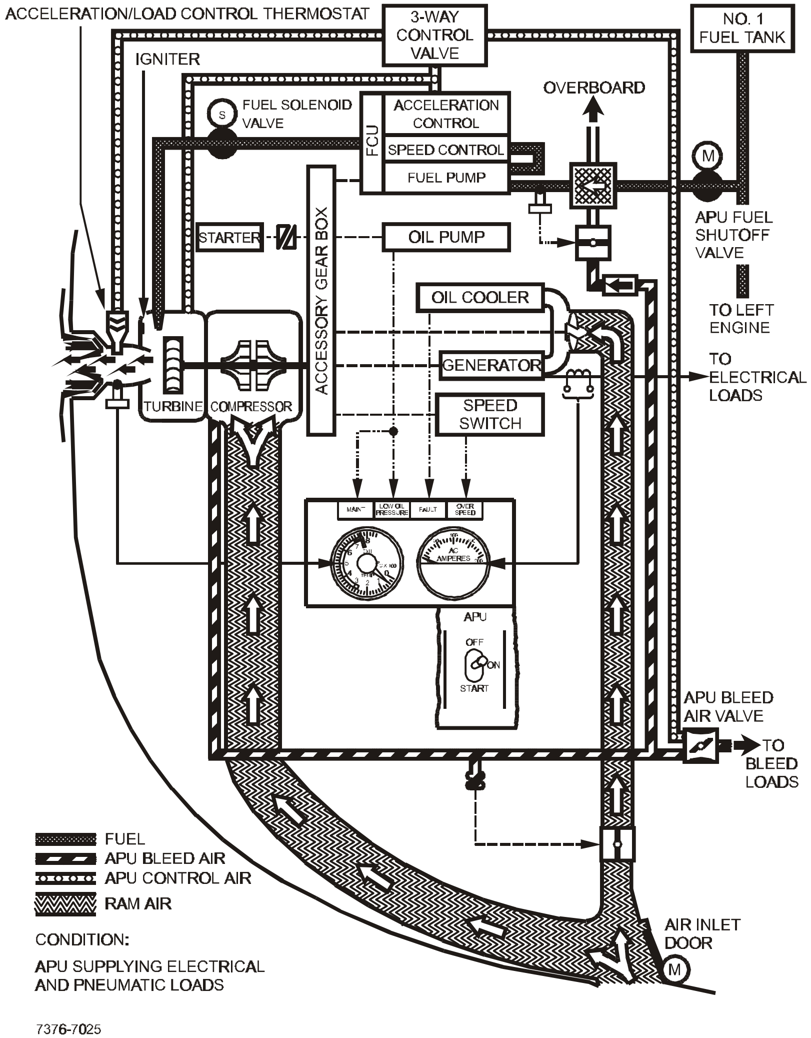
APU AUTOMATIC LOAD SHEDDING

③ No automatic galley load shedding provided.

③⑤ Galley electrical loads will automatically be shed should the total aircraft electrical power requirements exceed design limits with only the APU generator providing electrical power. The galley power switch will trip to the OFF position.

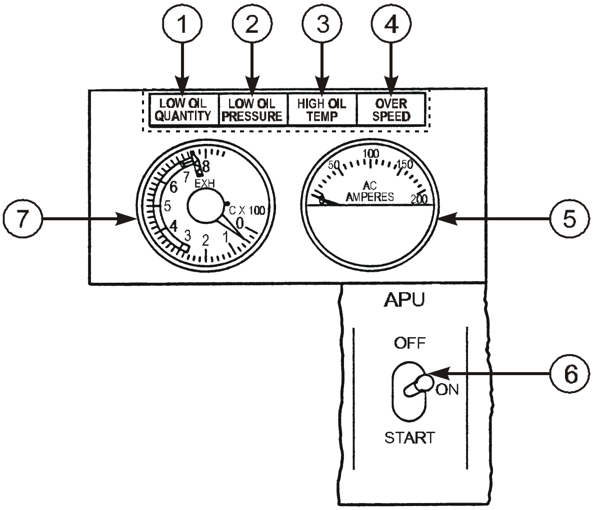
⑦⑧⑨ In flight, if the APU is the only source of electrical power, all galley busses are automatically shed. If electrical load still exceeds design limits, both main busses automatically shed until the load is within design limits. On the ground, the APU attempts to carry a full electrical load. If an overload condition is sensed, the APU sheds galley busses first and then both main busses until the load is within limits.

③③⑤ APU SCHEMATIC

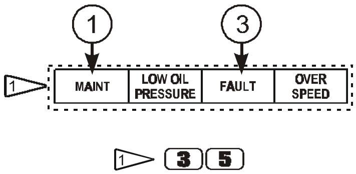


APU CONTROLS AND INDICATORS

③



FORWARD OVERHEAD PANEL



7376-7026

① APU LOW OIL QUANTITY / MAINT Light (blue)

Illuminated – APU oil quantity is insufficient for extended operation.

- Light is disarmed when the APU switch is in the OFF position.

② APU LOW OIL PRESSURE Light (amber)

Illuminated – APU oil pressure is low causing the APU to initiate an automatic shutdown (after the start cycle is complete).

- Light is illuminated during start until the APU oil pressure is normal.
- Light is disarmed when the APU switch is in the OFF position.

③ APU HIGH OIL TEMP / FAULT Light (amber)

Illuminated – APU oil temperature is excessive, causing the APU to initiate an automatic shutdown.

- Light is disarmed when the APU switch is in the OFF position.

④ APU OVERSPEED Light (amber)

Illuminated – APU speed is excessive, causing the APU to initiate an automatic shutdown.

- Light illuminates if an APU start is aborted prior to reaching governed speed, but extinguishes following a normal start.
- Light illuminated during APU shutdown indicates overspeed shutdown protection is lost.

⑤ APU Generator AC Ammeter

- Displays APU generator load current.

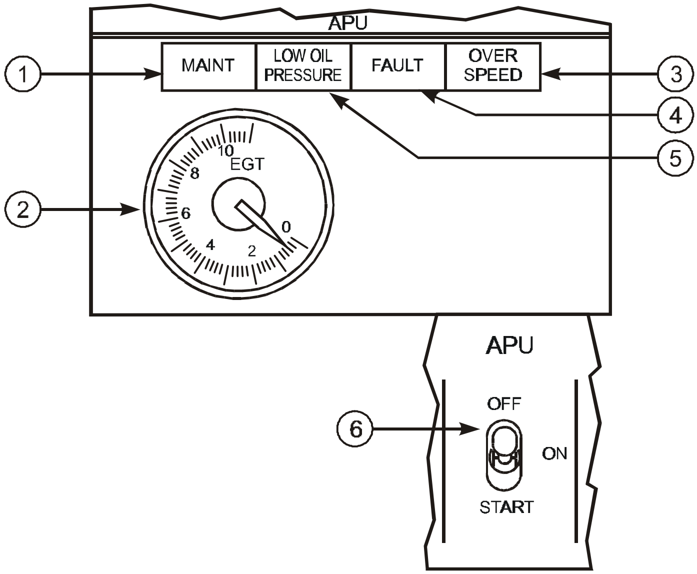
⑥ APU Switch

OFF – Normal position when the APU is not running. Positioning the switch to OFF with the APU running, initiates an APU shutdown.

ON – Normal position with the APU running.

START (Momentary) – Positioning the APU switch from OFF to START and releasing it to ON initiates an automatic start sequence.

7 8 9 APU



FORWARD OVERHEAD PANEL

7376-7027

① APU Maintenance (**MAINT**) Light

Illuminated (blue) – APU maintenance problem exists:

- APU may be operated.
- Light is disarmed when APU switch is in OFF.

② APU Exhaust Gas Temperature (**EGT**) Indicator

Displays APU EGT.

EGT indicator remains powered for 5 minutes after shutdown.

③ APU OVERSPEED Light

Illuminated (amber) –

- APU RPM limit has been exceeded resulting in an automatic shutdown.
- Overspeed shutdown protection feature has failed a self-test during a normal APU shutdown.
- If light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- Light is disarmed when the APU switch is in OFF position.

④ APU FAULT Light

Illuminated (amber) –

- A malfunction exists causing APU to initiate an automatic shutdown.
- If light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- Light is disarmed when APU switch is in OFF position.

⑤ APU LOW OIL PRESSURE Light

Illuminated (amber) –

- During start until the APU oil pressure is normal.
- Oil pressure is low causing an automatic shutdown (after start cycle is complete).
- If light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- Light is disarmed when APU switch is in OFF position.

⑥ APU Switch

OFF – Normal position when APU is not running.

- Positioning switch to OFF with APU running trips APU generator off the bus(es), if connected, and closes APU bleed air valve. APU continues to run for a 60 second cooling period.
- APU air inlet door automatically closes after shutdown.

ON – Normal position when APU is running.

START (momentary) – Positioning APU switch from OFF to START and releasing it to ON, initiates an automatic start sequence.

LIST OF EFFECTIVE PAGES

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FLIGHT CONTROLS

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FLIGHT CONTROLS SYSTEM DESCRIPTION

GENERAL

The primary flight controls are the ailerons, elevators and rudder. These hydraulically powered surfaces provide flight control in roll, pitch and yaw. Hydraulic power is provided from hydraulic systems A and B; either system can operate all primary flight controls. With a failure of the A and B systems the ailerons and elevators may be operated manually. The rudder may be operated by the standby hydraulic system if system A and/or B pressure is not available.

The ailerons are assisted by flight spoilers for roll control. The spoilers are hydraulically powered from system A and B and operate proportionally with aileron movement.

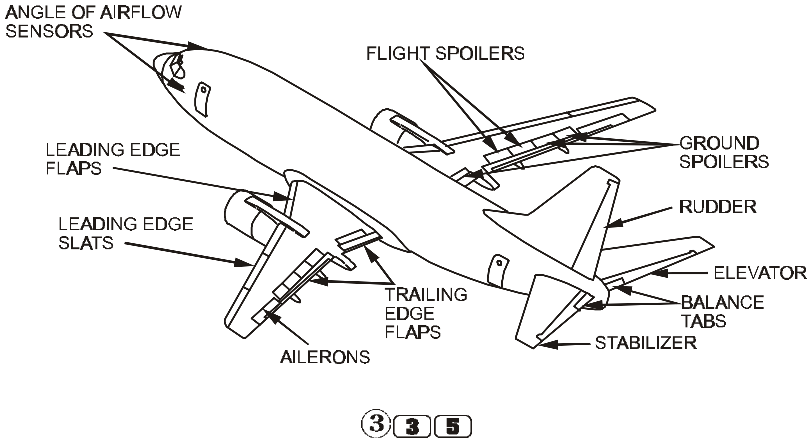
A variable pitch horizontal stabilizer may be positioned by pilot inputs to the electric trim or manually through the trim wheels. During automatic flight the autopilot trim controls the stabilizer position.

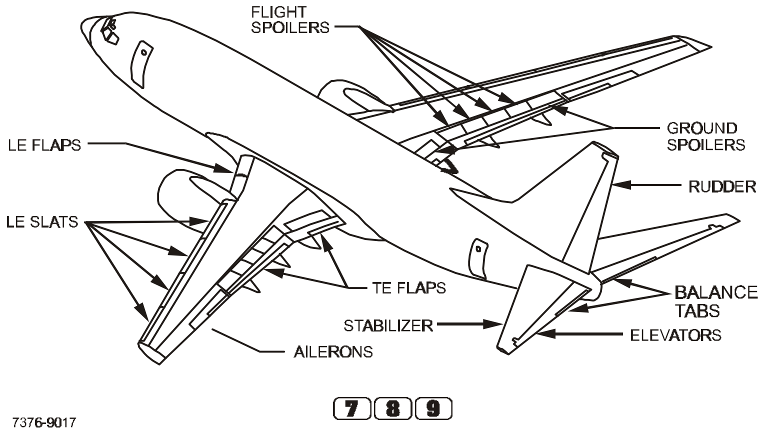
Aerodynamic braking is provided in the air by the flight spoilers operating as speedbrakes. On the ground, speedbrakes use both flight spoilers and ground spoilers to destroy lift and make braking more efficient.

High lift for takeoff and landing is provided by trailing edge flaps, and leading edge flaps and slats (LE devices). Normally, these surfaces are extended and retracted by hydraulic system B. Alternatively, the trailing edge flaps may be extended and retracted electrically. The leading edge devices may be extended by the standby hydraulic system. Under certain conditions the power transfer unit (PTU) automatically powers the LE devices. No alternate retraction system is provided for the leading edge devices.

The autoslat system improves handling qualities at high angles of attack during operations with flaps set at positions 1, 2 or 5. Autoslat deployment is designed to occur prior to stick shaker activation.

FLIGHT CONTROL SURFACES LOCATION





ROLL CONTROL

The roll control surfaces consist of hydraulically powered ailerons and flight spoilers, which are controlled by rotating either control wheel.

Ailerons

The ailerons provide roll control of the aircraft around its longitudinal axis. The ailerons are positioned by the pilots' control wheels, which are linked together by cables to supply the mechanical input to two separate hydraulic power control units. Hydraulic systems A and B provide pressure to separate power control units to operate the ailerons via cables. The two flight control switches control hydraulic pressure shutoff valves for each aileron. These same switches also control hydraulic pressure to the elevator and rudder.

The right and left ailerons are bussed together by the cable-drive system. Either hydraulic system is capable of providing full power control. In the event of total hydraulic power failure, rotation of the pilots' control wheels mechanically positions the ailerons. Manual control forces required are higher due to frictional and aerodynamic loads. If the aileron system jams, the Aileron Transfer Mechanism allows the copilot to bypass the aileron system and operate the fight spoilers for roll control.

Aileron Transfer Mechanism

If the ailerons or spoilers are jammed, force applied to the Captain's and the First Officer's control wheels will identify which system, ailerons or spoilers, is usable and which control wheel, Captain's or First Officer's, can provide roll control. If the aileron control system is jammed, force applied to the First Officer's control wheel provides roll control from the spoilers. The ailerons and the Captain's control wheel are inoperative. If the spoiler system is jammed, force applied to the Captain's control wheel provides roll control from the ailerons. The spoilers and the First Officer's control wheel are inoperative.

Aileron Trim

Dual AILERON trim switches, located on the aft electronic panel, must be pushed simultaneously to command trim changes. The trim electrically repositions the aileron feel and centering unit, which causes the control wheel to rotate and redefines the aileron neutral position. The amount of aileron trim is indicated on a scale on the top of each control column.

If aileron trim is used with the autopilot engaged, the trim is not reflected in the control wheel position. The autopilot overpowers the trim and holds the control wheel where it is required for heading / track control. Any aileron trim applied when the autopilot is engaged can result in an out of trim condition and an abrupt rolling movement when the autopilot is disconnected.

Flight Spoilers

3 3 5 Two flight spoilers are located on the upper surface of each wing. Hydraulic system A provides power to the inboard spoilers and hydraulic system B provides power to the outboard spoilers.

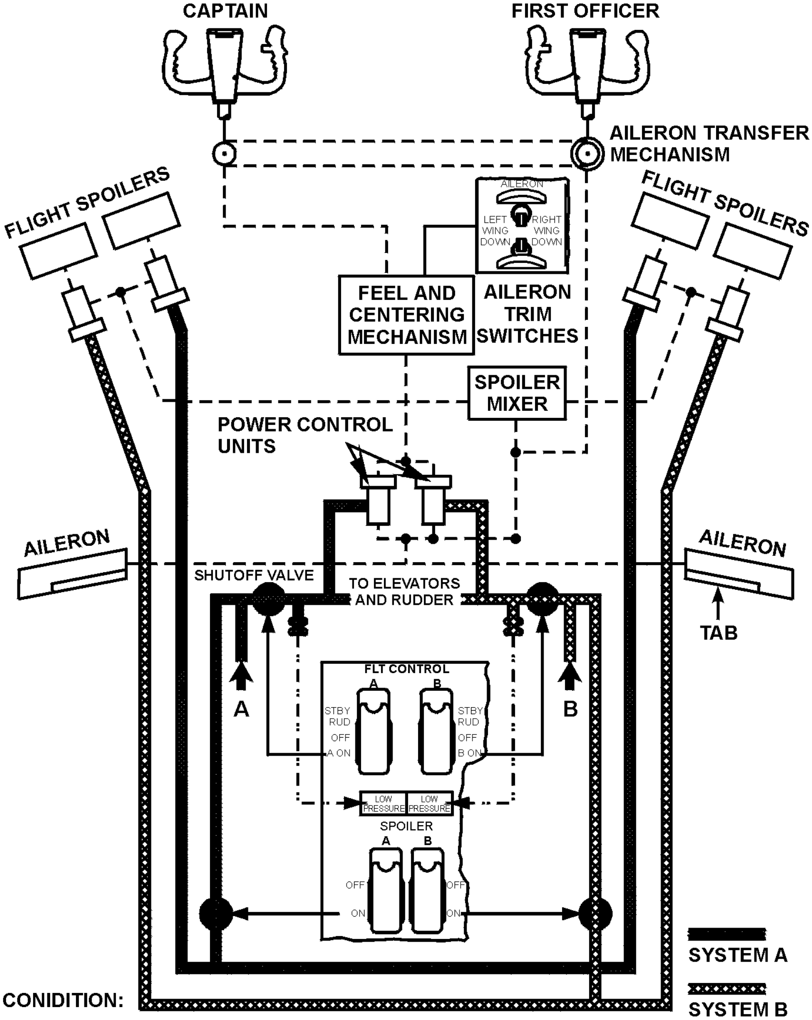
7 8 9 Four flight spoilers are located on the upper surfaces of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoiler pairs to provide isolation and maintain symmetric operation in the event of hydraulic system failure.

Hydraulic pressure shutoff valves are controlled by the two flight spoiler switches located on the overhead flight control panel.

The flight spoilers are hydraulically actuated in response to movement of the aileron controls. A spoiler mixer, connected to the aileron cable-drive, controls the hydraulic power control units on each spoiler panel to provide spoiler movement proportional to aileron movement.

The flight spoilers rise on the wing with up aileron and remain faired on the wing with down aileron. When the control wheel is displaced more than approximately 10°, spoiler deflection is initiated.

③③⑤ ROLL CONTROL SCHEMATIC



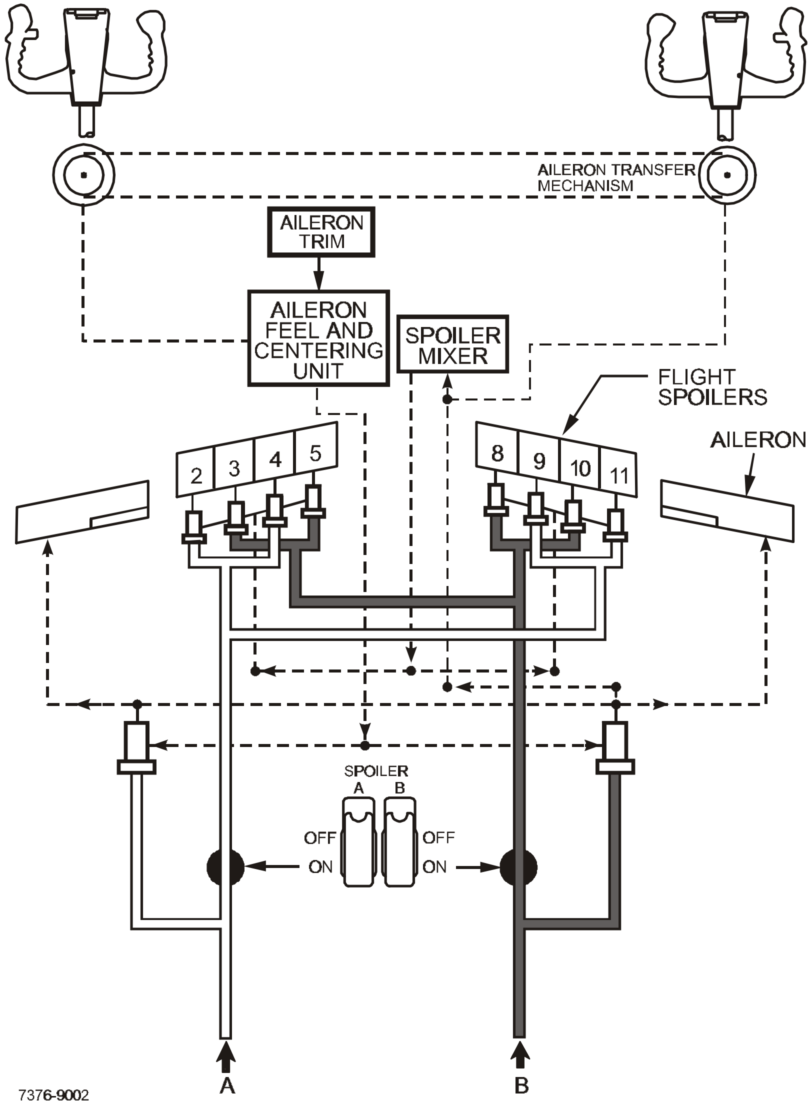
CONIDITION:

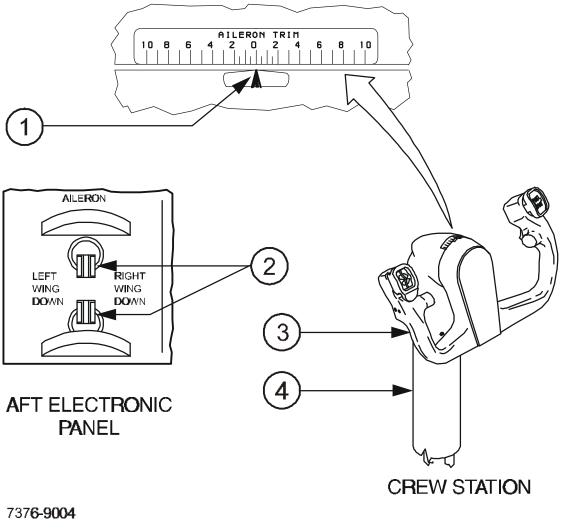
SYSTEMS
A AND B
PRESSURIZED

ROLL CONTROL SCHEMATIC

7376-9001

7 8 9 ROLL CONTROL SCHEMATIC





① AILERON TRIM Indicator

Indicates units of aileron trim.

② AILERON Trim Switches (spring-loaded to the neutral position)

Movement of both switches repositions the aileron neutral control position.

③ Control Wheel

Rotate – Operates ailerons and flight spoilers in desired direction.

④ Control Column

Push / Pull –

- Operates elevators in the desired direction.
- Movement opposing stabilizer trim stops electric trimming.

PITCH CONTROL

The pitch control surfaces consist of hydraulically powered elevators and an electrically powered stabilizer. The elevators are normally controlled by forward or aft movement of the control column. The stabilizer is normally controlled by either the stabilizer trim switches on the control wheel or the autopilot.

Elevators

The elevators provide pitch control around the aircraft's lateral axis. The elevators are positioned by the pilots' control columns. The A and B FLT CONTROL switches control hydraulic shutoff valves for the elevators.

Cables connect the pilots' control columns to elevator power control units (PCUs) which are powered by hydraulic system A and B. Either hydraulic system is capable of full elevator operation. The elevators are interconnected by a torque tube. With loss of hydraulic system A and B the elevators can be mechanically positioned by forward or aft movement of the pilots' control columns. Control forces are higher due to friction and aerodynamic loads.

Elevator balance tabs operate continuously during normal or manual reversion operations.

Elevator Control Column Transfer Mechanism

7 8 9 In the event of a control column jam, a transfer mechanism allows the control columns to be physically separated. Applying force against the jam will breakout either the Captain's or First Officer's control column. Whichever column moves freely after the breakout can provide adequate elevator control. If the jam occurs during the takeoff or landing phase, higher forces are required to generate sufficient elevator control to rotate for takeoff or flare for landing. Electric stabilizer trim is still available to counteract the sustained control column force.

Elevator Feel System

The elevator feel computer provides simulated aerodynamic forces using airspeed (from the elevator pitot system) and stabilizer position. Feel is transmitted to the control columns by the elevator feel and centering unit. To operate the feel system the elevator feel computer uses either hydraulic system A or B pressure, whichever is higher. When either hydraulic system or elevator feel pitot system fails, excessive differential hydraulic pressure is sensed in the elevator feel computer and the **FEEL DIFF PRESS** light illuminates.

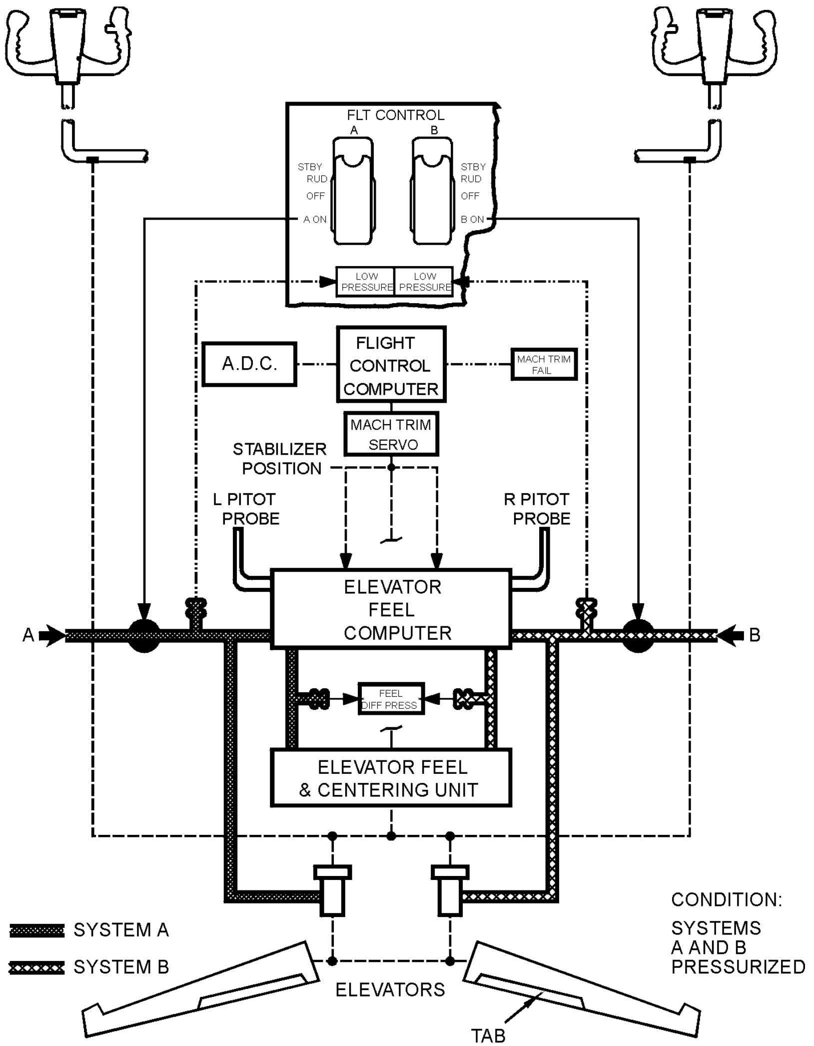
Mach Trim System

A Mach trim system provides speed stability at the higher Mach numbers. Mach trim is accomplished above Mach .615. The elevators are adjusted in a programmed manner with respect to the stabilizer as speed is increased. Engagement and disengagement are accomplished automatically as a function of airspeed.

③ [3] [5] Mach information received from the air data computer or [7] [8] [9] Air Data Inertial Reference Unit (ADIRU) is used by the flight control computers to generate a servo position command signal. The signal causes a rotation of the elevator feel and centering unit, which adjusts the control column neutral position.

A dual channel failure would result in a failure or unreliable Mach trim indicated by illumination of the **MACH TRIM FAIL** light. A single channel failure causes the **MACH TRIM FAIL** light to illuminate when the Master Caution Annunciator recall is activated.

③③⑤ ELEVATOR CONTROL SCHEMATIC



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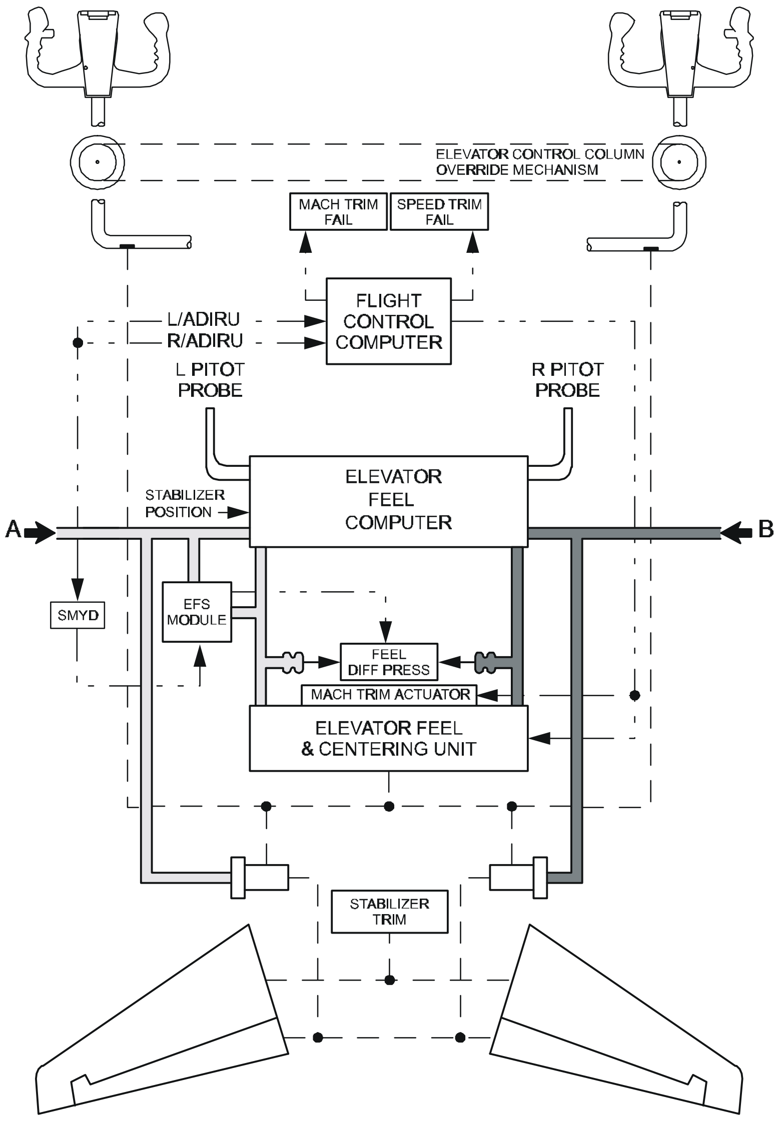
7 8 9 ELEVATOR CONTROL SCHEMATIC



7376-9003

7 8 9 MODIFIED PITCH FEEL - STALL IDENTIFICATION

Stall identification and control is enhanced by the yaw damper, the Elevator Feel Shift (EFS) module and the speed trim system. These three systems work together to help the pilot identify and prevent further movement into a stall condition.

During high Angle Of Attack (AOA) operations, the Stall Management / Yaw Damper Computer reduces yaw damper commanded rudder movement.

The EFS module increases hydraulic system A pressure to the elevator feel and centering unit during a stall. This increases forward control column force to approximately two times normal feel pressure. The EFS module is armed whenever an inhibit condition is not present. Inhibit conditions are: on the ground, radio altitude less than 100 feet and autopilot engaged. However, if EFS is active when descending through 100 feet RA, it remains active until AOA is reduced below approximately stickshaker threshold. There are no flight deck indications that the system is properly armed or activated.

As airspeed decreases towards stall speed, the speed trim system trims the stabilizer nose down and enables trim above stickshaker AOA. With this trim schedule the pilot must pull more aft column to stall the aircraft. With the column aft, the amount of column force increases with the onset of EFS.

Stabilizer Trim

③ 3 5 The horizontal stabilizer may be operated by either a main electric trim motor, an autopilot trim motor or by manual cable control.

7 8 9 The horizontal stabilizer may be positioned by a single electric trim motor, controlled by either the autopilot trim or by stabilizer trim switches on the control wheel or by manual cable control.

③ 3 5 The main electric trim has two speed modes: high speed with flaps extended and low speed with flaps retracted.

7 8 9 Stabilizer trim switches on each control wheel actuate the electric trim motor through the main electric stabilizer trim circuit when the aircraft is flown manually. With the autopilot engaged, stabilizer trim is accomplished through the autopilot stabilizer trim circuit. The main electric and autopilot stabilizer trim have two speed modes: high speed with flaps extended and low speed with flaps retracted.

If the autopilot is engaged, actuating either pair of stabilizer trim switches automatically disengages the autopilot.

The trim wheels follow automatically when electric stabilizer trim is actuated and the stabilizer trim indicator shows the trim unit setting.

Trim Authority

Main Electric Trim	③	3 5	7 8	9
Flaps Retracted	2.5 – 12.5 units	2.8 – 12.5 units	3.95 – 14.5 units	3.90 – 14.5 units
Flaps Extended	0.25 – 12.5 units	0.25 – 12.5 units	0.05 – 14.5 units	0.05 – 14.5 units
Autopilot Trim	0.25 – 14.0 units	0.25 – 14.0 units	0.05 – 14.5 units	0.05 – 14.5 units
Manual Trim	0 – 17.0 units	0 – 17.0 units	0.05 – 16.9 units	0.20 – 16.9 units

Stabilizer Position Indication And Green Band

Stabilizer position is displayed in units on two **STAB TRIM** indicators located inboard of each stabilizer trim wheel. The **STAB TRIM** indicators also display the TAKEOFF green band indication.

The green band range of the **STAB TRIM** indicator shows the takeoff trim range. An intermittent horn sounds if takeoff is attempted with the stabilizer trim outside the takeoff trim range.

Stabilizer Trim Operation With Forward Or Aft CG

In the event the stabilizer is trimmed to the end of the electrical trim limits, additional trim is available through the use of the manual trim wheels. If manual trim is used to position the stabilizer beyond the electrical trim limits, the stabilizer trim switches may be used to return the stabilizer to electrical trim limits.

Trim Cutout Switches

③ 3 5 Main electric and autopilot trim motors may be disengaged by individual cutout switches located on the control stand.

7 8 9 The stabilizer trim main electric cutout switch and the stabilizer trim autopilot cutout switch, located on the control stand, are provided to allow the autopilot or main electric trim inputs to be disconnected from the single stabilizer trim motor.

Stabilizer Trim Override Switch

Control column actuated stabilizer trim cutout switches stop operation of the main electric and autopilot trim when the control column movement opposes trim direction. When the STAB TRIM override switch, located on the control stand, is positioned to OVERRIDE, electric trim can be used regardless of control column position.

Speed Trim System

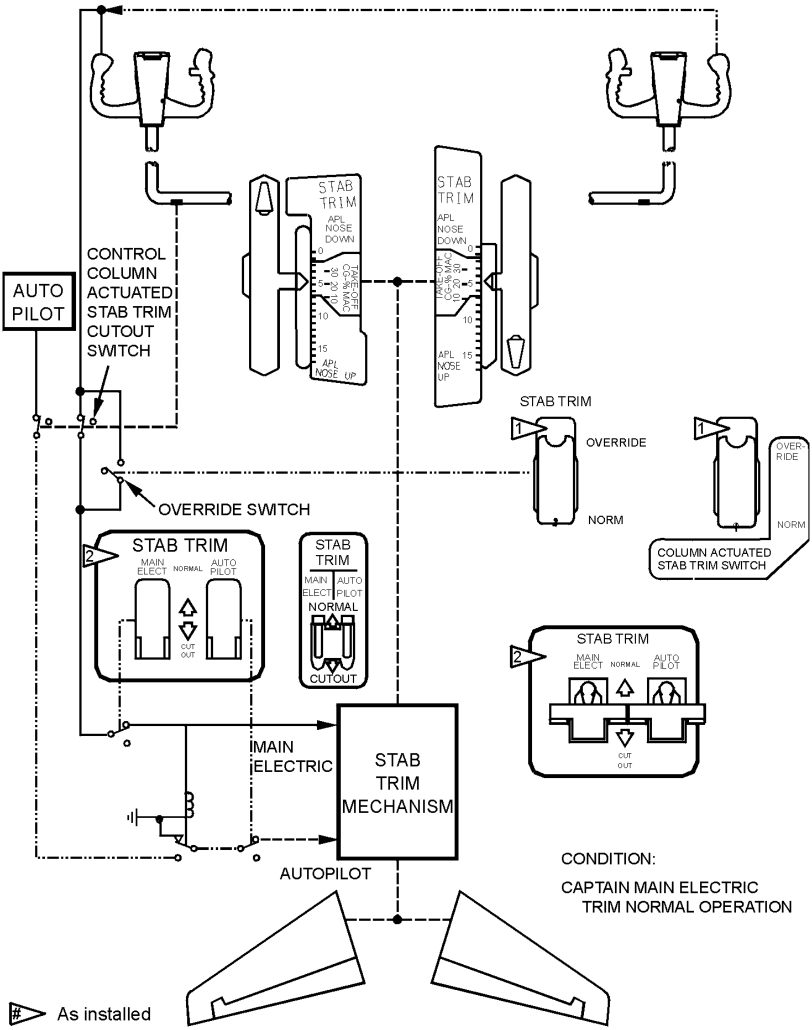
The speed trim system provides trim inputs to the stabilizer during low speed operations with a low gross weight, aft center of gravity, and flaps extended. Utilizing inputs of stabilizer position, thrust lever position, airspeed, and vertical speed, the system trims the aircraft using autopilot trim. It will most frequently be observed in operation during takeoffs and go-arounds.

Conditions for speed trim operation are:

- Flaps not up ③. Flaps up or down 3 5 7 8 9.
- Airspeed 100 – 300 KIAS ③ 3 5. 100 KIAS – Mach .50 7 8 9.
- 10 seconds after liftoff.
- 5 seconds following release of TRIM switches.
- N_1 above 60%.
- Autopilot not engaged.
- Sensing of trim requirement.

A dual channel failure would result in a failure or unreliable speed trim. This is indicated by illumination of the **SPEED TRIM FAIL** light. A single channel failure causes the **SPEED TRIM FAIL** light to illuminate when the master caution annunciator recall is activated.

STABILIZER CONTROL SCHEMATIC



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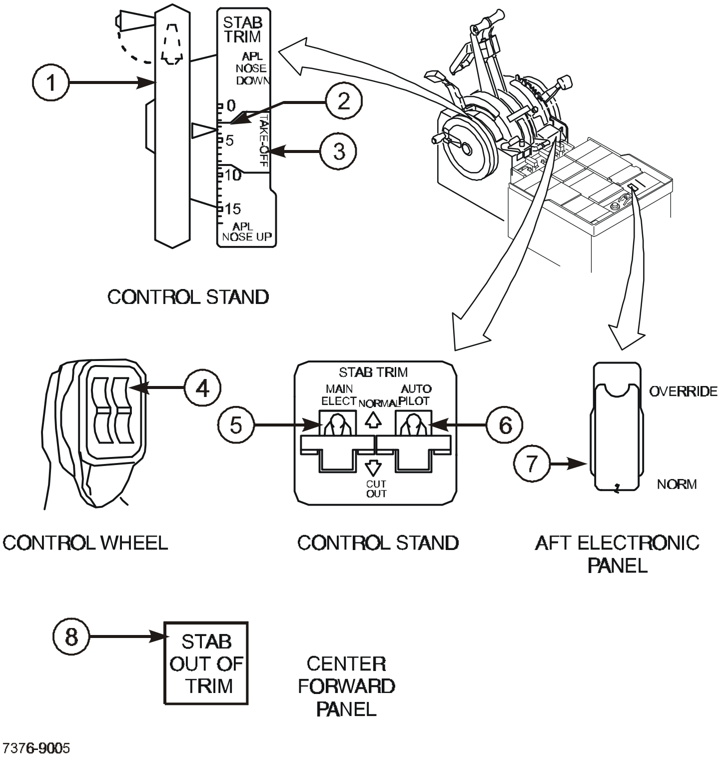
Stabilizer



① Stabilizer Trim Wheel

- Provides for manual operation of stabilizer.
- Overrides any other stabilizer trim inputs.
- Rotates when stabilizer is in motion.

Note: Handle should be folded inside stabilizer trim wheel for normal operation.

② Stabilizer Trim Indicator

Indicates units of aircraft trim on the adjacent scale.

③ Stabilizer Trim Green Band Range

Corresponds to allowable range of trim settings for takeoff.

④ Stabilizer Trim Switches (spring-loaded to neutral)

Push (both) –

- Electrically commands stabilizer trim in desired direction.
- Autopilot disengages if engaged.

⑤ Stabilizer Trim Main Electric (MAIN ELECT) Cutout Switch

NORMAL – Normal operating position.

CUTOUT – Deactivates stabilizer trim switch operation.

⑥ Stabilizer Trim AUTOPILOT Cutout Switch

NORMAL – Normal operating position.

CUTOUT –

- Deactivates autopilot stabilizer trim operation.
- Autopilot disengages if engaged.

⑦ Stabilizer Trim Override Switch

OVERRIDE – Bypasses the control column actuated stabilizer trim cutout switches to restore power to the stabilizer trim switches.

NORM (guarded position) – Normal operating position.

⑧ Stabilizer Out Of Trim (**STAB OUT OF TRIM**) Light

Operates only with autopilot engaged. Remains extinguished with autopilot not engaged.

Illuminated (amber) – Autopilot not trimming stabilizer properly.

YAW CONTROL

Rudder

Directional control about the vertical axis is provided by the rudder. Hydraulic system A and system B supply the main rudder power control unit. Either hydraulic system operates the rudder if required.

Either set of rudder pedals positions the rudder through the rudder power control units. Rudder feel is provided by a feel and centering unit utilizing the mechanical action of springs, cams and rollers.

Rudder trim is accomplished by operation of the Rudder Trim Control Switch located on the aft electronic panel. Operation of the Trim Control Switch electrically repositions the rudder feel and centering mechanism, which results in a shift in the rudder neutral position. The rudder pedals are displaced proportionately.

The standby pump furnishes hydraulic pressure to operate the rudder through a separate power control unit, in the event of a loss of system A or system B pressure.

Digital Yaw Damper Computer (DYDC)

③ [3] [5] The yaw damper system consists of a yaw damper coupler, rate gyro and a yaw damper actuator in the rudder power control unit.

The DYDC is located in the E&E compartment and provides rudder deflection commands to compensate for movement about the yaw axis. The DYDC receives inputs from the yaw rate gyro and the Air Data Computer (ADC). It then provides inputs to the rudder through the main rudder PCU. The yaw damper also assists in providing turn coordination. No rudder pedal movement results from yaw damper coordination. No rudder pedal movement results from yaw damper operation. Airspeed signals from the air data computer decrease the amount of yaw damper rudder deflection at high airspeeds.

[7] [8] [9] During normal operation the yaw damper system prevents unwanted (Dutch) roll and provides turn coordination and gust damping. The Stall Management / Yaw Damper (SMYD) computer receives inputs from both ADIRUs, both control wheels and the YAW DAMPER switch. It then provides inputs to the rudder through the main rudder PCU. At higher airspeeds the amount of yaw damper rudder deflection decreases. No rudder pedal movement results from yaw damper operation.

③ 3 5 The yaw damper uses hydraulic system B pressure only. The yaw damper is disengaged if the B flight control switch is positioned to OFF or STBY RUD. Loss of hydraulic system B pressure does not cause yaw damper switch disengagement or illumination of the amber **YAW DAMPER** light.

7 8 9 The yaw damper uses hydraulic system B or standby hydraulic system pressure. If hydraulic system B pressure is lost the YAW DAMPER switch remains in the ON position until the B FLT CONTROL switch is positioned to OFF or STBY RUD. Then the YAW DAMPER switch disengages and the amber **YAW DAMPER** light illuminates. Dutch roll and gust damping may be restored by resetting the YAW DAMPER switch to ON with the A and B FLT CONTROL switches in STBY RUD.

Rudder Pressure Reducer (RPR)

③ 3 5 The RPR reduces System A hydraulic pressure to the main rudder Power Control Unit (PCU) as a function of radio altitude and engine RPM, thereby reducing available rudder authority by about one-third. This reduced authority gives flight crews more time to respond to and recover from unnecessarily large rudder deflections. It also makes lateral controls (ailerons and spoilers) proportionately more effective in countering unnecessarily large rudder inputs. System B hydraulic pressure to the rudder is not affected.

Operation of the system is described below:

The DYDC interfaces with both radio altimeters to activate and deactivate the RPR solenoid. On takeoff after reaching 1000’ RA, system A hydraulic pressure to the rudder is reduced to 1000 psi. During approach at 700’ RA, system A pressure to the rudder returns to 3000 psi. If the RPR does NOT change system A pressure to normal at 700’ RA the system A **FLIGHT CONTROL LOW PRESSURE** light will illuminate; the standby hydraulic system will activate; the standby rudder shutoff valve will open; and the standby rudder PCU is pressurized.

System A hydraulic pressure to the rudder remains at or returns to normal 3000 psi with a loss of system B hydraulic pressure, loss of both radio altimeters or an engine failure. There is no flight deck indication if the RPR does not change from normal pressure to low pressure at 1000’ RA.

The relationship between rudder pedal position and rudder deflection angle remains constant with or without the RPR. Because the RPR reduces available rudder authority by about one-third, the amount of rudder pedal input required will vary based on altitude and airspeed. Although operation with the RPR installed is for the most part the same as before RPR installation, the crew should note two conditions described below:

1. If any rudder pedal is pushed to its limit when the RPR transitions to reduced pressure, airloads on the rudder reduces maximum rudder deflection and rudder pedal position also reduces.
2. If any rudder pedal is pushed to its limit when the RPR transitions to normal pressure, the rudder pedals will deflect further and the rudder deflection will correspondingly increase pressure.

Illumination of the system A **FLIGHT CONTROL LOW PRESSURE** light on final approach with system A and B hydraulic pressure remaining normal indicates a failure of the RPR to switch to the high (3000 psi) mode. Under this condition there is sufficient rudder authority to accomplish a normal landing, a crosswind landing, a single engine (S.E.) landing, or a S.E. missed approach / rejected landing. The standby hydraulic system will continue to activate automatically. Autopilot / autoland operations are not affected in the event that the RPR fails to change to normal pressure.

During preflight operations, when hydraulic system power is established, the system A **FLIGHT CONTROL LOW PRESSURE** light will remain illuminated for 5 – 7 seconds before extinguishing.

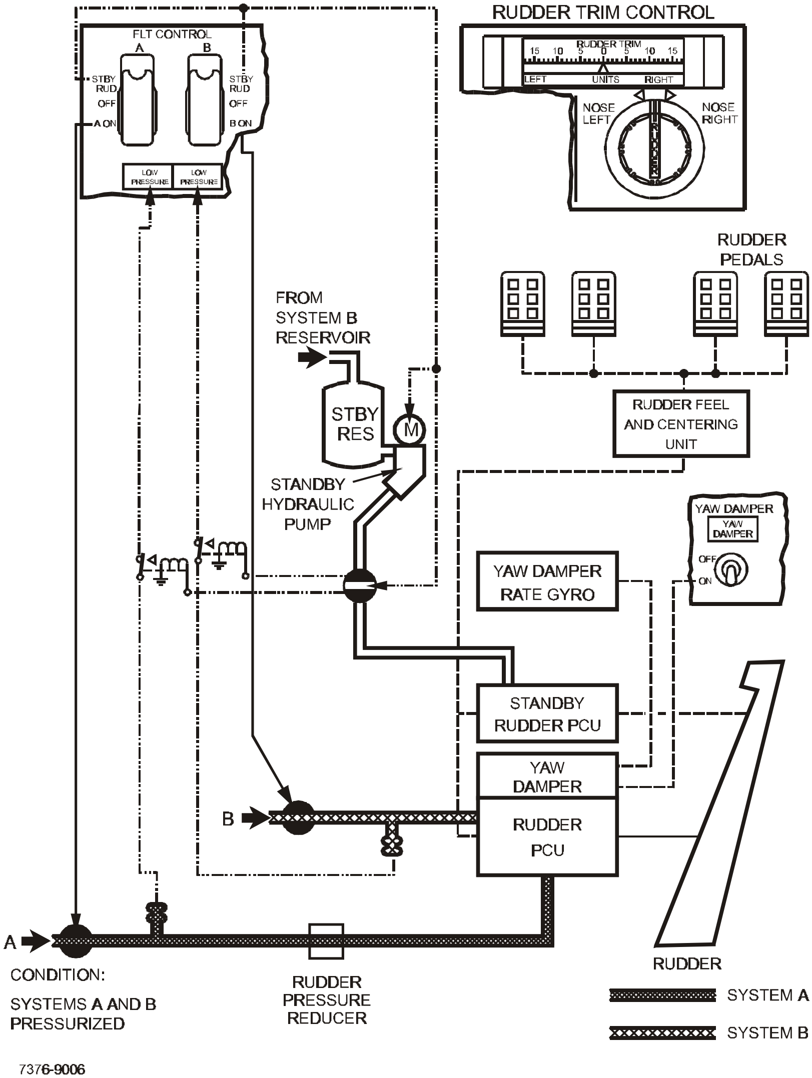
789 At speeds above approximately 135 kts hydraulic system A pressure to the rudder PCU is reduced. This limits full rudder authority in flight after takeoff and before landing.

7 8 9 Wheel To Rudder Interconnect System (WTRIS)

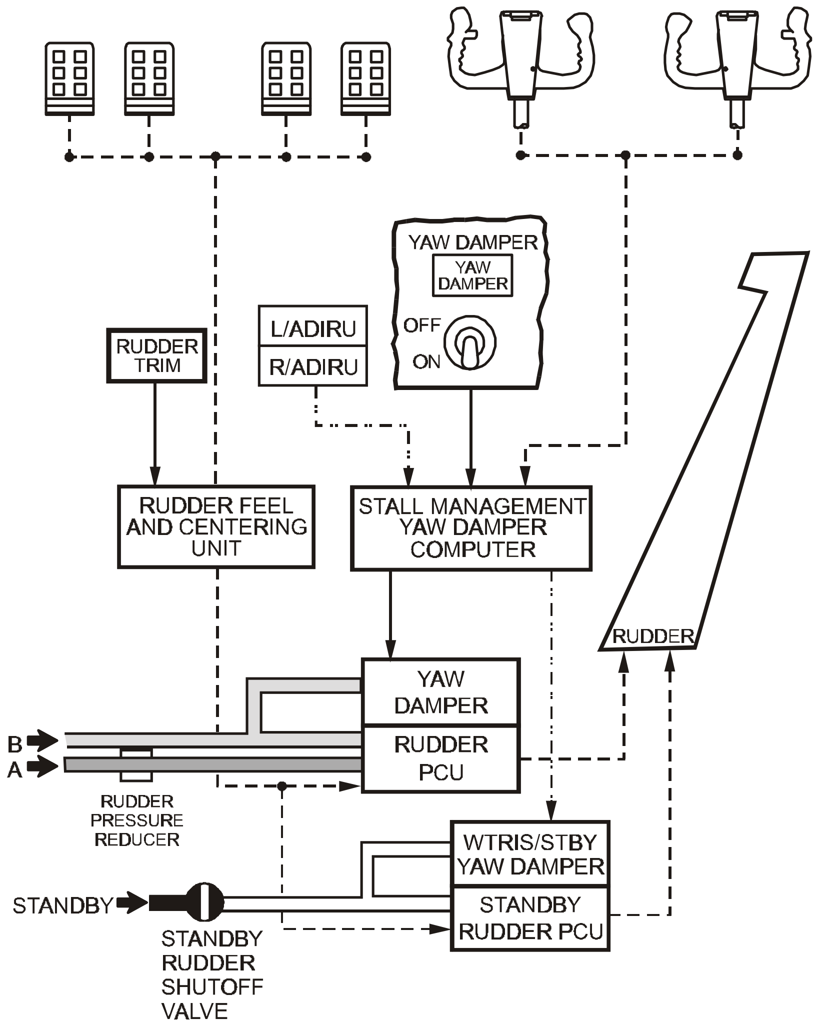
The purpose of WTRIS is to improve handling qualities during manual reversion flight (loss of hydraulic system A and B pressure). The WTRIS function is provided by the SMYD computer, which commands a small amount of standby rudder deflection (up to 2.5 degrees) when it senses a control wheel input. The pilot can override the WTRIS input using either the rudder pedals or trim inputs. Rudder movements due to WTRIS does not displace the rudder pedals and is not shown on the yaw damper indicator.

WTRIS is available only when both FLT CONTROL switches are positioned to STBY RUD and the YAW DAMPER switch has been reset to ON. WTRIS is capable of operation from takeoff through landing rollout.

③③⑤ YAW CONTROL SCHEMATIC



7 8 9 YAW CONTROL SCHEMATIC



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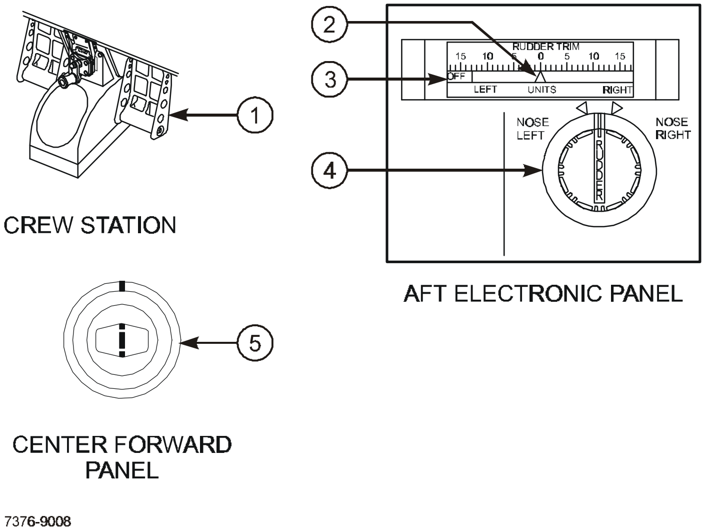
Rudder



① Rudder Pedals

Push –

- Controls rudder position.
- Permits limited nose gear steering up to 7 degrees each side of center.

② Rudder Trim Indicator

Indicates units of rudder trim.

③ Rudder Trim **OFF** Flag

Illuminated (amber) (in view) – Rudder trim indicator is inoperative.

④ Rudder Trim Control (spring-loaded to neutral)

Rotate – Electrically trims the rudder in the desired direction.

⑤ YAW DAMPER Indicator

- Indicates main yaw damper movement of rudder.
- Pilot rudder pedal inputs are not indicated.

Speed Brakes

The speed brakes consist of flight spoilers and ground spoilers. Hydraulic system A powers all ground spoilers. Both A and B hydraulic systems power the flight spoilers. The SPEED BRAKE lever controls the spoilers. When the SPEED BRAKE lever is actuated all the spoilers extend when the aircraft is on the ground and only the flight spoilers extend when the aircraft is in the air.

7 8 9 The **SPEEDBRAKES EXTENDED** light provides an indication of spoiler operation in-flight and on the ground. In-flight, the light illuminates to warn the crew that the speed brakes are extended while in the landing configuration or below 800 feet AGL. On the ground, the light illuminates when hydraulic pressure is sensed in the ground spoiler shutoff valve with the speed brake lever in the DOWN position.

In-Flight Operation

By actuating the speedbrake lever, all flight spoiler panels rise symmetrically to act as speedbrakes. Caution should be exercised when using flight spoilers during a turn as this will greatly increase roll rate. Movement of the speedbrake lever past the flight detent causes buffeting and is therefore not permitted.

Ground Operation

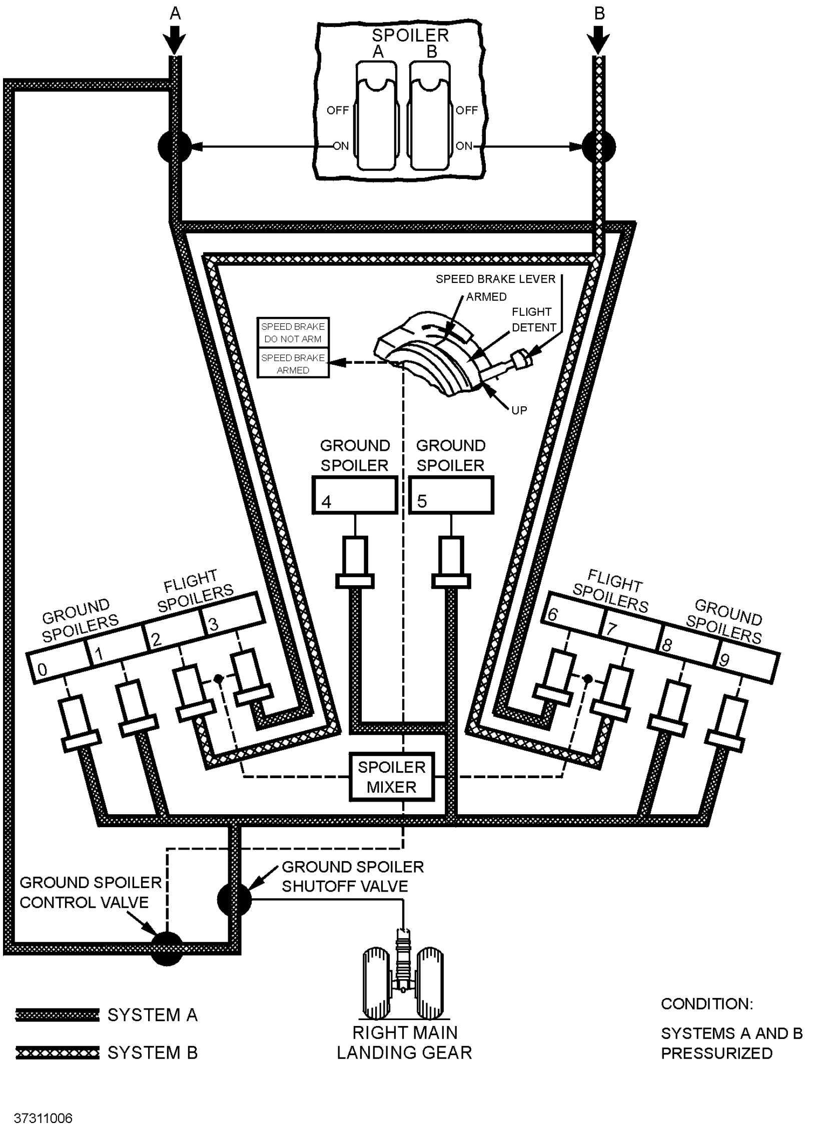
All flight and ground spoilers will automatically rise to full extend on landing if the speed brake lever is in the ARMED position and both thrust levers are at IDLE. When spin-up occurs on <u>any two main wheels</u>, the speed brake lever moves to the UP position and the flight spoilers extend. When the right main landing gear shock strut is compressed, a mechanical linkage opens the ground spoiler shutoff valve to extend the ground spoilers. If a wheel spin-up signal is not detected, the speed brake lever will move to the UP position and all spoiler panels will deploy automatically, after the ground safety sensor engages in the ground mode (main gear strut compression).

All spoiler panels will extend automatically if takeoff is rejected and the thrust reverse levers are positioned for reverse thrust. Wheel spin-up (60 kts.) must have occurred on any two main wheels in order for the automatic extension to take place.

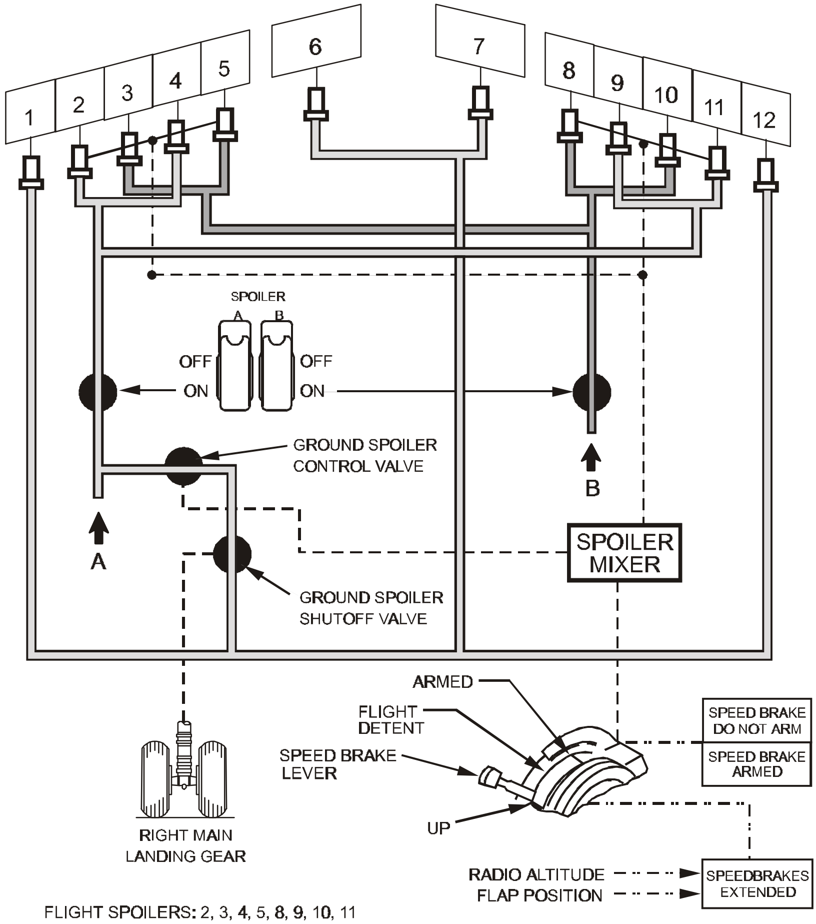
After an RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoiler panels retract. The spoiler panels may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

A failure in the automatic functions of the speed brakes is indicated by the illumination of the **SPEED BRAKE DO NOT ARM** light. In the event the automatic system is inoperative, the speedbrake lever must be moved manually to the UP position after landing.

③③⑤ SPEED BRAKES SCHEMATIC



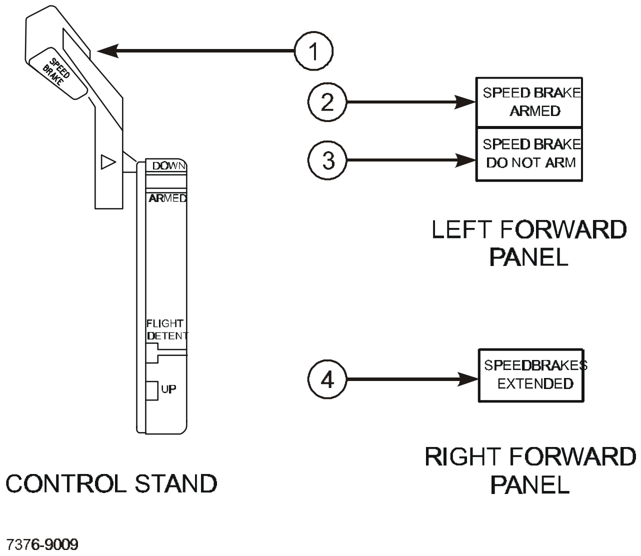
7 8 9 SPEED BRAKES SCHEMATIC



FLIGHT SPOILERS: 2, 3, 4, 5, 8, 9, 10, 11
GROUND SPOILERS: 1, 6, 7, 12

7376-9018

Speed Brakes



① SPEED BRAKE Lever

DOWN (detent) – All flight and ground spoiler panels in faired position.

ARMED –

- Automatic speed brake system armed
- Upon touchdown, the SPEED BRAKE lever moves to the UP position, and all flight and ground spoilers extend.

FLIGHT DETENT – All flight spoilers are extended to their maximum position for inflight use.

UP – All flight and ground spoilers are extended to their maximum position for ground use.

② **SPEED BRAKE ARMED** Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (green) – Indicates valid automatic speed brake system inputs.

③ **SPEED BRAKE DO NOT ARM** Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (amber) –

- Indicates non-normal condition or test inputs to the automatic speed brake system.

④ 7 8 9 **SPEEDBRAKES EXTENDED** Light

Illuminated (amber) –

- In-Flight –
  - SPEED BRAKE lever is beyond the ARMED position, and
  - TE flaps extended more than flaps 10, or
  - Radio altitude less than 800 feet.
- On the ground –
  - SPEED BRAKE lever is in the DOWN detent,
  - Ground spoilers are not stowed.

Note: On the ground, the **SPEEDBRAKES EXTENDED** light does not illuminate when hydraulic system A pressure is less than 750 psi.

High Lift Devices

High lift leading edge devices are used in combination with the trailing edge flaps to increase lift during takeoff and landing. The trailing edge flaps and leading edge devices, when extended, increase the wing area and the effective wing camber, which greatly increases lift. Trailing edge flap positions 1 – 15 provide increased lift; positions 15 – 40 provide increased lift and drag to permit slower approach speeds and greater maneuvering capability. Flap positions 30 and 40 are normal landing flap positions. Flaps 15 is used for some non-normal landing conditions.

③ [3] [5] The trailing edge devices consist of triple slotted flaps inboard and outboard of each engine.

[7] [8] [9] The TE devices consist of double slotted flaps inboard and outboard of each engine.

In the event of hydraulic system B failure, the trailing edge flaps can be operated electrically. In this case, control of the flaps is from two alternate flap switches. The guarded alternate flaps master switch actuates a flap bypass valve to prevent hydraulic lock of the flap drive unit and arms the alternate flaps position switch. This switch controls an electric motor that operates the drive unit to extend or retract the trailing edge flaps.

③ [3] [5] No asymmetry protection is provided through the alternate (electrical) flap drive system.

[7] [8] [9] No asymmetry or skew protection is provided through the alternate (electrical) flap drive system.

To prevent excessive structural loads from increased Mach at higher altitude, flap extension above 20,000 feet should not be attempted.

③ [3] [5] Asymmetry protection is provided by a flap comparator switch that monitors the flap gauge.

[7] [8] [9] Asymmetry or skew protection is provided by the Flaps / Slats Electronics Unit (FSEU) which monitors both LE and TE device positions.

If an asymmetrical or skew condition were to develop, as the case may be, hydraulic power will automatically be removed from the flap drive unit.

Flap Load Limiter

③ 3 5 A flap load limiter is installed in the trailing edge flap drive system. When the flap lever is in the 40 detent, the flaps will retract automatically to 30 if the airspeed exceeds 158 knots. The flap lever will not move; however, the flaps will return to 40 when the airspeed is reduced to 153 knots.

7 8 9 The Flaps / Slats Electronics Unit (FSEU) provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the Flaps 30 and Flaps 40 positions. The flap lever does not move, but the flap position indicator displays flap retraction and re-extension.

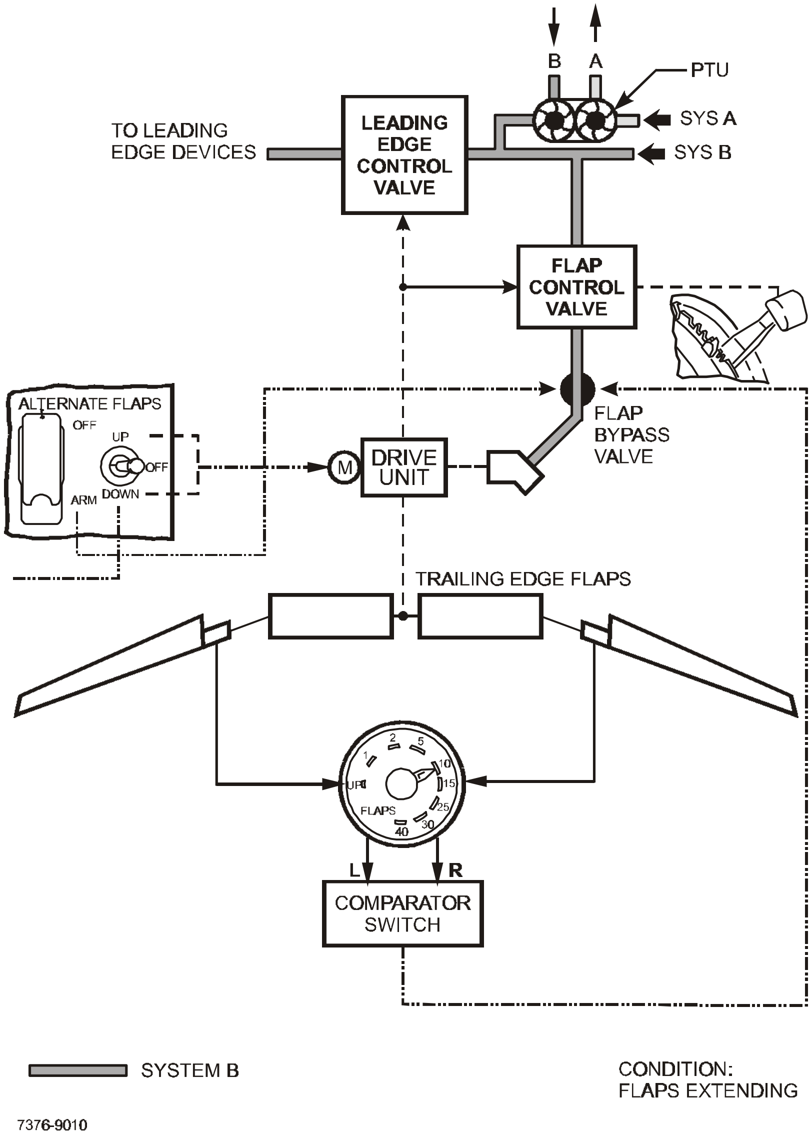
When the flaps are set at 40 the TE flaps:

- Retract to 30 if airspeed exceeds 162 knots.
- Re-extend when airspeed is reduced 5 knots below flaps 40 limit speed.

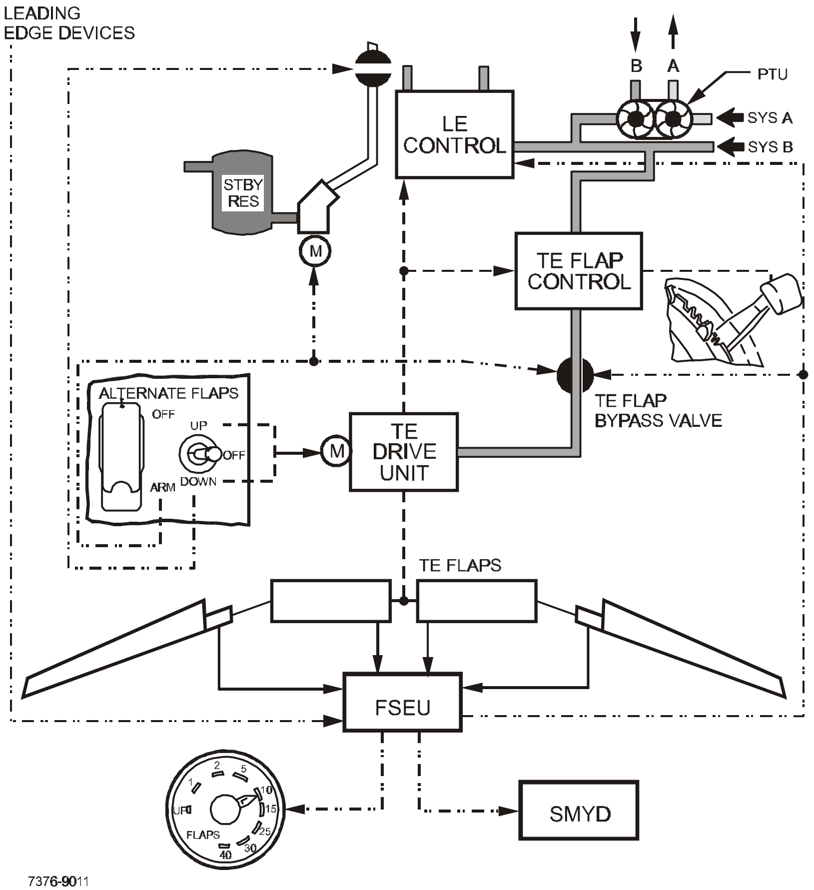
When the flaps are set at 30 the TE flaps:

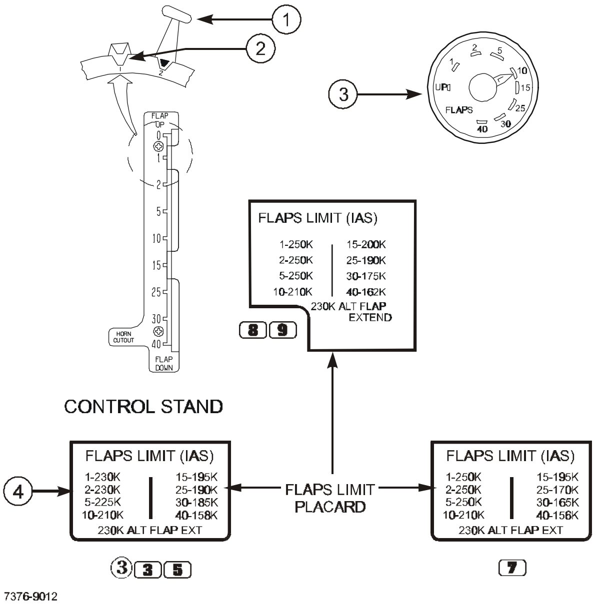
- Retract to 25 if the airspeed exceeds 175 knots.
- Re-extend when airspeed is reduced 5 knots below flaps 30 limit speed.

③③⑤ TRAILING EDGE FLAPS SCHEMATIC



7 8 9 TRAILING EDGE FLAPS SCHEMATIC





① FLAP Lever

- Selects position of flap control valve, directing hydraulic pressure for flap drive unit.
- Position of the LE devices is determined by selecting TE flap position.
- ③ 3 5 Flap position 30 arms the flap load relief system.
- 7 8 9 Flap positions 30 and 40 arm the flap load relief system.

② Flap Gates

Prevents inadvertent flap lever movement beyond:

- Position 1 – to check flap position for one engine inoperative go-around.
- Position 15 – to check flap position for normal go-around.

③ Flap Position Indicator

- Indicates position of left and right TE flaps.
- ③ 3 5 Provides TE flaps asymmetry protection circuit.
- 7 8 9 Provides TE flaps asymmetry and skew indication.

④ FLAPS LIMIT Placard

Indicates maximum speed for each flap setting. (As installed)

Leading Edge Devices

③ 3 5 The leading edge devices consist of four flaps and six slats: two flaps inboard of each engine and three slats outboard of each engine.

7 8 9 LE devices consist of four flaps and eight slats: two flaps inboard and four slats outboard of each engine.

Flaps are hinged surfaces that extend by rotating downward from the lower surface of the wing leading edge. Slats are sections of the wing leading edge that extend forward to form a sealed or slotted leading edge depending on the trailing edge flap position.

Leading edge devices are normally extended and retracted by hydraulic power from system B. The leading edge control valve is positioned by the trailing edge drive unit so that the leading edge devices operate in conjunction with the trailing edge flaps. When the trailing edge flaps leave the UP position, the leading edge flaps extend fully and the leading edge slats extend to an intermediate or EXTEND position. As the trailing edge flaps extend past the 5 position, the leading edge slats move to FULL EXTEND. When the flaps are retracted, the sequence is reversed.

In the event of hydraulic system B failure, the leading edge flaps and slats are driven to the FULL EXTEND position using power from the standby hydraulic system. In this case, the alternate flaps master switch energizes the standby pump and the alternate flaps position switch, when held in the down position momentarily, extends the leading edge devices.

Note: The leading edge devices cannot be retracted by the standby hydraulic system.

Indicator lights on the center instrument panel provide overall leading edge devices position status. The leading edge device annunciator on the aft overhead panel indicates the position of the individual flaps and slats.

Auto Slat Operation

The auto slat system provides improved handling qualities at high angles of attack during takeoff or approach to landing. When trailing edge flaps 1 through 5 are selected, the leading edge slats are in the EXTEND position. As the aircraft approaches the stall angle, the slats automatically drive to the FULL EXTEND position prior to stick shaker activation. The slats return to the EXTEND position when the pitch angle is sufficiently reduced below the stall critical attitude.

Auto slat operation is normally powered by system B hydraulics. An alternate source of power is provided by system A, through a Power Transfer Unit (PTU) if a loss of pressure from the system B engine driven pump is sensed. The power transfer unit provides system A pressure to power a hydraulic motorized pump and the pump pressurizes system B fluid to provide power for auto slat operation.

Asymmetry And Skew Detection, Protection And Indication

7 8 9 The Flaps / Slats Electronics Unit (FSEU) monitors the TE flaps for asymmetry and skew conditions. It also monitors the LE devices for improper position and skew conditions on slats 2 through 7. If a flap on one wing does not align with the symmetrical flap on the other wing, there is a flap asymmetry condition. A skew condition occurs when the two drives for any flap or slat panel do not operate at the same rate causing the panel to twist during extension or retraction.

There is no skew detection of the outboard slats, 1 and 8 or for the LE flaps. Slat skew detection is inhibited during auto slat operations.

If an asymmetrical condition were to develop between the right and left wing trailing edge flaps, hydraulic power will automatically be removed from the flap drive unit.

7 8 9 Uncommanded Motion Detection, Protection And Indication (LE Devices)

Motion

The FSEU provides protection from uncommanded motion by the LE devices.

Uncommanded motion is detected when no TE flap position or autoslat command is present and:

- Two LE flaps move on one wing, or
- Two or more slats move on one wing.

The FSEU shuts down the LE control and illuminates the amber **LE FLAPS TRANSIT** light.

In addition, to prevent uncommanded motion from occurring on the LE devices during cruise, the FSEU maintains pressure on the retract lines and depressurizes the Extend and Full Extend lines.

Indication

When the Flap / Slat Electronics Unit (FSEU) detects a LE device in an improper position or a LE slat skew condition, the **LE FLAPS TRANSIT** light remains illuminated and one of the following indications is displayed on the LE Devices Annunciator Panel:

- Amber **TRANSIT** light illuminated
- Incorrect green **EXT** or **FULL EXT** light illuminated
- No light illuminated.

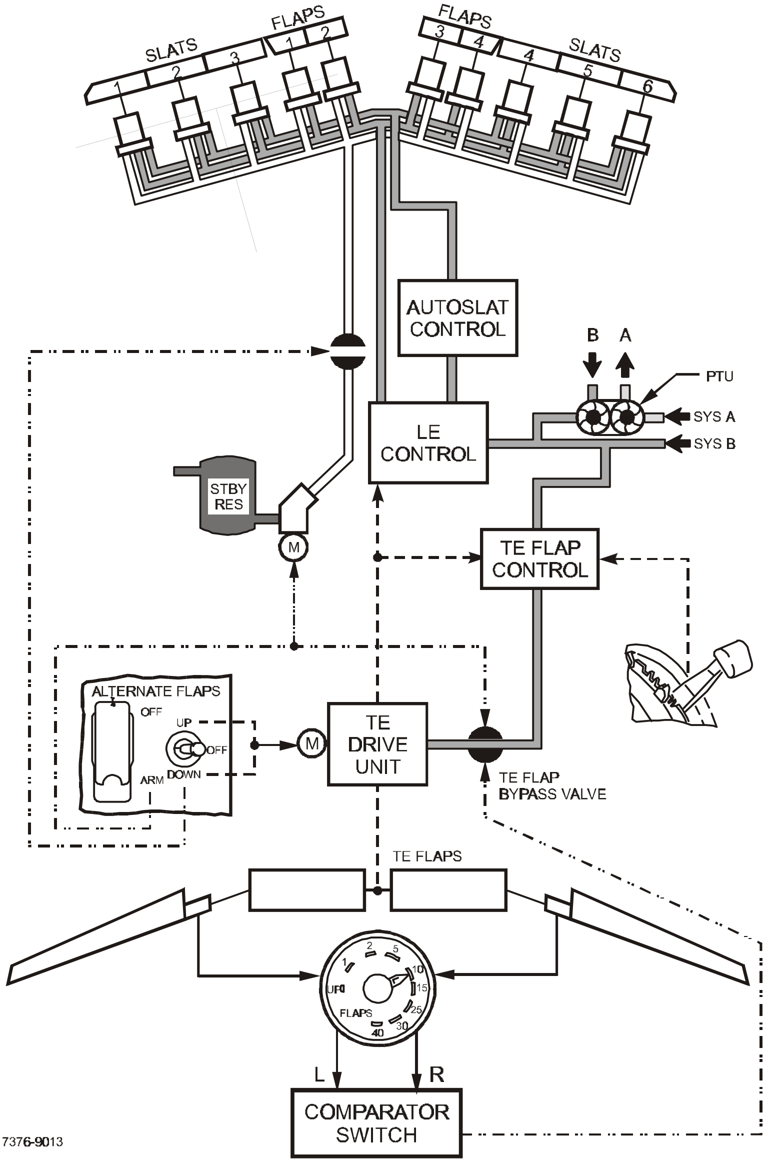
7 8 9 Uncommanded Motion Detection, Protection And Indication (TE Flaps)

Uncommanded motion is detected when no flap handle or flap load relief command is present and the TE flaps:

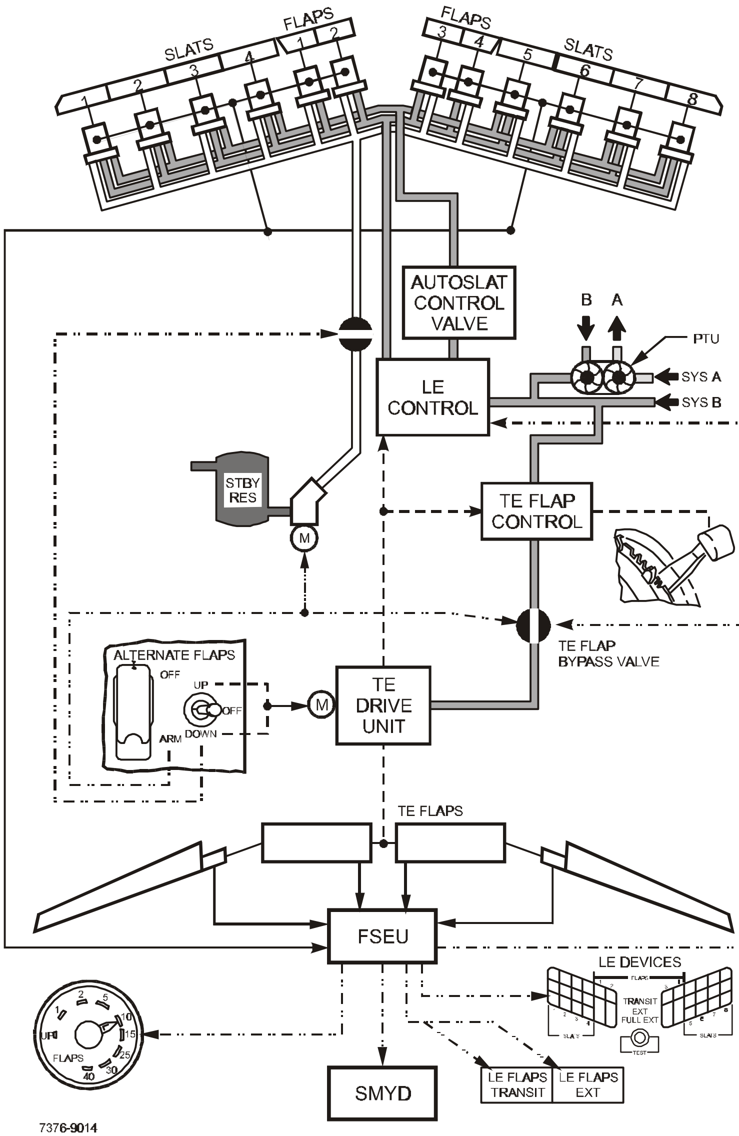
- Move away from the commanded position
- Continue to move after reaching a commanded position
- Move in a direction opposite to that command.

The FSEU shuts down the TE drive unit by closing the TE flap bypass valve. The TE flap shutdown cannot be reset by the flight crew and they must use the alternate flap system to control TE flaps. The shutdown is indicated by the Flap Position Indicator disagreeing with the flap handle position. There is no flap needle split.

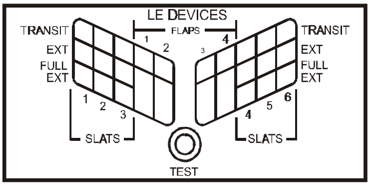
③③⑤ LEADING EDGE DEVICES AND TRAILING EDGE FLAPS SCHEMATIC



7 8 9 LEADING EDGE DEVICES AND TRAILING EDGE FLAPS SCHEMATIC



Leading Edge Devices



AFT OVERHEAD PANEL

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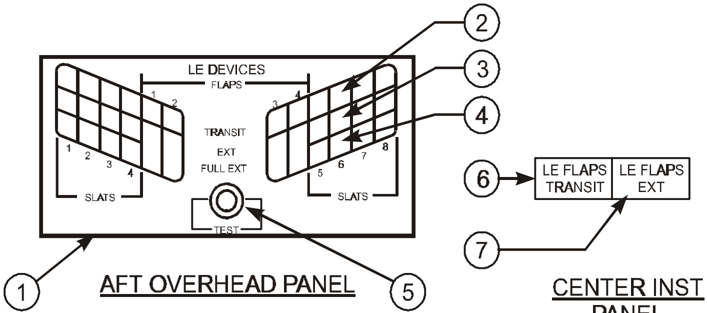

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① Leading Edge Devices (**LE DEVICES**) Annunciator Panel

Indicates position of individual LE flaps and slats.

Extinguished – Related LE device retracted.

② Leading Edge Devices **TRANSIT** Lights

Illuminated (amber) – Related LE device in transit.

③ Leading Edge Devices Extended (**EXT**) Lights

Illuminated (green) – Related LE slat in extended (intermediate) position.

④ Leading Edge Devices Full Extended (**FULL EXT**) Lights

Illuminated (green) – Related LE device fully extended.

⑤ Leading Edge Annunciator Panel TEST Switch

Press – Tests all annunciator panel lights.

⑥ Leading Edge Flaps Transit (**LE FLAP TRANSIT**) Light

Illuminated (amber) –

- Any LE device in transit.
- Any LE device not in programmed position with respect to TE flaps.
- 7 8 9 A LE slat skew condition exists (slats 2 through 7 only).
- During alternate flap extension until LE devices are fully extended and TE flaps reach approximately flaps 15.

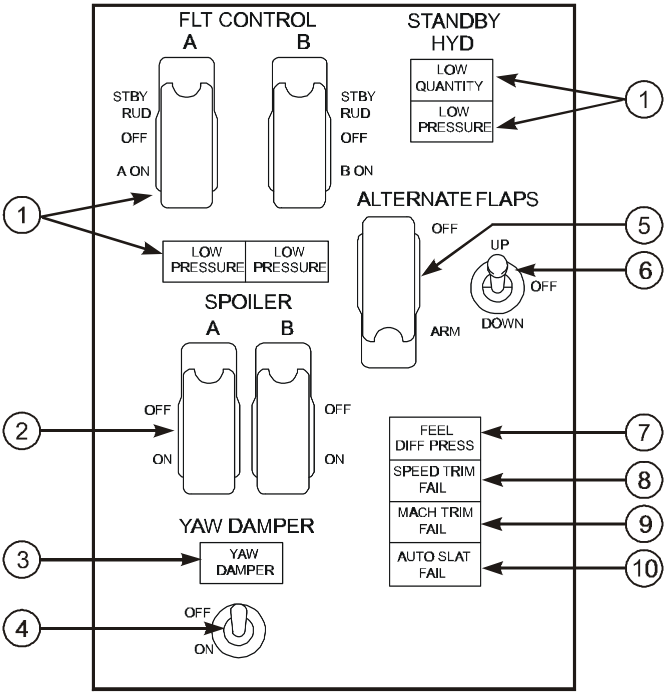
Note: Light is inhibited during auto slat operation in flight.

⑦ Leading Edge Flaps Extended (**LE FLAPS EXT**) Light

Illuminated (green) –

- All LE flaps extended and all LE slats in extended (intermediate) position (TE flap positions 1, 2 and 5).
- All LE devices fully extended (TE flap positions 10 through 40).

FLIGHT CONTROL PANEL



FORWARD OVERHEAD PANEL

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① Refer to Section 6.13 – Hydraulics

② Flight SPOILER Switches

ON (guarded position) – Normal operating position.

OFF – Closes the respective flight spoiler shutoff valve.

Note: Used for maintenance purposes only.

③ **YAW DAMPER** Light

Illuminated (amber) – Yaw damper is not engaged.

④ YAW DAMPER Switch

OFF – Disengages yaw damper.

ON –

- Engages the yaw damper to main rudder power control unit if the B FLT CONTROL switch is in the ON position.
- 7 8 9 Engages standby yaw damper to standby rudder power control unit if both the A and B FLT CONTROL switches are in the STBY RUD position.

⑤ ALTERNATE FLAPS Master Switch

OFF (guarded position) – Normal operating position.

ARM – Closes TE flap bypass valve, activates standby pump and arms the ALTERNATE FLAPS position switch.

⑥ ALTERNATE FLAPS Position Switch

Functions only when the ALTERNATE FLAPS master switch is in ARM.

UP –

- Electrically retracts TE flaps.
- LE devices remain extended and cannot be retracted by the alternate flaps system.

OFF – Normal operating position.

DOWN (spring loaded to OFF) –

- (Momentarily) fully extends LE devices using standby hydraulic pressure.
- (Hold) electrically extends TE flaps until released.

⑦ Feel Differential Pressure (**FEEL DIFF PRESS**) Light

Armed when the TE flaps are up.

Illuminated (amber) –

- Indicates excessive differential pressure in the elevator feel computer.

7 8 9
Note: Excessive differential pressure can be caused by erroneous activation of the Elevator Feel Shift module.

⑧ Speed Trim Failure (**SPEED TRIM FAIL**) Light

Illuminated (amber) –

- Indicates failure of the speed trim system.
- Indicates failure of a single FCC channel when **MASTER CAUTION** light recall is activated and light extinguished when master caution system is reset.

⑨ Mach Trim Failure (**MACH TRIM FAIL**) Light

Illuminated (amber) –

- Indicates failure of the mach trim system.
- Indicates failure of a single FCC channel when **MASTER CAUTION** light recall is activated and light extinguishes when master caution system is reset.

⑩ Automatic Slat Failure (**AUTO SLAT FAIL**) Light

Illuminated (amber) –

- Indicates failure of the auto slat system.
- Indicates failure of a single Stall Management / Yaw Damper (SMYD) computer when illuminated during **MASTER CAUTION** recall and extinguishes when master caution system is reset.

LIST OF EFFECTIVE PAGES

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* 1	11/15/02	* 34	11/15/02		
* 2	11/15/02	* 35	11/15/02		
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HYDRAULICS

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HYDRAULICS SYSTEM DESCRIPTION

INTRODUCTION

The aircraft has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following aircraft systems:

- flight controls
- leading edge flaps and slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- thrust reversers
- autopilots.

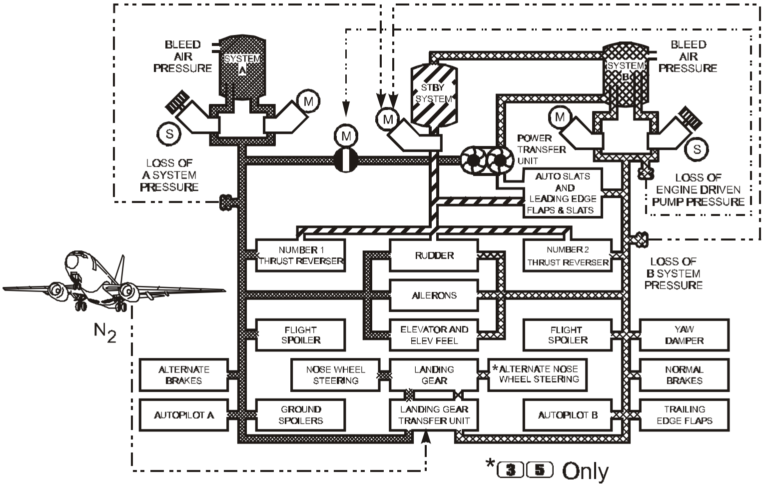
Either A or B hydraulic system can power all flight controls with no decrease in aircraft controllability.

Each hydraulic system has a fluid reservoir located in the main wheel well area. System A and B reservoirs are pressurized by bleed air. The standby system reservoir is connected to the system B reservoir for pressurization and servicing. Pressurization of all reservoirs ensures positive fluid flow to all hydraulic pumps.

Nominal operating pressure for each hydraulic system is 3,000 psi.

HYDRAULIC POWER DISTRIBUTION SCHEMATICS

③ 3 5



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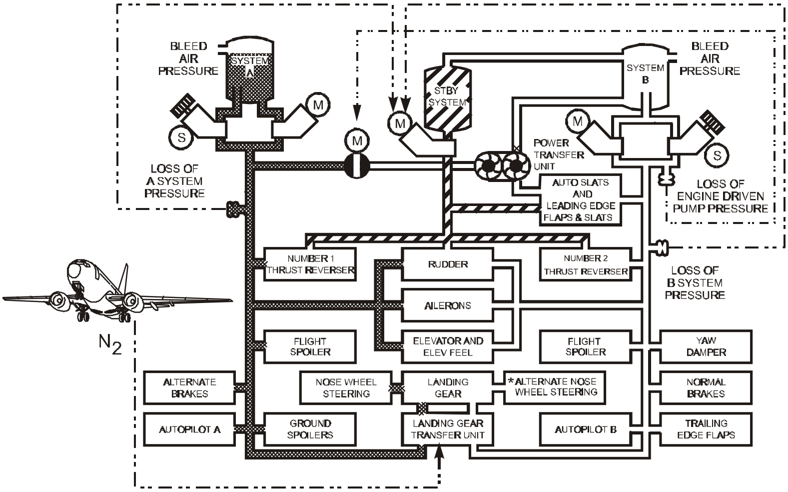

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A AND B HYDRAULIC SYSTEMS

Components powered by hydraulic systems A and B are:

System A

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers
- ground spoilers
- alternate brakes
- No. 1 thrust reverser
- autopilot A
- normal nose wheel steering
- landing gear
- power transfer unit (PTU).

System B

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers
- leading edge flaps and slats
- normal brakes
- No. 2 thrust reverser
- autopilot B
- alternate nose wheel steering
- landing gear transfer unit
- autoslats
- yaw damper
- trailing edge flaps.

A and B Hydraulic System Pumps

A and B hydraulic systems have an engine-driven pump and an AC electric motor-driven pump. System A engine-driven pump is powered by the No. 1 engine and system B engine-driven pump is powered by the No. 2 engine. An engine-driven hydraulic pump supplies more fluid volume than the related electric motor-driven hydraulic pump.

The ENG 1 (system A) or ENG 2 (system B) pump ON/OFF switch controls the engine-driven pump output pressure. Positioning the switch to OFF isolates fluid flow from the system components. However, fluid is not shutoff, the pump continues to rotate, and fluid continues, at a lower volume, to circulate through the pump for lubrication and cooling as long as the engine is operating. Pulling an engine fire warning switch shuts off the fluid flow to the related engine-driven pump and deactivates its **LOW PRESSURE** light.

The ELEC 2 (system A) or ELEC 1 (system B) pump ON/OFF switch controls the related electric motor-driven pump. If an overheat is detected in either system, the related **OVERHEAT** light illuminates.

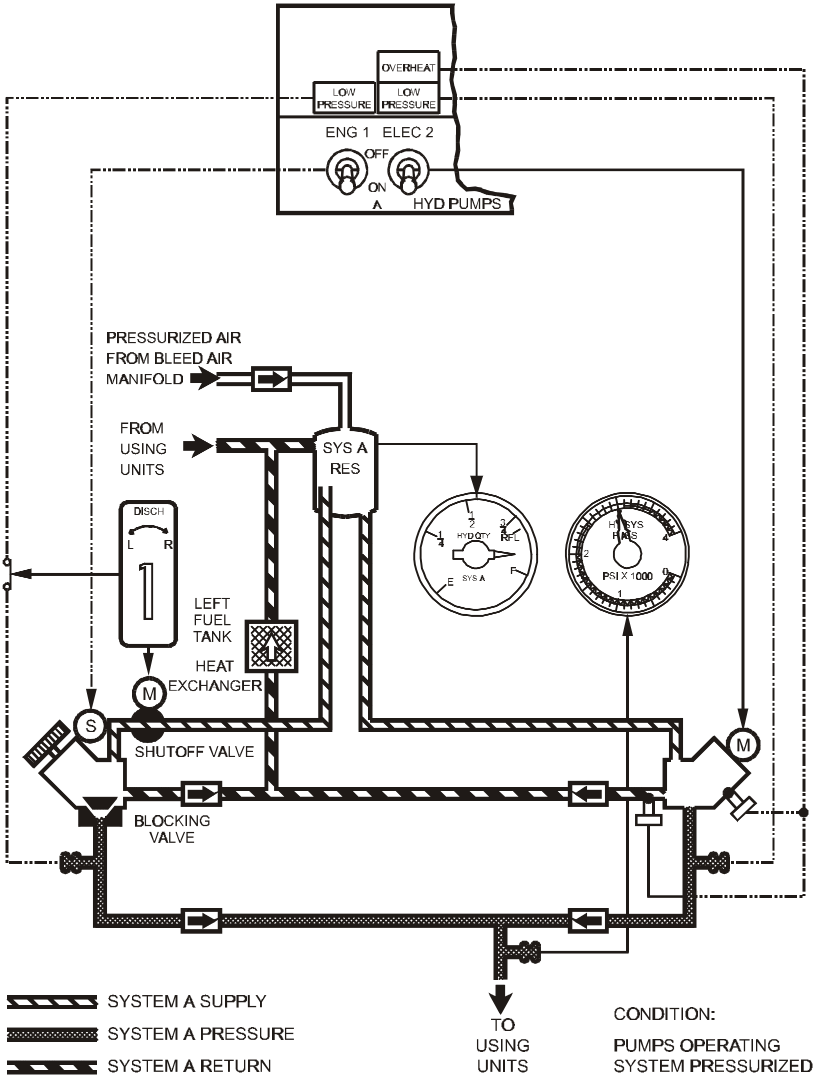
Note: Loss of the system A engine-driven hydraulic pump, and a heavy demand on system A, may result in an intermittent **LOW PRESSURE** light for the remaining electric hydraulic pump. The system A flight controls **LOW PRESSURE** light, **MASTER CAUTION** light, and the **FLT CONT** and **HYD** system annunciator lights also illuminate.

Hydraulic fluid used for cooling and lubrication of the pumps passes through a heat exchanger before returning to the reservoir. The heat exchanger for system A is in main fuel tank No. 1 and for system B is in main fuel tank No. 2.

Caution: Minimum fuel for ground operation of electric pumps is 1676 lbs. in the related main tank.

Pressure switches, in the engine-driven and electric motor-driven pump output lines, send signals to illuminate the related **LOW PRESSURE** light if pump output pressure is low. A check valve, in each output line, isolates the related pump from the system. The related system pressure transmitter sends the combined pressure of the engine-driven and electric motor-driven pump to the related hydraulic system pressure indicator.

③③⑤ HYDRAULIC SYSTEM A SCHEMATIC



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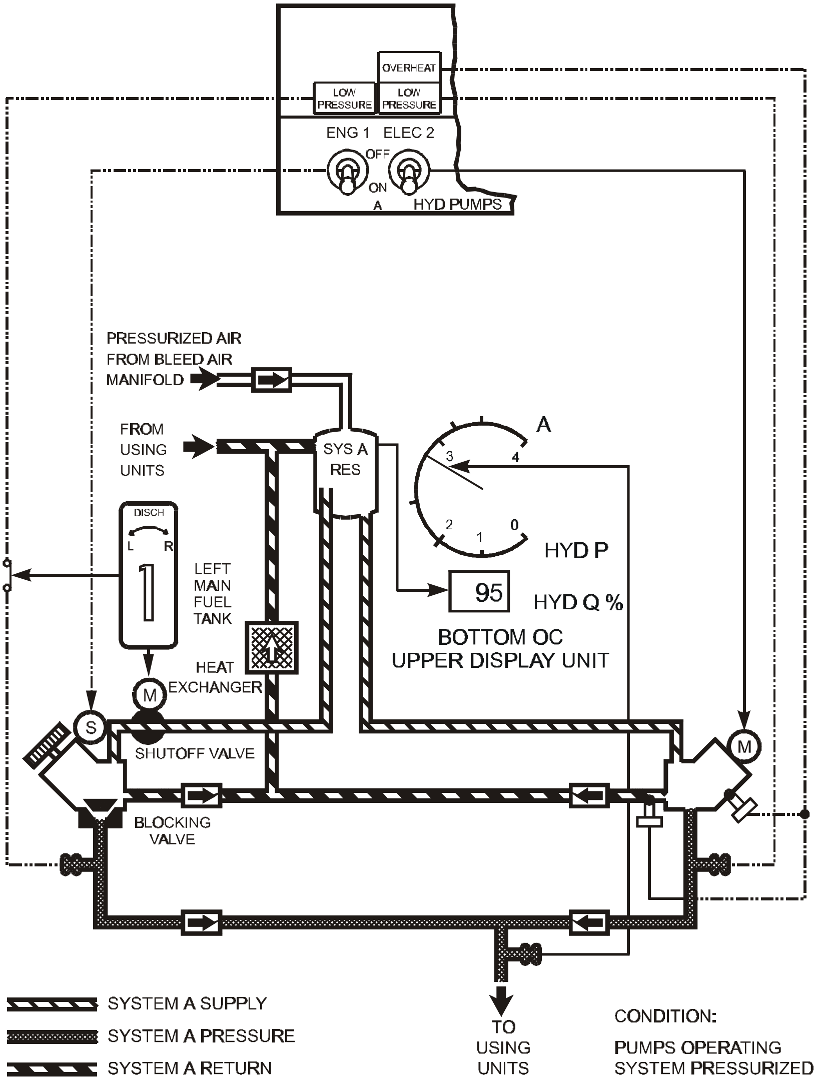
7 8 9 HYDRAULIC SYSTEM A SCHEMATIC



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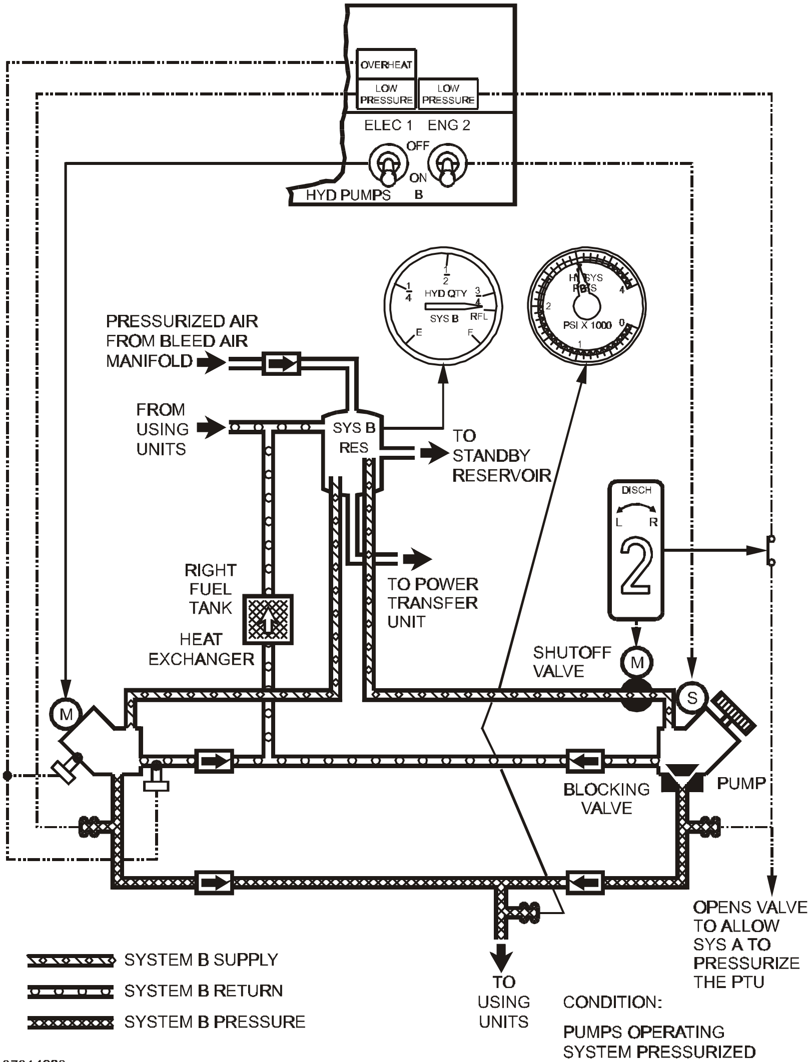
③③⑤ HYDRAULIC SYSTEM B SCHEMATIC



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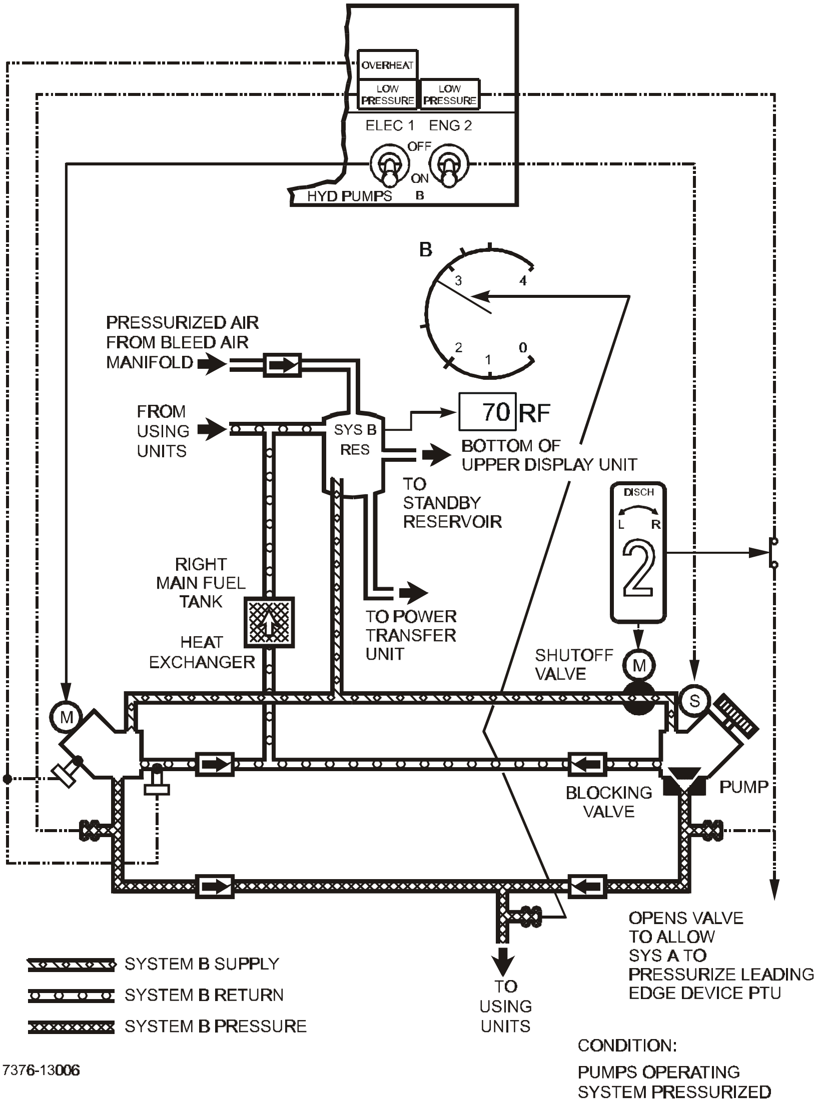
7 8 9 HYDRAULIC SYSTEM B SCHEMATIC



SYSTEM A HYDRAULIC LEAK

If a leak develops in the engine-driven pump or its related lines, a standpipe in the reservoir prevents a total system fluid loss.

③ 3 5 With fluid level at the top of the standpipe, the reservoir quantity displayed indicates approximately 1/4th full.

7 8 9 With fluid level at the top of the standpipe, the reservoir quantity displayed indicates approximately 20% full.

System A hydraulic pressure is maintained by the electric motor-driven pump.

If a leak develops in the electric motor-driven pump or its related lines, or components common to both the engine and electric motor-driven pumps, the quantity in the reservoir steadily decreases to zero and all system pressure is lost.

③ 3 5 SYSTEM B HYDRAULIC LEAK

The system B reservoir has two standpipes: one supplies fluid to the engine-driven pump; the other to the electric motor pump. If a leak develops in the engine-driven pump or associated lines, the system B quantity gauge reading decreases until approximately ½ full. System pressure is maintained by the electric motor pump. If the leak is in the electric motor pump or associated lines, system B pressure is lost. However, sufficient fluid will be retained in the reservoir for operation of the power transfer unit. A leak in B system does not drain the standby reservoir.

7 8 9 SYSTEM B HYDRAULIC LEAK

If a leak develops in either, pump, line or component of system B, the quantity decreases until it indicates approximately zero and system B pressure is lost. The system B reservoir has one standpipe, which supplies fluid to both the engine-driven pump and the electric motor-driven pump. However, fluid remaining in the system B reservoir is sufficient for power transfer unit operation.

A leak in system B does not affect the operation of the standby hydraulic system.

POWER TRANSFER UNIT

The purpose of the PTU is to supply the additional volume of hydraulic fluid needed to operate the autoslats or the leading edge flaps and slats at the normal rate when system B engine-driven hydraulic pump volume is lost. The PTU uses system A pressure to power a hydraulic motor-driven pump, which pressurizes system B hydraulic fluid. The PTU operates automatically when the following conditions exist:

- system B engine-driven pump hydraulic pressure drops below limits
- airborne

③ 3 5

- flaps are less than 10 but not up.

7 8 9

- flaps are less than 15 but not up.

LANDING GEAR TRANSFER UNIT

The purpose of the landing gear transfer unit is to supply the volume of hydraulic fluid needed to raise the landing gear at the normal rate when system A engine-driven pump volume is lost. The system B engine-driven pump supplies the volume of hydraulic fluid needed to operate the landing gear transfer unit when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value
- landing gear lever is positioned UP
- either main landing gear is not up and locked.

STANDBY HYDRAULIC SYSTEM

The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. The standby system can be activated manually or automatically and uses a single electric motor-driven pump to power:

- thrust reversers
- rudder
- leading edge flaps and slats (extend only).

7 8 9

- standby yaw damper.

MANUAL OPERATION

Positioning either FLT CONTROL switch to STBY RUD:

- activates the standby electric motor-driven pump
- shuts off the related hydraulic system pressure to ailerons, elevators, elevator feel, and rudder by closing the flight control shutoff valve
- opens the standby rudder shutoff valve
- deactivates the related flight control **LOW PRESSURE** light when the standby rudder shutoff valve opens
- allows the standby system to power the rudder and thrust reversers.

Positioning the ALTERNATE FLAPS master switch to ARM:

- activates the standby electric motor-driven pump
- operates the trailing edge flap bypass valve
- arms the ALTERNATE FLAPS position switch
- allows the standby system to power the leading edge flaps and slats and thrust reversers.

STANDBY PUMP AUTOMATIC OPERATION

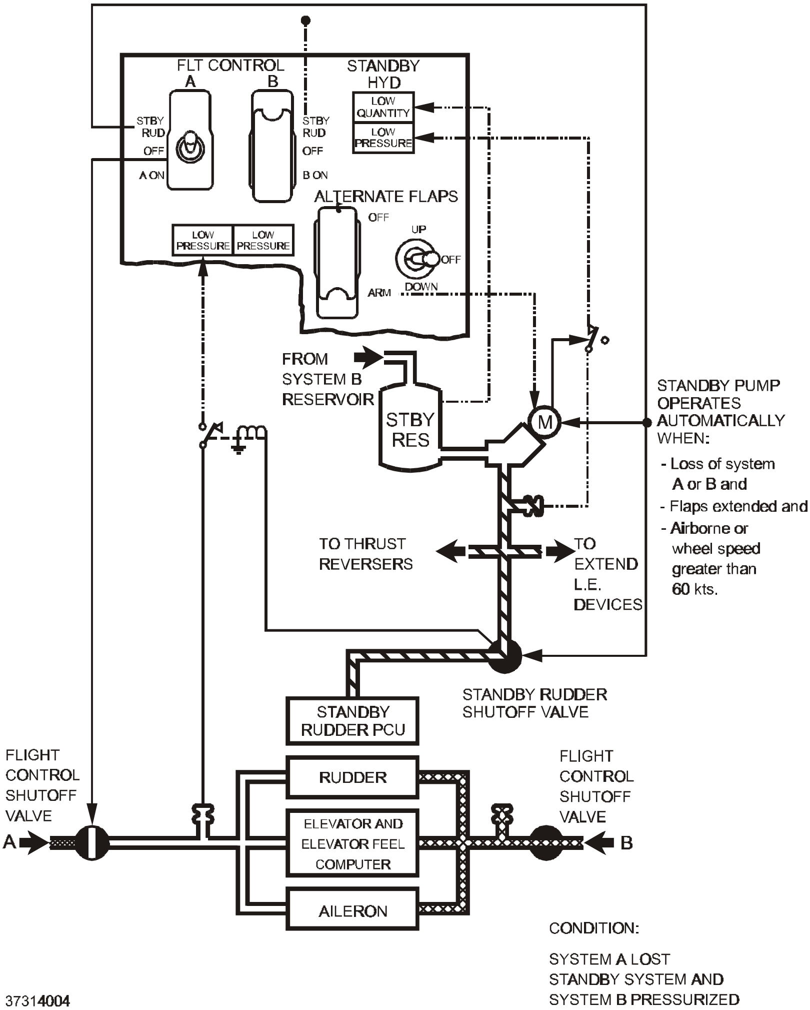
Automatic operation is initiated when all of the following conditions exist:

- loss of system A or B and
- flaps extended and
- airborne, or wheel speed great than 60 kts.

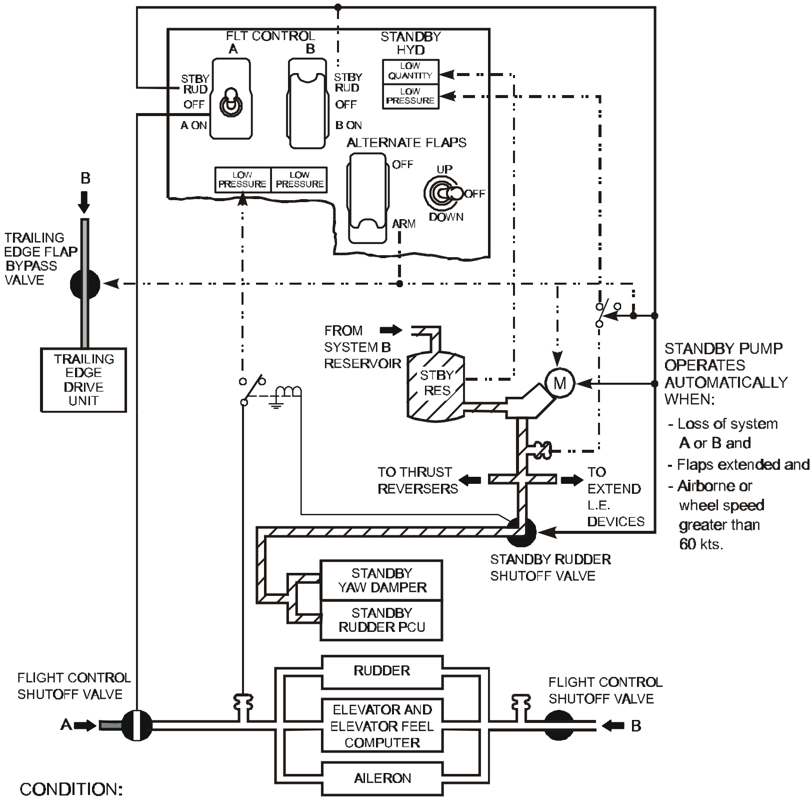
Automatic operation:

- activates the standby electric motor-driven pump
- opens the standby rudder shutoff valve
- allows the standby system, to power the rudder and thrust reversers.

③③⑤ HYDRAULIC STANDBY SYSTEM SCHEMATIC



7 8 9 HYDRAULIC STANDBY SYSTEM SCHEMATIC



CONDITION:
SYSTEM A LOST, STANDBY SYSTEM AND SYSTEM B PRESSURIZED

7376-13007

Standby Hydraulic System Leak

If a leak occurs in the standby system, the standby reservoir quantity decreases to zero. **LOW QUANTITY** light illuminates when the standby reservoir is approximately half empty.

③ 3 5 The system B reservoir fluid level decreases and stabilizes at the standby interconnect line level of approximately 64%.

7 8 9 The system B reservoir fluid level decreases and stabilizes at the standby interconnect line level of approximately 72%.

Variations In Hydraulic Quantity Indications

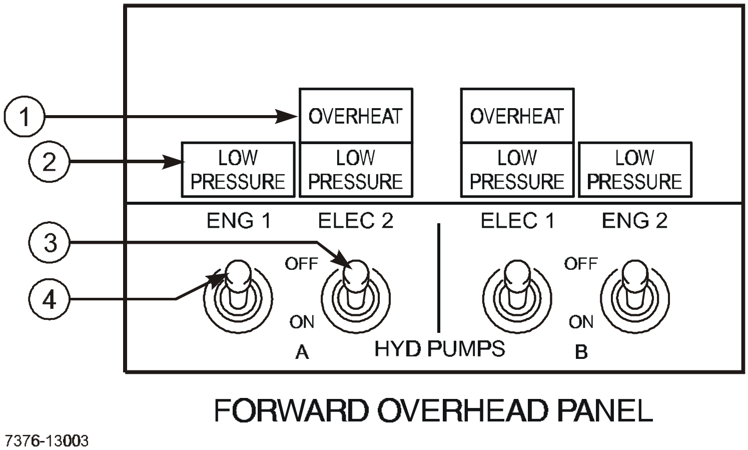
During normal operations, variations in hydraulic quantity indications occur when:

- the system becomes pressurized after engine start
- raising or lowering the landing gear or leading edge devices
- cold soaking occurs during long periods of cruise.

These variations have little effect on systems operations.

If the hydraulic system is not properly pressurized, foaming can occur at higher altitudes. Foaming can be recognized by pressure fluctuations and blinking of related **LOW PRESSURE** lights. **MASTER CAUTION** and **HYD** annunciator lights may also illuminate momentarily.

HYDRAULIC PANEL



① Electric Hydraulic Pump **OVERHEAT** Lights

Illuminated (amber) – Hydraulic fluid used to cool and lubricate the corresponding electric motor driven pump has overheated or the pump itself has overheated.

② Hydraulic Pump **LOW PRESSURE** Lights

Illuminated (amber) – output pressure of associated pump is low.

Note: Deactivated when respective engine fire warning switch is pulled.

③ ELECTRIC HYDRAULIC PUMPS Switches

ON – provides power to associated electric motor-driven pump.

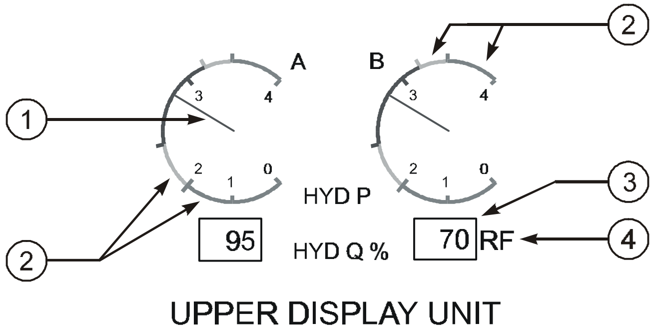
OFF – electrical power removed from pump.

④ ENGINE HYDRAULIC PUMPS Switches

ON – de-energizes blocking valve in pump to allow pump pressure to enter system.

OFF – energizes blocking valve to block pump output.

7 8 9 HYDRAULIC INDICATIONS



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① **HYDRAULIC** System **PRESSURE** Indications

Indicates system pressure:

- displayed (white) - normal operating range
- displayed (amber) - caution range
- displayed (red) - operating limit reached
- when both pumps for a system are OFF, respective pointer reads zero.

② Hydraulic Pressure Amber Bands / Redlines

Displayed (amber) – low / high hydraulic pressure caution range.

Displayed (red) – low / high hydraulic pressure operating limit.

③ **HYDRAULIC** System **QUANTITY** Indications

Indicates digital percentage (0% to 106%) of hydraulic quantity.

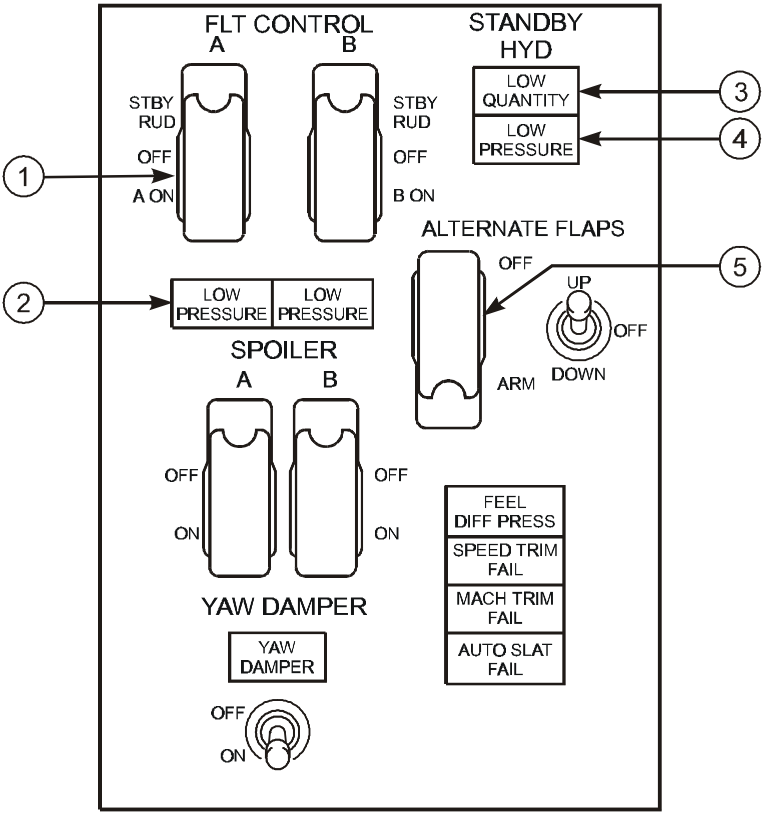
Quantity also displayed at each reservoir.

④ **REFILL** Indication (**RF**) (white)

Illuminated (white) – hydraulic quantity below 76%.

Valid only when aircraft is on the ground with both engines shutdown or after landing with flaps up during taxi-in.

FLIGHT CONTROL PANEL



FORWARD OVERHEAD PANEL

7376-13004

① FLIGHT CONTROL Switches

STBY RUD – activates standby pump, arms **LOW PRESSURE** light and opens standby rudder shutoff valve to pressurize standby rudder power control unit and thrust reversers.

OFF – closes flight control shutoff valve isolating ailerons, elevators, elevator feel, and rudder from associated hydraulic system pressure.

ON (guarded position) – normal operating position.

② Flight Control **LOW PRESSURE** Lights

Illuminated (amber) –

- indicates low hydraulic system (A or B) pressure to ailerons, elevator, elevator feel, and rudder
- deactivated when associated FLIGHT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens.

③ **STANDBY HYDRAULIC LOW QUANTITY** Light

Illuminated (amber) –

- indicates low quantity in standby hydraulic reservoir
- always armed.

④ **STANDBY HYDRAULIC LOW PRESSURE** Light

Illuminated (amber) –

- indicates output pressure if standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

⑤ ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – operates trailing edge flap bypass valve to bypass position, activates standby pump, arms **LOW PRESSURE** light, and arms ALTERNATE FLAPS position switch.

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/15/02				
* TOC-2	11/15/02				
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LANDING GEAR

TABLE OF CONTENTS

SYSTEM DESCRIPTION

INTRODUCTION

The aircraft has two main landing gear and a single nose gear. Each main gear is a conventional two-wheel landing gear unit. The nose gear is a conventional steerable two-wheel unit.

Hydraulic power for retraction, extension, and nose wheel steering is normally supplied by hydraulic system A. A manual landing gear extension system is installed. 3 5 7 8 9 are also provided with an alternate source of hydraulic power for nose wheel steering.

The normal brake system is powered by hydraulic system B. The alternate brake system is powered by hydraulic system A. Antiskid protection is provided on both brake systems, but the autobrake system is available only with the normal brake system.

LANDING GEAR OPERATION

The landing gear are normally controlled by the LANDING GEAR lever. On the ground, a landing gear lever lock, prevents the LANDING GEAR lever from moving to the up position. An override trigger in the lever may be used to bypass the landing gear lever lock. In flight, the air / ground system energizes a solenoid which opens the lever lock.

Landing Gear Retraction

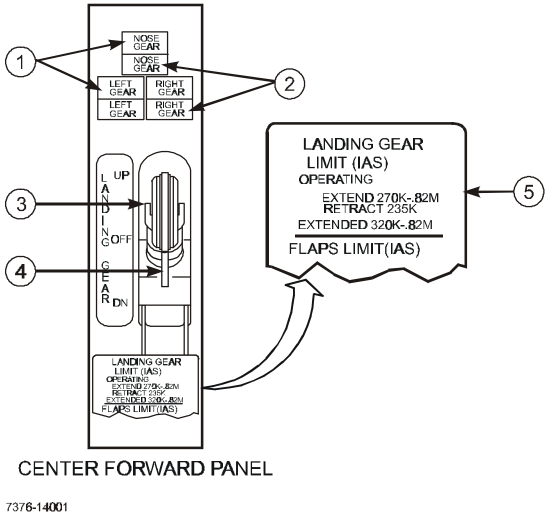
When the LANDING GEAR lever is moved to UP, the landing gear begins to retract. During retraction, the brakes automatically stop rotation of the main gear wheels. After retraction, the main gear are held in place by mechanical uplocks. Rubber seals and oversized hubcaps complete the fairing of the outboard wheels.

The nose wheels retract forward into the wheel well and nose wheel rotation is stopped by snubbers. The nose gear is held in place by an overcenter lock and enclosed by doors which are mechanically linked to the gear.

Hydraulic pressure is removed from the landing gear system with the LANDING GEAR lever in the OFF position.

7 8 9 If a main landing gear tire is damaged during takeoff, it is possible that braking of the main gear wheels during retraction may be affected. A spinning tire with a loose tread must be stopped prior to entering the wheel well or it can cause damage to wheel well components. When a flailing tread impacts fittings in the wheel well ring opening, the retraction of that gear stops and free falls back to the down position. The affected gear cannot be retracted until the fittings are replaced.

LANDING GEAR PANEL



① Landing Gear Indicator Lights (top)

Illuminated (red) –

- landing gear is not down and locked (with either or both forward thrust levers retarded to idle, and below 800 feet AGL).
- 7 8 9 landing gear is not down and locked (with either or both forward thrust levers retarded to idle and below 800 feet AGL).
- related landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe).

Extinguished -

- landing gear is up and locked with landing gear lever UP or OFF.
- landing gear is down and locked with landing gear lever DN.

② Landing Gear Indicator Lights (bottom)

Illuminated (green) – related gear down and locked.

Note: Landing gear warning horn is deactivated with all gear down and locked.

Note: Landing gear is down and locked when a green landing gear indicator light (center panel) for each gear is illuminated.

Extinguished – landing gear is not down and locked.

③ LANDING GEAR Lever

UP – landing gear retract.

OFF – hydraulic pressure is removed from landing gear system.

DN – landing gear extend.

④ Override Trigger

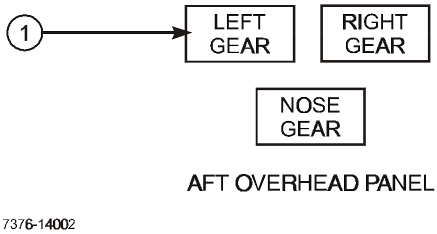
Allows LANDING GEAR lever to be raised, bypassing the landing gear lever lock.

⑤ **LANDING GEAR LIMIT** Speed Placard

Indicates maximum speed while operating landing gear and after gear extension.

7 8 9 LANDING GEAR INDICATOR LIGHTS

This is a redundant but separate set of landing gear indicator circuits and lights.



① Landing Gear Indicator Lights (overhead)

Illuminated (green) – related gear down and locked.

Note: Landing gear warning horn is deactivated with all gear down and locked.

Note: Landing gear is down and locked as long as one green landing gear indicator light (center panel or overhead panel) for each gear is illuminated.

Extinguished – landing gear is not down and locked.

Landing Gear Transfer Unit

Hydraulic system B pressure is available for raising the landing gear through the landing gear transfer unit. Hydraulic system B supplies the volume of hydraulic fluid required to raise the landing gear at the normal rate when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value
- LANDING GEAR lever is positioned UP
- either main landing gear is not up and locked.

Landing Gear Extension

When the LANDING GEAR lever is moved to DN, hydraulic system A pressure is used to release the uplocks. The landing gear extends by hydraulic pressure, gravity and air loads. Overcenter mechanical and hydraulic locks hold the gear at full extension. The nose wheel doors remain open when the gear is down.

Landing Gear Manual Extension

③ 3 5

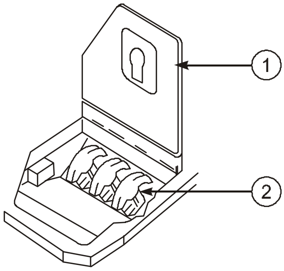
The manual extension access door provides no input to the landing gear system. It only allows access to the manual extension handles.

With the manual extension access door open:

- manual landing gear extension is possible with the LANDING GEAR lever in the OFF position
- normal landing gear extension is possible if hydraulic system A pressure is available.

Following a manual extension, the landing gear may be retracted normally by accomplishing the following steps:

- move the LANDING GEAR lever to DOWN with hydraulic system A pressure available, and then
- position the LANDING GEAR lever to UP.



FLIGHT DECK FLOOR

7376-14003

7 8 9

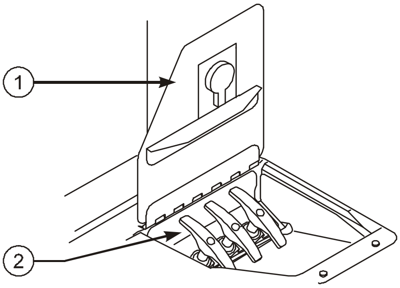
With the manual extension access door open:

- manual landing gear extension is possible with the LANDING GEAR lever in any position
- normal landing gear extension is possible if hydraulic system A pressure is available
- landing gear retraction is disabled.

Following a manual extension, the landing gear may be retracted normally by accomplishing the following steps:

- close the manual extension access door
- move the LANDING GEAR lever to DOWN with hydraulic system A pressure available, and then
- position the LANDING GEAR lever to UP.

MANUAL GEAR EXTENSION



FLIGHT DECK FLOOR

7376-14004

① Manual Extension Access Door

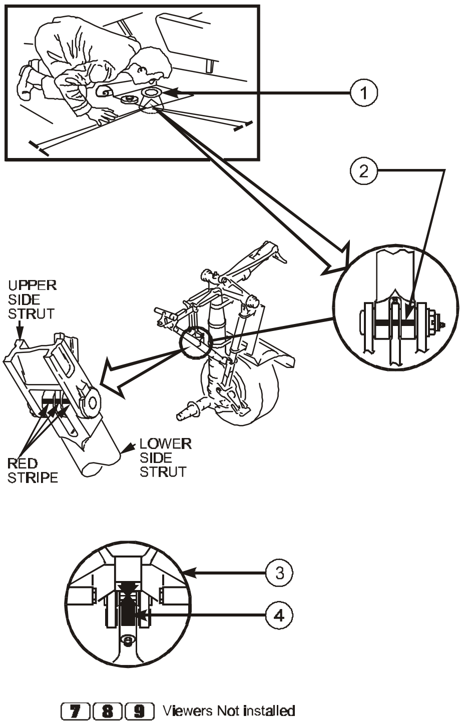
Open –

- manual landing gear extension is possible with landing gear lever in any position
- normal landing gear extension is still possible if hydraulic system A pressure is available
- 7 8 9 landing gear retraction is disabled.

Closed – landing gear operate normally.

② Manual Gear Extension Handles

Right main, nose, left main – Each landing gear uplock is released when related handle is pulled to its limit, approximately 24 inches (61 cm).



7376-14005

GEAR DOWNLOCK VISUAL INDICATORS

③ 3 5

Main Gear Viewer

① Opposite the 3rd window behind the aft overwing exit and one foot left of center. Pull up on the carpet identified by a metal button to sight through viewer. Before leaving the flight deck, position the wheel well light switch ON.

② Indication that the landing gear is down and locked is provided by observing the alignment of red paint stripes, located on the down lock and the side struts.

- In some installations viewer may be under aisle seat.

Nose Gear Viewer

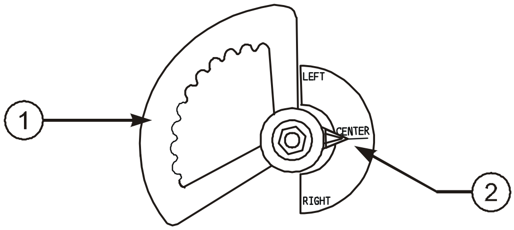
③ Cover plate for the nose landing gear viewer is located on the floor just inside the flight deck door. The wheel well light switch must be ON.

④ Indication that the landing gear is down and locked is provided by observing the two red arrowheads on the down lock strut are in contact.

③ NOSE WHEEL STEERING

Steering is provided by hydraulic system A through the nose gear down line. Nose wheel steering is operative only when hydraulic system A is pressurized and the landing gear lever is in the down position.

NOSE WHEEL STEERING WHEEL



CAPTAIN SIDE PANEL

7376-14006

① Nose Wheel Steering Wheel

Rotate –

- turns nose wheel up to 78 degrees in either direction
- overrides rudder pedal steering.

② Nose Wheel Steering Indicator

LEFT – indicates nose wheel steering displacement left of center position.

CENTER – normal straight ahead position.

RIGHT – indicates nose wheel steering displacement right of center position.

3 5 7 8 9 NOSE WHEEL STEERING

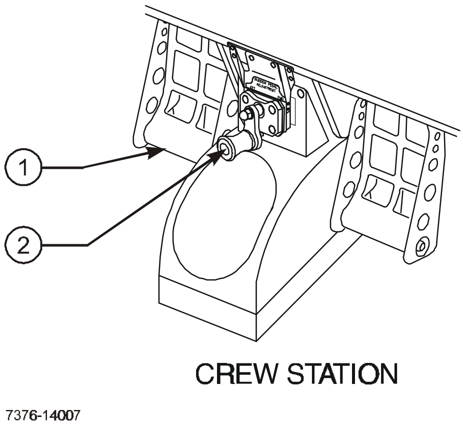
The aircraft is equipped with nose wheel steering which is powered by hydraulic system A when the NOSE WHEEL STEERING switch is in the NORM position. Nose wheel steering is powered by hydraulic system B when the NOSE WHEEL STEERING switch is placed to ALT. Nose wheel steering is powered only when the aircraft is on the ground. In the event of a hydraulic leak downstream of the Landing Gear Transfer Unit, resulting in a loss of hydraulic system B fluid in the reservoir, a sensor closes the Landing Gear Transfer Valve and alternate steering will be lost.

Primary steering is controlled through the nose wheel steering wheel. Limited steering control is available through the rudder pedals. A pointer on the nose steering wheel assembly shows nose wheel steering position relative to the neutral setting. Rudder pedal steering is deactivated as the nose gear strut extends.

RUDDER PEDALS

Rudder pedals allow 7 degrees of nose steering each direction. The steering wheel overrides the rudder pedals. Rudder pedal steering is deactivated as the nose gear strut extends.

Rudder / Brake Pedals



① Rudder / Brake Pedals

Push full pedal – turns nose wheel up to 7 degrees in either direction.

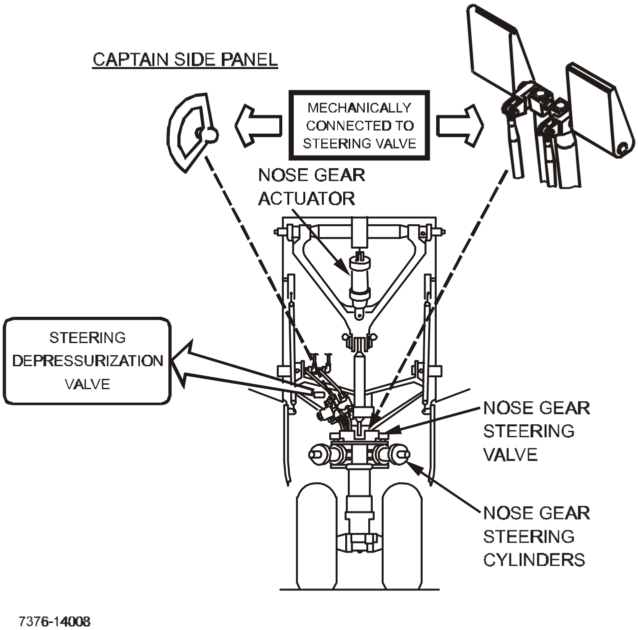
Push top of pedal only – activates wheel brakes.

② RUDDER PEDAL ADJUSTMENT Crank

AFT (counter–clockwise) – adjusts rudder pedals aft.

FWD (clockwise) – adjusts rudder pedals forward.

A lockout pin may be installed in the steering depressurization valve to bypass hydraulic system pressure. This allows aircraft push back or towing without depressurizing system A.

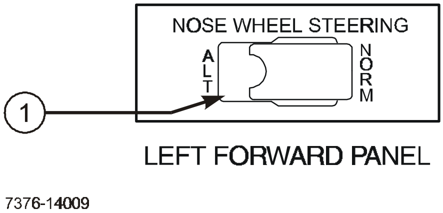


③ COMPONENT FUNCTIONS TABLE

COMPONENT	ACTUATED BY	ALTERNATE	MONITORED BY
Main and Nose Gear	System A	Manual Extension	Lights, horn, Hyd sys press indicator
Brakes (anti-skid on or off)	System B	System A Alternate Brakes	Lights and Hyd brake press indicator
Nose Wheel Steering	System A	Brakes	Hyd sys press A indicator
Autobrakes	System B	Manual Brakes	Autobrake disarm light
Autobrakes RTO selected	Wheel speed > 90 knots. Both thrust levers idle.	Manual Brakes	Autobrake disarm light

INTENTIONALLY LEFT BLANK

3 5 7 8 9 NOSE WHEEL STEERING SWITCH



① NOSE WHEEL STEERING Switch

ALT – hydraulic system B provides power for nose wheel steering.

NORM (guarded position) – hydraulic system A provides power for nose wheel steering.

3 5 7 8 9 COMPONENT FUNCTIONS TABLE

COMPONENT	ACTUATED BY	ALTERNATE	MONITORED BY
Main and Nose Gear	System A	Manual Extension	Lights, horn, Hyd sys press indicator
Brakes (anti-skid on or off)	System B	System A Alternate Brakes	Lights and Hyd brake press indicator
Nose Wheel Steering	System A	Brakes or System B	Hyd sys press A indicator
Autobrakes	System B	Manual Brakes	Autobrake disarm light
Autobrakes RTO selected	Wheel speed > 90 knots. Both thrust levers idle.	Manual Brakes	Autobrake disarm light

TIRE BURST PROTECTION

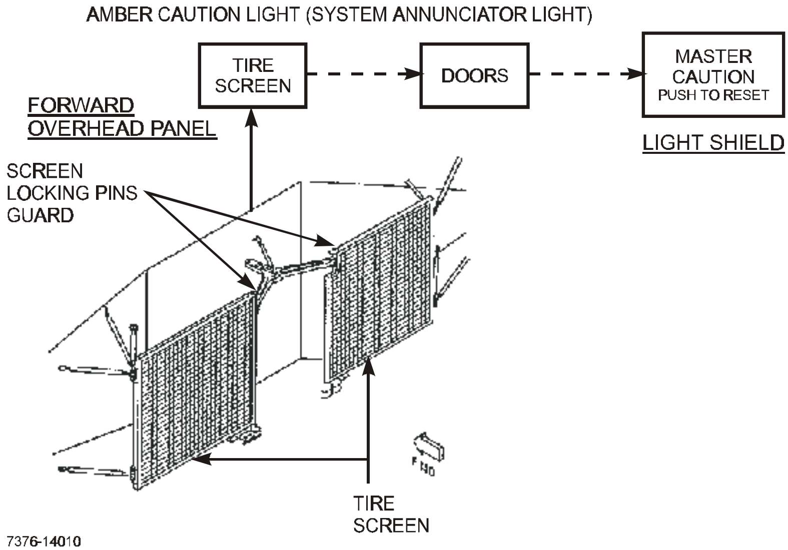
③ The tire screens (if installed) provide protection for critical hydraulic and flight control equipment in the event of tire burst when the main landing gear is retracted.

The **TIRE SCREEN** light monitors the screen locking pins in the wheel well.

Illumination of the **TIRE SCREEN** amber caution light activates the Doors system annunciator and **MASTER CAUTION** lights on the light shield, indicating the screens are not secure.

Pushing either **MASTER CAUTION** light to rest extinguishes the doors annunciator and **MASTER CAUTION** lights. The **TIRE SCREEN** amber caution light remains illuminated until the fault is cleared.

Caution: If the **TIRE SCREEN** light is illuminated and the cause is a tire burst screen not secure, equipment damage could result when the gear is retracted.



BRAKE SYSTEM

Each main gear wheel has a multi-disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The brake system includes:

- normal brake system
- alternate brake system
- brake accumulator
- antiskid protection
- autobrake system
- parking brake

Normal Brake System

The normal brake system is powered by hydraulic system B.

Alternate Brake System

The alternate brake system is powered by hydraulic system A. If hydraulic system B is low or fails, hydraulic system A automatically supplies pressure to the alternate brake system.

Brake Accumulator

The brake accumulator is pressurized by hydraulic system B. If both normal and alternate brake system pressure is lost, trapped hydraulic pressure in the brake accumulator can still provide several braking applications or parking brake application.

Brake System Components

Brake Metering Valves

The brake metering valves are mechanically linked to the brake pedals and supply hydraulic pressure to inboard and outboard brakes.

Autobrake Control Module

When autobrakes are selected, the autobrake-controlled pressure bypasses the manual brake system, and applies system pressure directly to the anti-skid valves.

Autobrake Shuttle Valves

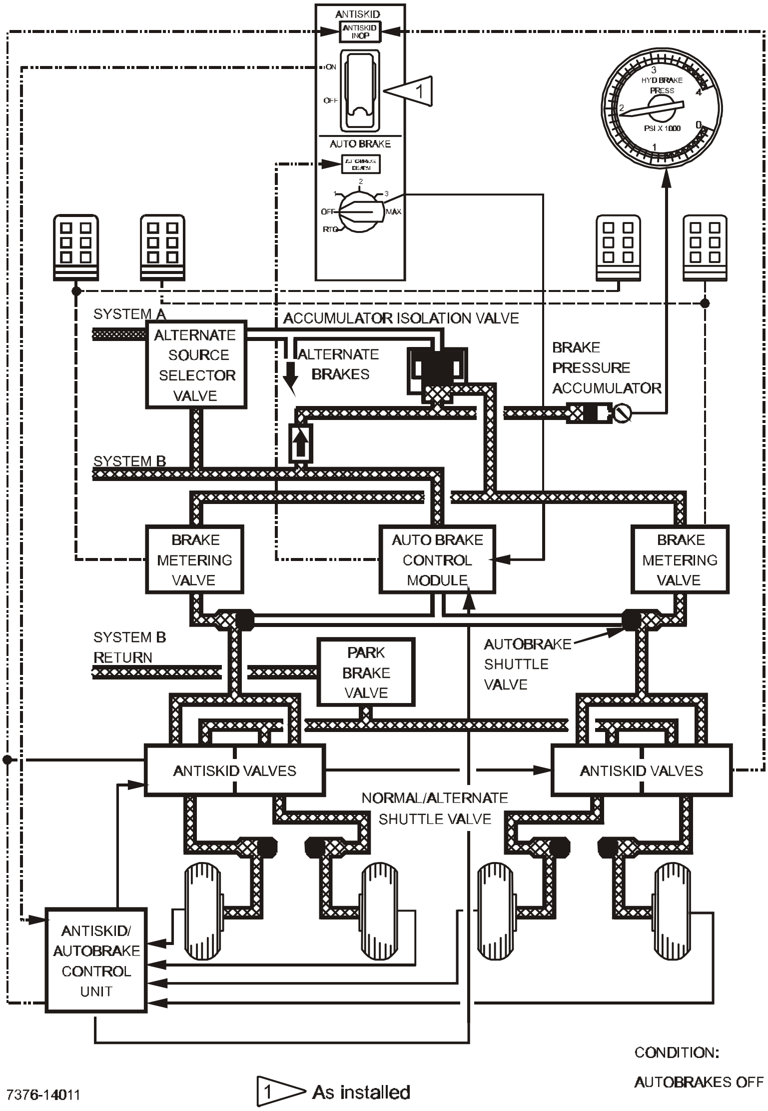
The autobrake shuttle valves supply either brake metering pressure or autobrake pressure to the anti-skid valves, determined by the higher pressure.

Anti-Skid Valves

The anti-skid valves regulate brake pressure to control wheel rotation by applying or releasing hydraulic pressure to the brakes as determined by the anti-skid control unit.

Anti-Skid Control Unit

The anti-skid control unit electrically regulates the anti-skid valves to control wheel rotation continuously.

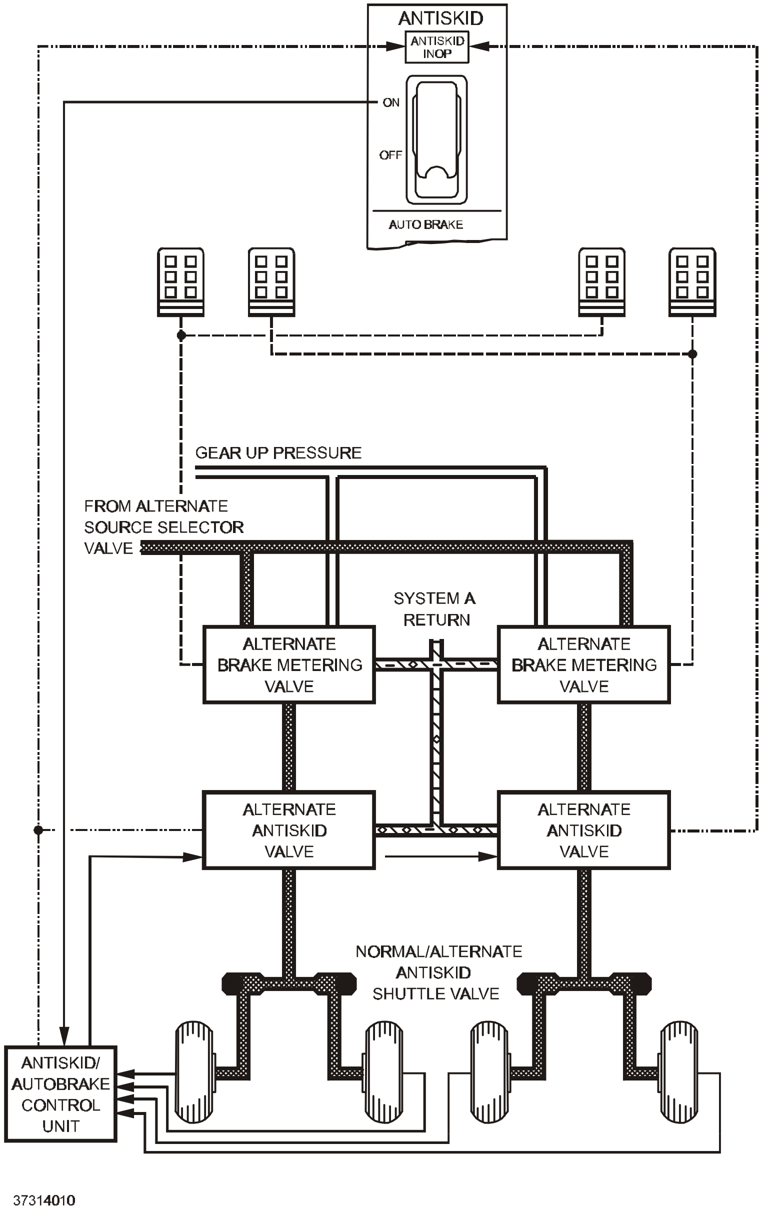


NORMAL BRAKE SYSTEM SCHEMATIC

Alternate Brake System

The alternate brake system is powered by hydraulic system A. When the system B pressure to the normal brakes system is low, an alternate source selector valve opens to supply system A pressure to the alternate brakes system. Pushing a brake pedal opens the respective alternate brake metering valve, allowing pressure to pass through the alternate anti-skid valves to the brakes.

Autobrakes are inoperative when system B pressure is not available.



ALTERNATE BRAKE SYSTEM SCHEMATIC

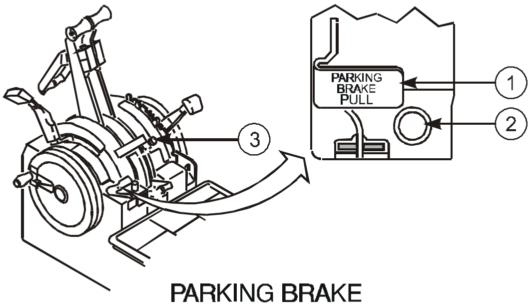
Parking Brake

The parking brake can be set with either A or B hydraulic systems pressurized. If A and B hydraulic systems are not pressurized, parking brake pressure is maintained by the brake accumulator. Accumulator pressure is shown on the HYD BRAKE PRESS indicator.

The parking brake is set by depressing both brake pedals fully, while simultaneously pulling the PARKING BRAKE lever up. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the PARKING BRAKE lever releases. A fault in the parking brake system may cause the **ANTISKID INOP** light to illuminate.

3 5 7 8 9 The takeoff configuration warning horn sounds if either forward thrust lever is advanced for takeoff with the parking brake set.



PARKING BRAKE

7376-14012

① PARKING BRAKE Lever

Forward – parking brakes released.

Aft – sets parking brakes when either Captain's or First Officer's brake pedals are fully depressed and hydraulic pressure, above 1000 psi, is available in the brake system.

② Parking Brake Warning Light

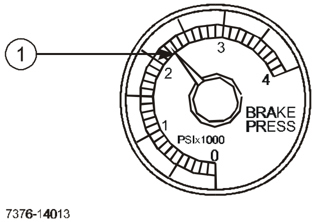
Illuminated (red) – parking brake is set (light operates from battery power).

Extinguished – parking brake is released.

③ Landing Gear Warning Horn Cutout Switch

Enables thrust lever operated warning horn to be silenced.

Hydraulic Brake Pressure Indicator



RIGHT FORWARD PANEL

1 Hydraulic Brake Pressure (HYD BRAKE PRESS) Indicator

Indicates brake accumulator pressure:

- normal pressure – 3000 psi
- maximum pressure – 3500 psi
- normal precharge – 1000 psi.

Brake Pressure Accumulator

The brake pressure accumulator is also a source of brake pressure. When the alternate brake system is pressurized, brake accumulator pressure is protected from leakage by closing an accumulator isolation valve. When system B pressure is lost, system A pressure closes the accumulator isolation valve. This traps pressure in the accumulator. System A actuates the valve but does not provide fluid or pressure to the accumulator or normal brakes.

If both system B and system A pressure is lost, the accumulator isolation valve opens to provide several applications of brake power through the normal brake lines. (See Normal Brake System Schematic for illustration of brake pressure accumulator system.) The accumulator also provides pressure for aircraft parking brake application.

Anti-Skid Protection

Anti-skid protection is provided in the normal and alternate brake systems.

The normal brake hydraulic system provides each main gear wheel with individual anti-skid protection. When the system detects a skid, the associated anti-skid valve reduces brake pressure until skidding stops. The alternate brake hydraulic system works similar to the normal system however anti-skid protection is applied to main gear wheel pairs instead of individual wheels.

With a fixed amount of brake pressure, the rate at which a wheel slows down is dependent on how much force the tire can exert against the runway surface before skidding. For instance, on an icy runway the tire can exert very little force against the runway before it skids. Without anti-skid, the wheel stops almost immediately and begins to slide, greatly increasing the stopping distance. Since the skid detector senses the rate of deceleration of the wheel, it senses the coefficient of friction of the runway. By modulating pressure to the brakes the anti-skid can give the maximum allowable braking effort for the condition of the runway. In addition to skid protection, the anti-skid system provides locked wheel, touchdown (normal brake system only), and hydroplane protection.

Alternate Anti-Skid

The alternate brake system uses the same anti-skid controller and control switch as the normal brake system. The controller regulates pressure through each alternate anti-skid valve and is based on transducer inputs from each of the four wheels. One alternate anti-skid valve controls the left wheels and one valve controls the right wheels. When a skid is detected, the controller signals the appropriate valve to reduce brake pressure. Since each valve controls pressure for two wheels, brake pressure is reduced to both wheels.

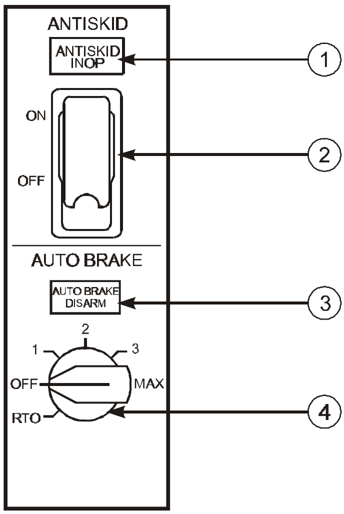
③ 3 5 Touchdown and locked-wheel protection are not available with the alternate brake system.

7 8 9 Both normal and alternate brake systems provide anti-skid, locked wheel, and touchdown protection.

Anti-Skid Control Switch And Light

The anti-skid control switch on the center instrument panel controls the anti-skid system. The annunciator light illuminates anytime there is a system malfunction or there is a disagreement between the parking brake lever and the parking brake shutoff valve position.

③ 3 5



CENTER INST PANEL

7376-14014

① **ANTISKID INOP** Light (amber)

Illuminated – When a system fault is defected by automatic antiskid monitoring systems or switch is OFF.

② Antiskid Control Switch

ON – Guarded position.

OFF – Turns off antiskid system, illuminates **ANTISKID INOP** light and illuminates **AUTO BRAKE DISARM** light if the system is armed.

③ **AUTOBRAKE DISARM** Light (amber)

Illuminated – A malfunction exists in the automatic braking system, pilot has turned off antiskid or has manually disarmed system during braking.

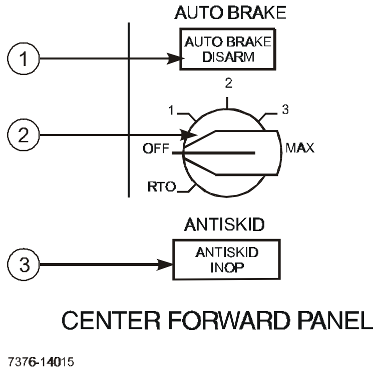
Note: When selecting RTO, the **AUTOBRAKE DISARM** light will illuminate for approximately 2 seconds to indicate self test initiation. After 2 seconds the light will extinguish.

④ Autobrake Select Switch

Used to select the level of desired braking. The switch must be pulled out to select MAX deceleration.

Autobrake And Anti-Skid Controls

7 8 9



① AUTO BRAKE DISARM Light

Illuminated (amber) –

- SPEED BRAKE lever moved to down detent during RTO or landing
- manual brakes applied during RTO or landing
- thrust lever(s) advanced during RTO or landing
  - except during first 3 seconds after touchdown for landing
- landing made with RTO selected
- RTO mode selected on ground
  - illuminates for one to two seconds then extinguishes
- a malfunction exists in automatic braking system.

Extinguished –

- AUTO BRAKE select switch set to OFF
- autobrakes armed.

② AUTO BRAKE Select Switch

OFF – autobrake system deactivated.

1, 2, 3, or MAX –

- selects desired deceleration rate for landing
- switch must be pulled out to select MAX deceleration.

RTO – automatically applies maximum brake pressure when thrust levers are retarded to idle at or above 90 knots.

③ Anti-skid Inoperative (ANTISKID INOP) Light

Illuminated (amber) – a system fault is detected by anti-kid monitoring system.

Extinguished – anti-skid system operating normally.

Autobrake System

The autobrake system uses hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at pre-selected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning. Anti-skid system protection is provided during autobrake operation.

Rejected Takeoff (RTO)

The RTO mode can be selected only when on the ground. Upon selection, the **AUTO BRAKE DISARM** light illuminates for one to two seconds and then extinguishes, indicating that an automatic self-test has been successfully accomplished.

To arm the RTO mode prior to takeoff the following conditions must exist:

- aircraft on the ground
- anti-skid and autobrake systems operational
- AUTO BRAKE select switch positioned to RTO
- wheel speed less than 60 knots
- forward thrust levers positioned to IDLE.

With RTO selected, if the takeoff is rejected prior to wheel speed reaching 90 knots autobraking is not initiated, the **AUTO BRAKE DISARM** light does not illuminate and the RTO autobrake function remains armed. If the takeoff is rejected after reaching a wheel speed of 90 knots, maximum braking is applied automatically when the forward thrust levers are retarded to IDLE. Braking force is the equivalent of full manual braking.

7 8 9 The RTO mode is automatically disarmed when both air / ground systems indicate the air mode.

The **AUTO BRAKE DISARM** light does not illuminate and the AUTO BRAKE select switch remains in the RTO position. To reset or manually disarm the autobrake system, position the selector to OFF. If a landing is made with RTO selected (AUTO BRAKE select switch not cycled through OFF), no automatic braking action occurs and the **AUTO BRAKE DISARM** light illuminates two seconds after touchdown.

Landing

When a landing autobrake selection is made, the system performs a turn-on-self-test. If the turn-on-self-test is not successful, the **AUTO BRAKE DISARM** light illuminates and the autobrake system does not arm.

Four levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both forward thrust levers are retarded to IDLE
- the main wheels spin-up.

To maintain the selected landing deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration.

The autobrake system brings the aircraft to a complete stop unless the braking is terminated by the pilot.

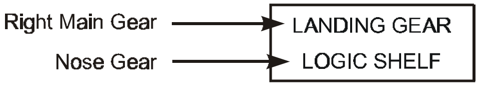
Autobrake – Disarm

The pilots may disarm the autobrake system by moving the selector switch to the OFF position. This action does not cause the **AUTO BRAKE DISARM** light to illuminate. After braking has started, any of the following pilot actions disarm the system immediately and illuminate the **AUTO BRAKE DISARM** light:

- moving the SPEED BRAKE lever to the down detent
- advancing the forward thrust lever(s), except during the first 3 seconds after touchdown for landing
- applying manual brakes.

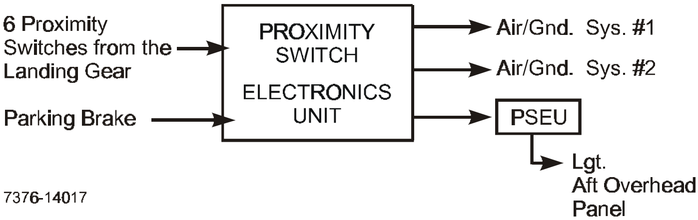
Air / Ground Safety Sensors

③ 3 5 Air / ground safety sensors, located on the right main gear and nose gear, provide logic control for equipment or functions intended for operation only in the air or on the ground.



7376-14016

7 8 9 The system receives air / ground logic signals from six sensors, two on each landing gear. These signals are used to configure the aircraft systems to the appropriate air or ground status.



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Air / Ground Safety Sensor Logic Table

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Drain Mast Heaters ③ [3] [5]	115 volt AC operation	28 volt AC operation	1
Emergency Exit Doors [7] [8] [9]	Flight locks engaged when either engine N2 is more than 50% and 3 or more Entry/Service doors are closed.	Flight locks disengaged when either thrust lever is set below approximately 53 degrees.	1
Pack Valves ③ [3] [5]	With one pack operating, regulates to high flow with flaps up.	Pack operation restricted to low flow.	2
Pack Valves [7] [8] [9]	With one pack operating, regulates to high flow with flaps up.	With one pack operating, regulates to high flow only when pack is operating from the APU and both engine bleed switches are OFF.	2

Air / Ground System Logic Table

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Pressurization ③ [3] [5]	Allows programmed pressurization in the automatic modes.	Allows pressurization on the ground.	2
Pressurization [7] [8] [9]	Allows programmed pressurization in the automatic modes.	Allows pressurization only at high power settings.	2
Ram Air ③ [3] [5]	Turbofan(s) operate only when air conditioning packs operate and flaps are not up.	Turbofans operate whenever air conditioning packs operate. Deflectors are extended.	2
Ram Air [7] [8] [9]	Ram Air fans operate whenever air conditioning packs operate.	Ram Air fans operate whenever air conditioning packs operate. Deflectors are extended.	2
Wing Anti-Ice	Control valves open when switch is ON. Thrust setting and duct temperature logic is bypassed.	With switch ON, valves cycle open and closed. Switch trips to OFF at lift-off.	3
Autothrottle	Enables go-around below 2000 ft radio altitude.	Disengaged 2 seconds after landing. Takeoff mode enabled.	4
TO/GA Switch	Flight director engages go-around mode.	Flight director engages takeoff mode.	4
ACARS	Sends out signal on strut extension for takeoff signal.	Sends out signal on strut compression for landing signal.	5
Voice Recorder	Prevents tape erasure.	Allows tape erasure when parking brake is set.	5
Standby Power ③ [3] [5]	Standby busses automatically transferred to battery and inverter power when the standby power switch is in AUTO.	BAT position must be selected for transfer of standby busses.	6
Standby Power [7] [8] [9]	Standby busses automatically transferred to battery and inverter power when the standby power switch is in AUTO.	Standby busses automatically transferred to battery and inverter power when the standby power switch is in AUTO.	6

Air / Ground System Logic Table (Continued)

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
APU Control ③ 3 5	APU operation possible with battery switch OFF.	APU shutdown if battery switch is positioned OFF.	7
APU Control 7 8 9	APU operation not possible with battery switch OFF.	APU shutdown if battery switch is positioned OFF.	7
APU Generator ③ 3 5	May be connected to only one electrical bus.	May be connected to two electrical busses.	7
APU Generator 7 8 9	May be connected to two electrical busses.	May be connected to two electrical busses.	7
Engine Idle Control ③ 3 5	Idle control and indication system is armed.	Maintains high idle until 4 seconds after landing.	7
Engine Idle Control 7 8 9	Enables minimum flight idle.	Enables minimum ground idle.	7
Thrust Reverser	Thrust reverse disabled.	Thrust reverse enabled.	7
APU Fire Horn	Wheel well horn disabled.	Wheel well horn enabled.	8
Cargo Fire Protection 7 8 9	Second extinguishing bottle timer enabled.	Second extinguishing bottle timer disabled.	8
Speed Brake Lever Actuator	Can be armed to raise ground spoilers for landing.	Activates SPEED BRAKE lever on landing if armed. Rejected take-off feature available. Drives to DOWN when thrust lever advanced.	9
Auto Slat	System enabled with flaps 1, 2, or 5 selected. PTU available if system B pressure is lost.	System disabled.	9
Flight Recorder	Operates anytime electrical power is available.	Operates anytime electrical power is available and either engine is operating.	10

Air / Ground System Logic Table (Continued)

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
FMC ③ 3 5	Position updated from DME or VOR/DME.	Does not update.	11
FMC 7 8 9	FMC position updated from GPS, DME or VOR/DME.	FMC position updated from GPS.	11
Standby Hydraulic	Pump automatic operation with flaps extended and A or B pressure lost.	Wheel speed must be greater than 60 knots for automatic operation.	13
Anti-Skid ③ 3 5	Releases normal brakes for touchdown protection.	Allows normal anti-skid braking after wheel spin-up.	14
Anti-Skid 7 8	Releases normal brakes or alternate for touchdown protection.	Allows normal anti-skid braking after wheel spin-up.	14
Autobrakes ③ 3 5	Allows selection of landing mode.	RTO mode available.	14
Autobrakes 7 8 9	Allows selection of landing mode.	RTO mode available and landing mode may be selected after touchdown if wheel speed is greater than 60 knots.	14
Landing Gear Lever Lock	Lever lock solenoid released.	Lever lock solenoid latched.	14
Landing Gear Transfer Unit	Enabled.	Disabled.	14
Stall Warning	Enabled.	Disabled.	15
Takeoff Warning	Disabled.	Enabled.	15

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WARNING SYSTEMS

TABLE OF CONTENTS

WARNING SYSTEMS

GENERAL

Aural, visual and tactile signals provide warnings, cautions and advisories that require attention. The indications vary, depending upon degree of urgency or hazard. Signals are used singularly or in combinations to provide information about the condition.

LIGHTS

Red warning lights on forward panels indicate immediate action conditions. Master fire warning lights for engine, wheel well, cargo compartment or APU fires. Autopilot / autothrottle lights, and landing gear unsafe configurations are also indicated by red lights.

Amber caution lights indicate system conditions which require timely corrective action.

Blue lights provide information on system status such as electrical power availability, valve position, equipment status and call lights.

Specific information for lights is found in the appropriate system section.

TACTILE

Control column shakers mounted on both columns warn of impending stall.

AURAL

Airspeed limit warning sounds a clacker. Autopilot disconnect sounds an intermittent wobble horn. Exceeding cabin altitude limit and takeoff configuration warnings generate an intermittent horn. Unsafe landing gear position generates a steady horn. Fire warnings activate a fire warning bell. APU ground fire also sounds a steady horn in the main wheel well.

GPWS warnings and alerts are indicated by lights, whoop, whoop sounds and voice.

Warnings, cautions and alerts for takeoff and landing gear configurations, exceeding Mach / airspeed limits approaching stall, ground proximity warning system warnings and alerts, windshear warnings and alerts, and TCAS are addressed in this section. Cabin altitude warning is found in the air conditioning pressurization section. Autopilot and autothrottle disconnect warnings are discussed in the autopilot / flight guidance section. Fire warnings and conditions which cause the fire bell and APU fire horn in the main gear wheel well are located in the fire warning and protection section.

An aural automatically silences when the associated non-normal condition no longer exists. Some aurals can be manually silenced.

MASTER FIRE WARNING LIGHTS

Two **MASTER FIRE WARN** lights illuminate when any fire condition occurs. The lights remain illuminated as long as the condition exists or until cancelled by the crew. Pressing either **MASTER FIRE WARN** light or BELL CUTOUT switch extinguishes both lights, silences the fire bell / APU main gear wheel horn and resets the system for future warnings.

SYSTEM ANNUNCIATOR LIGHTS

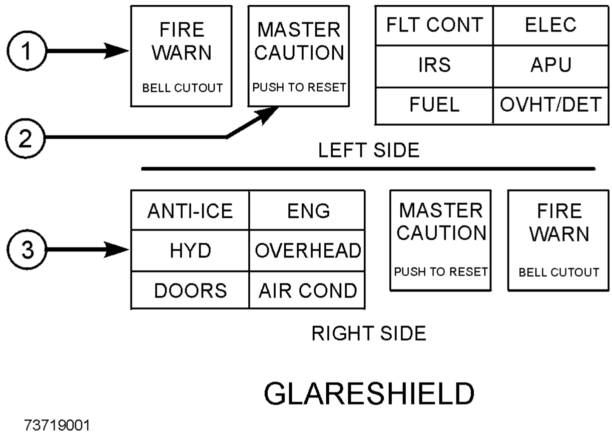
Two system annunciator light panels are on the lightshield. The annunciator light panel lights monitor caution lights on aft and forward overhead and fire control panels. If a caution condition exists, the appropriate system annunciator and **MASTER CAUTION** lights illuminate.

Master Caution Lights

Two **MASTER CAUTION** are lights integrated with the annunciator light panels. Both **MASTER CAUTION** lights and the appropriate system annunciator light illuminate when a system caution light comes on outside the normal field of vision of the crew. System caution lights remain illuminated as long as the caution exists or until cancelled by the crew. Pressing either **MASTER CAUTION** light extinguishes both lights and resets the annunciator light for further cautions. Pressing either annunciator light panel recalls existing caution annunciations.

Single failures in dual / redundant systems do not illuminate **MASTER CAUTION** and system annunciator lights. However, pressing either annunciator light panel recalls the system failure. The appropriate system caution light, annunciator and **MASTER CAUTION** lights illuminate.

Fire Warning And Master Caution System



① Master Fire Warning (**FIRE WARN**) Lights

Illuminated (red) – Indicates a fire warning (or system test) in engine, cargo, APU or main gear wheel well.

- Fire warning bell sounds
- If on ground, remote APU fire warning horn sounds.

Push –

- Extinguishes both master **FIRE WARN** lights
- Silences fire warning bell
- Silences remote APU fire warning horn
- Resets system for additional warnings.

Pushing fire warning BELL CUTOUT switch on overheat / fire protection panel results in the same actions.

② MASTER CAUTION Lights

Illuminated (amber) – A system annunciator light has illuminated.

Push – Extinguishes both MASTER CAUTION lights

- System annunciator light(s) extinguish
- Resets system for additional master caution conditions.

③ System Annunciator Panel

Illuminated (amber) – An amber system annunciator light, has illuminated on the forward overhead, aft overhead or overheat / fire protection panel.

To extinguish – Push either MASTER CAUTION light.

To recall – Push and release either system annunciator panel

- If a master caution condition exists, appropriate system annunciator(s) and MASTER CAUTION lights illuminate
- A single fault in certain redundant systems, or some simple faults, cause the system annunciator light to illuminate during a recall. The system annunciator light extinguishes when the MASTER CAUTION light is pushed.
- A single GPS sensor failure only illuminates the IRS system annunciator while the panel is pushed and held.

FLT CONT
- ◆ LOW QUANTITY
- ◆ LOW PRESSURE
- ◆ FEEL DIFF PRESS
- ◆ SPEED TRIM FAIL
- ◆ MACH TRIM FAIL
- ◆ AUTO SLAT FAIL
- ◆ YAW DAMPER

IRS
- ◆ FAULT
- ◆ ON DC
- ◆ DC FAIL
- ● GPS

FUEL
- ◆ LOW PRESSURE
- ◆ FILTER BYPASS

FLT CONT	ELEC
IRS	APU
FUEL	OVHT/DET

LEFT SIDE LIGHT SHIELD

ELEC
- ■ LOW OIL PRESSURE
- ■ HIGH OIL TEMP
- ◆ STANDBY PWR OFF
- ◆ TRANSFER BUS OFF
- ■ BUS OFF
- ● DRIVE
- ● SOURCE OFF
- ● TR UNIT
- ● BATTERY DISCHARGE
- ● ELEC

APU
- ◆ LOW OIL PRESSURE
- ◆ FAULT/HIGH OIL TEMP
- ◆ OVERSPEED

OVHT/DET
- ◆ ENGINE 1 OVERHEAT
- ◆ ENGINE 2 OVERHEAT
- ◆ APU DET INOP

◆ ③ 3 5 7 8 9
● 7 8 9
■ ③ 3 5

SYSTEM ANNUNCIATORS AND RELATED AMBER LIGHTS

ANTI-ICE
- ◆ WINDOW OVERHEAT
- ◆ PITOT HEAT
- ◆ COWL ANTI-ICE

HYD
- ◆ OVERHEAT
- ◆ LOW PRESSURE
- ◆ STANDBY SYSTEM LOW PRESSURE
- ◆ STANDARD SYSTEM LOW QUANTITY

DOORS
- ◆ FWD/AFT ENTRY
- ◆ EQUIP
- ◆ FWD/AFT CARGO
- ◆ FWD/AFT SERVICE
- ⓧ TIRE SCREEN
- ● LEFT/RIGHT OVERWING

ANTI-ICE	ENG
HYD	OVERHEAD
DOORS	AIR COND

RIGHT SIDE LIGHT SHIELD

ENG
- ◆ REVERSER
- ■ PMC-INOP
- ■ LOW IDLE
- ● EEC ALTN MODE
- ● ENGINE CONTROLS

OVERHEAD
- ◆ EQUIP COOLING - OFF
- ◆ EMER EXIT LIGHTS-NOT ARMED
- ◆ FLIGHT RECORDER-OFF
- ◆ PASS OXY ON
- ● PSEU

AIR COND
- ◆ DUCT OVERHEAT
- ◆ DUAL BLEED
- ◆ PACK TRIP OFF
- ◆ WING-BODY OVERHEAT
- ◆ BLEED TRIP OFF
- ◆ AUTO FAIL
- ◆ OFF SCHED DESCENT
- X ZONE TEMP
- X PACK

ⓧ	③
◆	③ 3 5 7 8 9
●	7 8 9
■	③ 3 5
X	8 9

SYSTEM ANNUNCIATORS AND RELATED AMBER LIGHTS

TAKEOFF CONFIGURATION WARNING

Takeoff configuration warning is armed when on the ground and either or both thrust levers are advanced for takeoff. An intermittent takeoff warning horn sounds for the following conditions:

- Stabilizer trim not in the green band range.
- ③ 3 7 8 9 Trailing edge flaps are not in the flaps 1 through 15 takeoff range.
- 5 Trailing edge flaps are not in the flaps 5 through 15 takeoff range.
- Leading edge devices are not in the correct position for takeoff.
- Speed brake lever is not in the DOWN position.
- 7 8 9 Spoilers not down with the speedbrake lever in the DOWN position.
- 3 5 7 8 9 Parking brake set.

The intermittent horn is canceled when the unsafe configuration is corrected or the throttles are retarded.

LANDING GEAR CONFIGURATION WARNINGS

General

Indications for landing gear positions are provided by green and red gear lights and a steady warning horn.

Landing Gear Visual Indications

Landing gear lights monitor signals from each gear, landing gear lever and throttle position switches.

A green light illuminates when each gear is down and locked.

A respective red light illuminates when:

- Gear in disagreement with lever position (transit or unsafe).
- ③ 3 5 Gear not down and locked (either or both thrust levers retarded to IDLE).
- 7 8 9 Gear not down and locked (either or both thrust levers retarded to idle, and below 800 feet AGL).

Green and red lights are extinguished when the three gears are up and locked with the landing gear lever UP or OFF.

Landing Gear Aural Indications

③ 3 5 A steady warning horn sounds any time the aircraft is in a landing configuration and any gear not down and locked.

7 8 9 A steady horn sounds any time the aircraft is below 800 feet AGL, in landing configuration and any gear not down and locked.

The warning horn monitors flap and thrust lever position in respect to gear position.

Flaps 1 through 10:

- Either or both thrust levers between idle and approximately 10 degrees thrust lever angle.
- Horn can be silenced (reset) with the landing gear warning horn cutout switch.

Flaps 15:

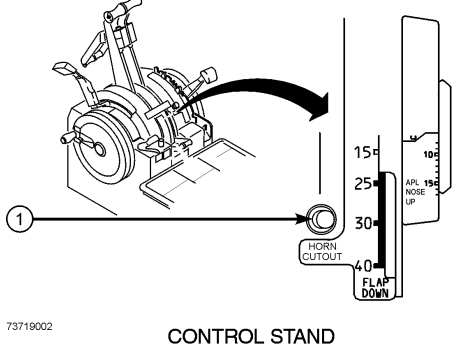
- Either thrust lever between idle and 10 degrees with the opposite thrust lever greater than 30 degrees.
  - Horn can be silenced (reset) with the horn cutout switch.
- Both thrust levers set below approximately 30 degrees.
  - Horn cannot be silenced.

Flaps Greater Than 15:

- Regardless of thrust lever position.
  - Horn cannot be silenced.

Warnings are canceled when the configuration error is corrected.

Landing Gear Warning Cutout Switch



CONTROL STAND

① Landing Gear Warning Cutout Switch

7 8 9

Push – Silences landing gear configuration warning aural indication at flaps up through 10 and above 800 feet RA.

The aural indication cannot be silenced with the cutout switch at flaps greater that 10.

7 8 9 Proximity Switch Electronic Unit (PSEU)

The PSEU, sensors and input signals are monitored for internal faults. When faults are detected, the **PSEU** light on the aft overhead panel illuminates, the **OVERHEAD** system annunciator light and **MASTER CAUTION** lights also illuminate. The **PSEU** light can be reset following a maintenance BITE check or repair of the cause of the fault.

The **PSEU** light and **OVERHEAD** system annunciator do not illuminate for some faults unless a system annunciator panel is pushed. Resetting the **MASTER CAUTION** system extinguishes the **PSEU** light.

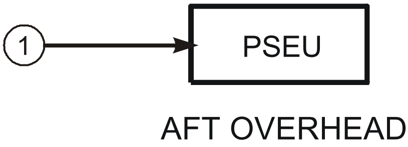
The PSEU monitors:

- Takeoff configuration warnings.
- Landing configurations warnings.
- Landing gear.
- Air / ground sensing.

The PSEU light is inhibited:

- When a thrust lever is advanced toward takeoff thrust position.
- In flight.
- Thirty seconds after landing.

Proximity Switch Electronic Unit Light



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7 8 9

① Proximity Switch Electronic Unit (PSEU) Light

Illuminated (amber) –

- On the Ground –
  - A fault is detected in the PSEU, or
  - An overwing exit flight lock fails to disengage when commanded.
- In Flight –
  - Inhibited from thrust lever advance for takeoff until 30 seconds after landing.

Flight Deck Door Warning Light

7376-1501

Illuminates steady or flashing (red) – There is a fault within the flight deck door system. Can be extinguished by pushing the HARD LOCK switch.

MACH / AIRSPEED WARNING SYSTEM

Two independent Mach / airspeed warning systems provide a distinct aural warning (clacker) any time the maximum operating airspeed of V_{MO}/M_{MO} is exceeded. Clackers are silenced by reducing airspeed below V_{MO}/M_{MO}. Maximum airspeed at lower altitudes are dictated by structural limitations.

Altitude speed limits at high altitudes (above approximately 26,000 feet) are dictated aircraft Mach critical (shock wave formation on airfoils).

3 $\boxed{3}$ $\boxed{5}$ Air Data Computers provide signals to the clacker through an internal mechanism in each pilot's Mach/airspeed indicator. The clacker is checked with system test switches on the aft overhead panel. The indicated airspeed limit, (340 knots) remains constant until reaching about 26,000 feet, where the Mach limit, 82 M_{MO} is reached. At this point, indicated airspeed decreases as altitude increases to allow maintenance of a constant .82 Mach limit. The system can only be tested on the ground.

$\boxed{7}$ $\boxed{8}$ $\boxed{9}$ The airspeed indicator displays red warning bands for maximum and minimum airspeeds. Amber bands indicate maximum and minimum maneuvering airspeeds. When overspeed occurs, the Air Data Inertial Reference Unit (ADIRU) transmits a signal to the aural warning module, which sounds the clacker. Test switches cause ADIRU overspeed signal input to the aural warning modules clacker. The system can only be checked on the ground.

Stall Warning System

Warning for impending stall is required to occur above actual stall speed. An artificial stall warning device (stick shaker) provides the required warning.

The stick shakers are eccentric weight motors on each control column. Either one causes both control columns to vibrate. The system operates in all flight conditions and configurations but is deactivated on the ground.

Two test switches are on the aft overhead panel. Pressing either switch initiates a self-test of the respective stall warning channel. The No. 1 activates the captain stick shaker and the No. 2 activates the first officer stick shaker.

3 $\boxed{3}$ $\boxed{5}$ Two independent digital computers provide stall warnings. Stall warnings occur when the airspeed falls below a specified value for a clean wing or selected flap setting. The computers receive inputs from angle of attack vanes, flap position transmitter, N_1 and N_2 indicators, air / ground relay, air data computers and leading edge module.

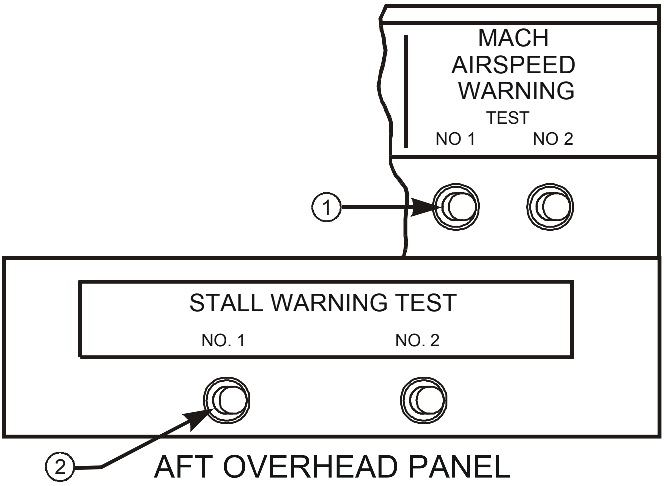
3 5 The stall management computers send data to the electronic flight instrument system symbol generator. The symbol generator provides stall warning information to the EADI speed tape and signals for the pitch limit indicator when the flaps are out of the up position.

7 8 9 Two identical independent, Stall Management Yaw Damper (SMYD) computers determine when stall warning is required. Signals for the SMYD's are:

- Angle of attack
- ADIRU outputs
- Anti-ice configuration
- Wing configuration
- Air / ground sensing
- Thrust
- FMC outputs.

The SMYD computers provide outputs for the stick shaker, signals for the pitch limit indicator and airspeed displays, GPWS windshear warnings, cautions and alerts.

Mach / Airspeed Warning And Stall Warning Test Switches



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① MACH AIRSPEED WARNING TEST Switches

Push – Tests respective mach / airspeed warning system

- Clacker sounds
- Inhibited while airborne.

② STALL WARNING TEST Switches

③ [3] [5] Press– On ground with APU or external power: control columns shake.

- Test the respective stall warning computer.

[7] [8] [9] Push – On ground with AC power available: each test switch tests its respective stall management yaw damper (SMYD) computer. No.1 SMYD computer shakes Captain's control column, No.2 SMYD computer shakes First Officer's control column. Vibrations can be felt on both columns

- Inhibited while airborne.
- Will not test if leading edge flaps are not retracted.

Altitude Alerting System

Altitude alerting occurs when approaching or departing the MCP – selected altitude. Altitude alerting is inhibited when trailing edge flaps are extended to 25 or greater, or while G/S is captured.

Acquisition Alerting

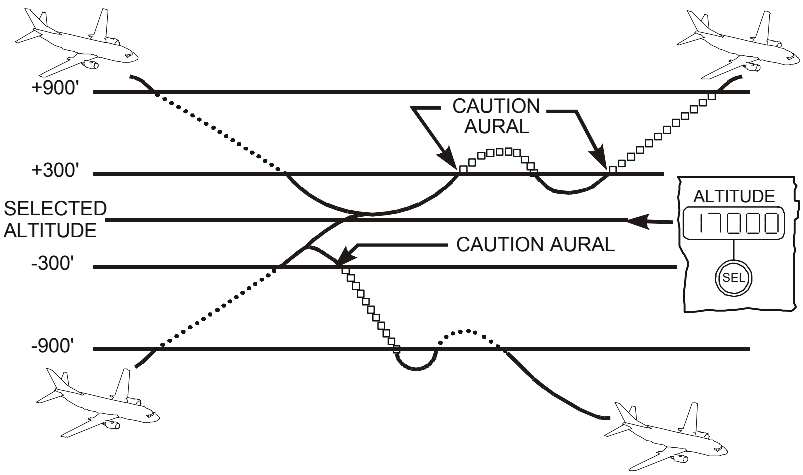
900 feet before reaching the selected altitude, both **ALT ALERT** annunciations show and a momentary tone sounds. At 300 feet from selected altitude, the **ALT ALERT** annunciations extinguish.

Deviation Alerting

When deviating by 300 feet from the selected altitude, a momentary tone sounds and the **ALT ALERT** annunciations flash. Flashing continues until:

- Altitude deviation becomes less than 300 feet
- Altitude deviation becomes more than 900 feet
- A new altitude is selected.

Altitude Alert Profile



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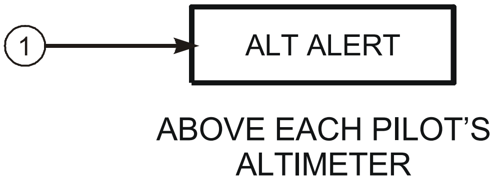


73719006

① Altitude Alert (**ALT ALERT**) Annunciation

One on each pilot's primary display above altimeter.

—— NO INDICATIONS

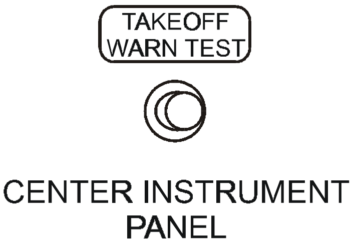
• • • Acquisition - Aural warning tone momentarily sounds and ALT ALERT annunciations show.

▫▫▫ Deviation of ± 300 ft - Aural warning tone momentarily sounds and ALT ALERT annunciations flash.

73719007

TAKEOFF WARNING TEST SWITCH

The switch must be depressed and held to activate the test. The test switch is installed in parallel with the existing Takeoff Configuration Warning system. Depressing this switch will activate the takeoff warning horn if any of the flight control surfaces or their associated proximity switches are not in the proper position for takeoff. This will allow flight crews or maintenance to verify all flight control surfaces and associated proximity switches are configured properly prior to takeoff without advancing the thrust levers.



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GROUND PROXIMITY WARNING SYSTEM (GPWS)

GENERAL

3 5 Ground Proximity Warning System (GPWS) and ③ 7 8 9 Enhanced (EGPWS) provide aural and visual warnings, cautions and alerts for potentially hazardous flight conditions involving possible controlled flight into terrain (CFIT).

GPWS uses No. 1 radio altitude, ADC / ADIRU, glide slope and combinations of barometric altitude, airspeed, and aircraft configuration (landing gear lever and flap position).

3 5 - No. 1 IRS and stall warning computer inputs, 7 8 9 - ADIRU / SMYD are required for reactive windshear mode.

③ 7 8 9 - EGPWS requires a terrain database correlated with the FMC position and enhance by GPS if installed.

GPWS MODES

MODE 1 - Excessive descent rate.

MODE 2 - Excessive terrain closure rate.

MODE 3 - Altitude loss after takeoff or go-around.

MODE 4 - Unsafe terrain clearance when not in the landing configuration.

MODE 5 - Excessive deviation below an ILS glide slope.

MODE 6 - ③ Descent below selected minimum radio altitude.

MODE 6 - 3 5 7 8 9 Excessive bank angles and radio altitude callouts below 100 feet RA.

MODE 7 - 3 5 7 8 9 Windshear condition encountered (reactive windshear system).

Windshear warnings take priority over all other modes.

GPWS / EGPWS is armed when all inputs are valid.

The loss of an input signal deactivates only the affected mode(s), however failure of the No. 1 Radio Altimeter causes failure of all GPWS modes.

3 5 GPWS

Aircraft without Enhanced GPWS will not receive indications for flight toward sheer vertical terrain or slow descents toward unprepared terrain while in landing configuration.

③ 7 8 9 ENHANCED GPWS

EGPWS includes all modes 1 through 7. In addition, EGPWS uses a world terrain database that contains detailed information for airport terminal areas and less detailed information between airports. The database is correlated with FMC position. This enables aural and visual indications for flight toward potential terrain encounters or descent toward any type of terrain while in landing configuration.

EGPWS builds a terrain clearance floor around airports in the database and provides a 3-degree descent path from the final approach fix. Penetration of the terrain clearance floor causes a terrain warning regardless of aircraft configuration, rate of descent, or terrain closure rate.

Man made objects are not contained in the database and terrain clearance floors are not available for non-database airports.

Mode 1 – Excessive Descent Rate

Mode 1 has two boundaries and is independent of aircraft configuration. Penetration of the first boundary sounds the "SINK RATE" alert and illuminates the red **PULL UP** lights. If the more critical second boundary is entered, the "WHOOP, WHOOP, PULL UP" warning sounds.

Mode 2 – Excessive Terrain Closure Rate

Mode 2 has two sub-modes and is dependent on airspeed, radio and barometric altitude and radio altitude rate of change and configuration. Penetrating the first boundary illuminates the **PULL UP** lights and generates a twice-repeated "TERRAIN" followed by repeated "WHOOP, WHOOP, PULL UP" warnings when the second boundary is penetrated.

Mode 2A

If landing gear <u>and</u> flaps are not in the landing position when climbing out of the "WHOOP, WHOOP, PULL UP" envelope, 300 feet of barometric altitude must be gained before the "TERRAIN" warning is silenced.

Mode 2B

If flaps are in the landing configuration when approaching terrain at an unacceptable baro rate, no altitude gain is required to silence the "TERRAIN, TERRAIN" warning.

When landing gear or flaps are extended, the altitude gain function is inhibited. When both landing gear and flaps are extended, the "WHOOP, WHOOP, PULL UP" warning is replaced by the "TERRAIN, TERRAIN" warning.

Mode 3 – Altitude Loss After Takeoff Or Go-Around

Mode 3 is active at low radio altitudes during takeoff or go-around. A "DON'T SINK" alert sounds when accumulated barometric altitude loss equals approximately ten percent of the original radio altitude gained. The alert continues until positive rate of climb is established. If the aircraft descends again before climbing to the initial descent altitude, another alert sounds based on the original descent altitude.

The takeoff mode arms automatically after flaps or landing gear are retracted. Go-around mode is armed when the aircraft descends below 200 feet RA in the landing configuration and either flaps or landing gear are retracted.

Mode 4

Mode 4 has two sub modes and is dependent on radio altitude, airspeed and flap / gear configuration.

Mode 4A – Unsafe Terrain Clearance With Landing Gear Not Down

At airspeeds below approximately 180 knots to 190 knots and below 500 feet RA, a "TOO LOW GEAR" warning is repeated when the gear is not down. As speed increases above approximately 180 knots to 190 knots at any altitude to 1000 RA the "TOO LOW TERRAIN" warning is repeated if the gear is not down.

Mode 4B – Unsafe Terrain Clearance With Flaps Not In A Landing Position

At airspeeds below approximately 150 to 160 knots and below 200 feet RA, the "TOO LOW FLAPS" warning is repeated. As speed increases above approximately 150 knots, the "TOO LOW TERRAIN" is repeated.

The "TOO LOW GEAR" warning takes priority over the "TOO LOW FLAPS" warning.

Mode 5 – Below Glide Slope Deviation Alert

Mode 5 descents below 1.3 dots on ILS glideslope cause a repeated "GLIDESLOPE" alert accompanied by two **BELOW G/S** lights. If deviation continues, the "GLIDESLOPE" aural gets louder and the repetition rate is increased.

The mode arms when a valid signal is being received by the No. 1 glideslope receiver and the radio altitude is 1000 feet or less.

The mode may be canceled or inhibited by pressing either **BELOW G/S** light when in the soft warning area.

Modes 1 through 4 aurals have priority over Mode 5 aurals; however, both **PULL UP** and **BELOW G/S** lights may illuminate simultaneously.

Mode 6 – Voice Alerts

③ Mode 6 is available from 1000 feet RA to 50 feet RA (301 – 332), 10 feet RA (333 – 358) with the landing gear down. When the "bug" is set in the No. 1 radio altimeter, "MINIMUMS, MINIMUMS" sounds when the "bug" RA is reached.

All other GPWS aurals have priority over the radio altitude aural callouts. All decision height callouts are inhibited for positive decision height settings less than or equal to ten feet.

3 5 7 8 9 Mode 6 alerts sounds "BANK ANGLE, BANK ANGLE" at 35, 40, and 45degrees of bank; and "ONE HUNDRED," "FIFTY," THIRTY," "TWENTY," "TEN" AGL as the aircraft descends for landing.

The accuracy of this warning is degraded by irregular approach terrain.

Mode 7 - Reactive Windshear Warning

3 5 7 8 9 The reactive windshear warning occurs <u>after penetration</u> of the windshear area if engaged in TOGA and provides flight director recovery guidance.

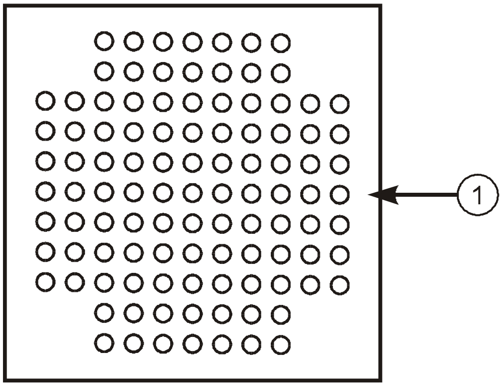
A red **WINDSHEAR** annunciation appears on the EADIs and is accompanied by a siren followed and once sounded "WINDSHEAR, WINDSHEAR, WINDSHEAR." The annunciation remains until the aircraft is flown out of windshear condition.

Windshear warnings take priority over all other GPWS modes.

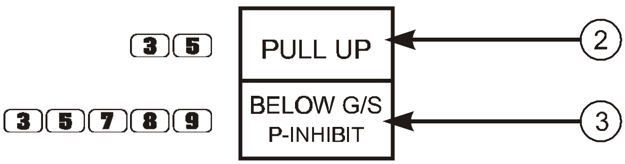
A windshear condition is detected using comparisons of angle-of-attack, IRS accelerations, and air data computer airspeed or ADIRU, SMYD as installed. The windshear intensity which activates a warning is dependent upon flap position, radio altitude, and phase of flight (takeoff or approach). Warnings occur below 1500 feet RA and during takeoff, at rotation.

If using the autopilot, autothrottle, and/or flight director during a windshear encounter, normal TO/GA functions are available.

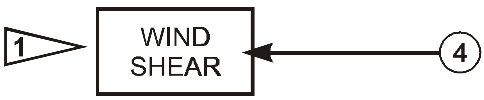
GPWS CONTROLS AND INDICATORS



AFT OVERHEAD PANEL



CAPT INST PANEL
F/O INST PANEL



CAPT INST PANEL
F/O INST PANEL

1 As Installed

7376150018

① GPWS Speaker

Provides GPWS aural alerts and warnings.

② PULL UP WARNING LIGHT (red)

Illuminated – Indicates that one or more of the following conditions exists:

- Excessive descent rate
- Excessive terrain closure rate
- Altitude loss after takeoff or go-around
- Unsafe terrain clearance when not in the landing configuration.

③ BELOW GLIDE SLOPE ALERT LIGHT (amber)

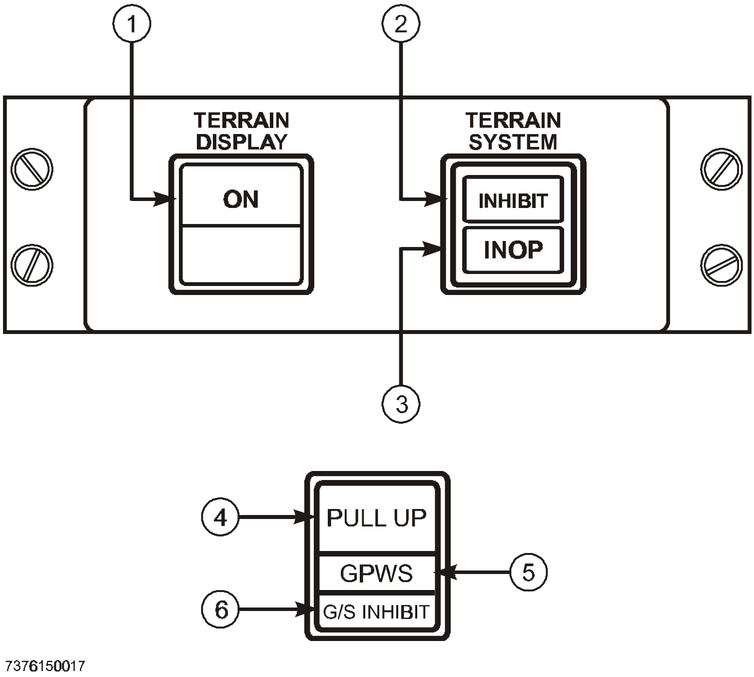
Illuminated – Aircraft is more than 1.3 dots below the glide slope.

Press – Inhibits or cancels below glide slope alerting if pressed while in the alerting area.

④ WINDSHEAR WARNING LIGHT (red)

Illuminated – Indicates windshear condition exists.

③ EGPWS CONTROLS AND INDICATORS



① Terrain Display Switch (green)

Push – Provides manual selection / deselection of EGPWS terrain display.

② Terrain System Inhibit Switch (white)

Push – Inhibit Terrain Awareness Alerting and Display, and Terrain Clearance Floor functions.

INHIBIT light illuminated when selected.

③ Terrain System **INOP** Light (amber)

Illuminated – Indicates:

- Terrain Awareness Alerting and Display, and Terrain Clearance Floor functions are inoperative. Self corrections are possible.
- Windshear detection remains operational.
- EGPWS will revert to basic GPWS protection (Mode 1 – 6/7).

④ **PULL UP** Warning Light (red)

Illuminated – Indicates that one or more of the following conditions exists:

- Excessive descent rate
- Excessive terrain closure rate
- Altitude loss after takeoff or go-around
- Unsafe terrain clearance when not in the landing configuration
- Terrain display with solid red warning area displayed
- Audible “PULL UP” or “TERRAIN, TERRAIN, PULL UP” or (siren) “WINDSHEAR, WINDSHEAR, WINDSHEAR” warning
- Red **WINDSHEAR** light (windshear configurations only).

⑤ **GPWS** Caution Light (amber)

- **GPWS** light will illuminate with any of the following aural alerts: “CAUTION TERRAIN,” “TOO LOW TERRAIN,” “SINK RATE,” “DON’T SINK,” “GLIDESLOPE,” “TOO LOW FLAPS,” or “TOO LOW GEAR.”
- Terrain display with solid amber alert area displayed.

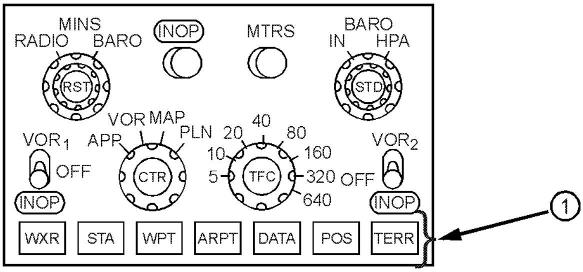
⑥ Below Glide Slope Alert Light (amber)

Illuminated – Aircraft is more than 1.3 dots below the glide slope.

Push – Inhibits or cancels below glide slope alerting if pushed while in the alert area.

7 8 9 EGPWS (LOOK-AHEAD) EFIS CONTROL PANEL

EGPWS (LOOK - AHEAD) EFIS CONTROL PANEL



GLARESHIELD

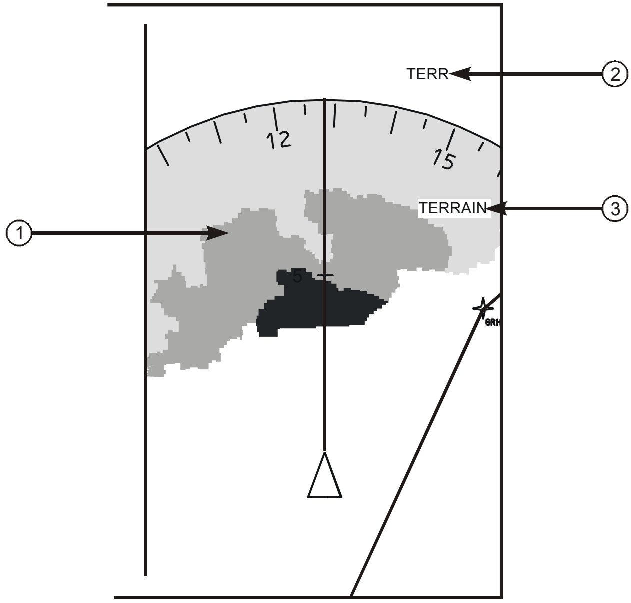
737TB018

① Terrain (TERR) Display Select Switch

Push –

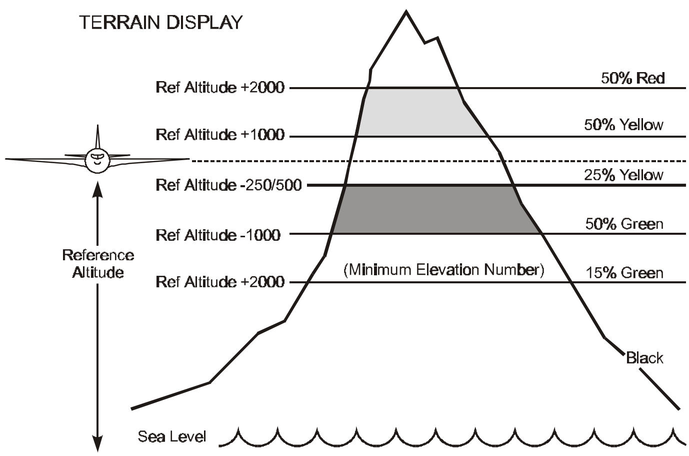
- Shows terrain data in expanded MAP, center MAP, expanded VOR, and expanded APP modes
- Arms terrain data in PLN, center VOR, and center APP modes
- Deselects weather radar display regardless of mode selector position
- Second push deselects terrain display.

③⑦⑧⑨ Terrain Display



NAVIGATION DISPLAY

73719009



7376-1503

Note: The terrain display on the ③ will be shown on the radar screen.

① Terrain Display

Color and density vary based on terrain height vs. aircraft altitude:

- Terrain not shown more than 2000’ below the aircraft
- Light density green: 1000’-2000’ below the aircraft
- Medium density green: 500’ (gear up) / 250’ (gear down) – 1000’ below the aircraft
- Medium density amber: 500’ (gear up) / 250’ (gear down) – 1000’ above the aircraft
- Solid amber: 1000’ – 2000’ above the aircraft (First aural alert “CAUTION TERRAIN” approximately 60 seconds from CFIT)
- Solid red: more than 2000’ above the aircraft (Terrain warning active “TERRAIN, TERRAIN, PULL UP” approximately 30 seconds from CFIT)

Note: In areas without terrain data, look-ahead terrain alerting and display functions not available. Radio altitude based terrain alerts function normally.

Note: Terrain more than 2,000 feet below aircraft altitude or within 400 feet of nearest airport runway elevation does not show.

② Terrain Mode Annunciation 7 8 9

TERR (cyan) – Terrain display enabled (manual or automatic display).

③ **TERRAIN** Annunciation 7 8 9

TERRAIN (amber) – look-ahead terrain caution alert active.

TERRAIN (red) – look-ahead terrain warning alert active.

Shows in all navigation display modes.

Use Of Terrain Awareness Display

③ The terrain awareness display may be selected on the weather radar indicator by selecting the terrain display switch. The terrain display may be selected in place of weather radar display at any time that the weather radar indicator is selected to the TEST, WX/TURB, or MAP mode. The display may be used as one component of maintaining awareness of separation from terrain.

Note: The display is not intended to be used for navigation.

Weather radar and terrain information can not be displayed simultaneously on the single weather radar indicator. For operation near convective activity, the crew should use the weather radar as usual. In the event that an EGPWS terrain alert occurs, the terrain display will "pop up" on the weather radar indicator in the 10 NM range and the terrain system **ON** annunciator will be illuminated. This "pop up" feature occurs with the weather radar indicator in any mode including OFF.

789 The terrain awareness display on the navigation display can be selected in EXPANDED APPROACH, EXPANDED VOR, EXPANDED and CENTER MAP, but cannot be displayed together with the weather radar. However, each pilot's display is independent, permitting one pilot to show terrain and the other to have weather radar displayed, if desired.

The terrain display will "pop up," or display without the pilot taking a switch action. This pop up will occur along with the first terrain related aural alert. The terrain display will replace the weather radar display and the radar mode annunciation will change to **TERR**. The pop up display can be removed when the threat is no longer active.

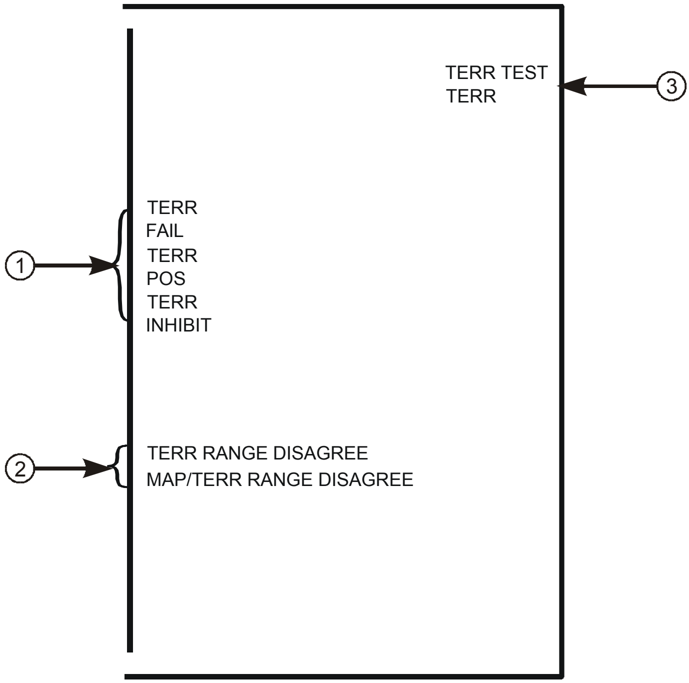
System Constraints

③ If the Terrain Awareness and Terrain Clearance Floor functions of the Enhanced Ground Proximity Warning System have been inhibited or the Terrain System **INOP** is annunciated, windshear detection remains operational and the EGPWS will revert to basic Ground Proximity Warning System protection (Mode 1 – 6). In this standard GPWS condition, the system may give little or no advance warning time for flight into precipitous terrain where there are few or no preceding obstructions. If the aircraft is flown toward obstructing terrain, the GPWS will give no warnings if all the following conditions apply:

- The aircraft is in landing configuration.
- The aircraft is in a stabilized descent at a normal approach descent rate.
- There is no ILS Glideslope signal being received by the Enhanced Ground Proximity Warning System (i.e., there is no ILS available or the #1 Glideslope receiver connected to the Enhanced Ground Proximity Warning Computer is not tuned to the appropriate ILS frequency).

For the above conditions, the only alerts available are the Windshear, if configured, and Mode 6 Advisory Callouts.

7 8 9 LOOK-AHEAD TERRAIN MESSAGES (EGPWS)



737190014

① Terrain Status Annunciation (amber)

TERR FAIL – Look-ahead terrain alerting and display have failed.

TERR POS – Look-ahead terrain alerting and display unavailable due to position uncertainty.

TERR INHIBIT – EGPWS terrain inhibit switch in TERR INHIBIT position.

② Terrain Range Status Annunciation (amber)

TERR RANGE DISAGREE –

- Terrain display enabled, and
- Terrain output range disagrees with selected EFIS control panel range.

MAP/TERR RANGE DISAGREE –

- Terrain display enabled, and
- Terrain output range disagrees with selected EFIS control panel range, and
- Map display output range disagrees with selected EFIS control panel range.

③ Terrain Mode Annunciation (cyan)

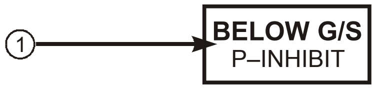
TERR TEST – GPWS is operating in self-test mode.

TERR – Terrain display enabled (manual or automatic display).

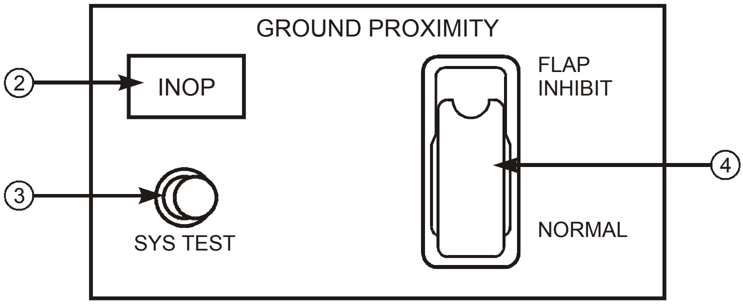
Ground Proximity Warnings

Positioning the ground proximity flap inhibit switch to FLAP INHIBIT cancels the warning / alerts caused by the flaps not in the proper configuration.

③ EGPWS (Look-Ahead) / 3 5 GPWS



LEFT AND RIGHT FORWARD PANEL



RIGHT FORWARD PANEL

7371903B

① **BELOW G/S** (Glideslope) Light

Illuminated (Amber) - Below glideslope alert is active.

Push - Inhibits ground proximity glideslope alert when below 1,000 feet radio altitude.

② Inoperative (**INOP**) Light

Illuminated (Amber) - EGPWS computer malfunction or power loss.

Invalid inputs are being received from radio altimeter, ADC, ILS receiver, IRS, FMC, stall management computers, or EFIS control panel.

③ Ground Proximity System Test (SYS TEST) Switch

Push - Momentarily on ground, or above 1,000 feet radio altitude inflight:

- **BELOW G/S** and GPWS **INOP** lights illuminate.
- **PULL UP** lights illuminate and **WINDSHEAR** annunciations occur.
- "GLIDESLOPE," "PULL UP," and "WINDSHEAR" aurals sound.

At least 10 seconds on ground:

- Above indications always occur first, followed by any additional aurals as installed.

Push - Momentarily on ground.

- **BELOW G/S** and GPWS **INOP** lights illuminate.
- **TERR FAIL** and **TERR TEST** show on navigation displays.
- **PULL UP** and **WINDSHEAR** alerts illuminate.
- "GLIDESLOPE," "PULL UP," and "WINDSHEAR" aurals sound.
- Terrain display test pattern shows on navigation displays.
- "TERRAIN CAUTION" aural sounds and **TERRAIN CAUTION** message shows on navigation displays.

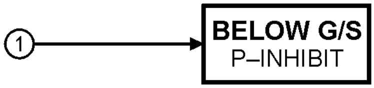
At least 10 seconds on ground:

- Above indications always occur first, followed by any additional aurals as installed.
- System test inhibited in-flight.

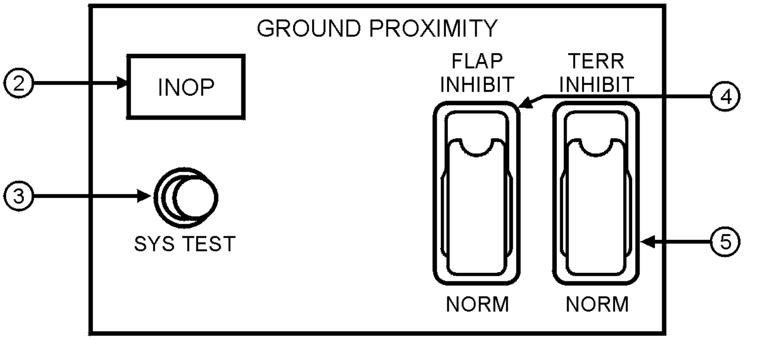
④ Ground Proximity FLAP INHIBIT Switch

- **FLAP INHIBIT** - Inhibits ground proximity "TOO LOW FLAPS" warning.
- **NORM** (Guarded Position) - Normal "TOO LOW FLAPS" warning active.

7 8 9



LEFT AND RIGHT
FORWARD PANEL



LOWER RIGHT FORWARD PANEL

7371903A

① **BELOW G/S** (Glideslope) Light

Illuminated (Amber) - Below glideslope alert is active.

Push - Inhibits ground proximity glideslope alert when below 1,000 feet radio altitude.

② Inoperative (**INOP**) Light

Illuminated (Amber) - GPWS computer malfunction or power loss.

- Invalid inputs are being received from radio altimeter, ADC, ILS receiver, IRS, FMC, stall management computers, or EFIS control panel.

③ Ground Proximity System Test (SYS TEST) Switch

Push - Momentarily on ground, or above 1,000 feet radio altitude inflight:

- **BELOW G/S** and GPWS **INOP** lights illuminate.
- **PULL UP** and **WINDSHEAR** alerts illuminate.
- "GLIDESLOPE," "PULL UP," and "WINDSHEAR" aurals sound.

At least 10 seconds, on ground, above indications always occur first, followed by any additional aurals as installed.

- Radio altitude based alerts
- Bank angle alert
- Approach callouts
- Windshear alert

System test inhibited from lift-off to 1000 feet radio altitude.

Push - Momentarily on ground.

- **BELOW G/S** and GPWS **INOP** lights illuminate.
- **TERR FAIL** and **TERR TEST** show on navigation displays.
- **PULL UP** and **WINDSHEAR** alerts illuminate.
- "GLIDESLOPE," "PULL UP," and "WINDSHEAR" aurals sound.
- Terrain display test pattern shows on navigation displays.
- "TERRAIN CAUTION" aural sounds and **TERRAIN CAUTION** message shows on navigation displays.

Until self-test aurals begin, on ground, above indications always occur first, followed by these additional aurals:

- Radio altitude based alerts
- Bank angle alert
- Approach callouts
- Windshear alert
- Look ahead terrain alerts

System test inhibited inflight.

④ Ground Proximity FLAP INHIBIT Switch

- **FLAP INHIBIT** - Inhibits ground proximity TOO LOW FLAPS alert.
- **NORM** (Guarded Position) - Normal TOO LOW FLAPS alert active.

⑤ Ground Proximity Terrain Inhibit (TERR INHIBIT) Switch

- TERR INHIBIT - Inhibits look-ahead terrain alerts and terrain display.
- NORM (Guarded Position) – Normal terrain alerts and terrain display active.

Predictive Windshear System

Provides detection of a windshear hazard a minimum of ten seconds prior to penetration allowing a normal go-around procedure (airborne) or RTO for avoidance.

③❸❺ The RDR-4B and the Collins WXR700X radar systems are designed to operate in the windshear mode automatically any time the aircraft is below 1500' AGL, at least one engine is running, and the transponder is **not** in OFF or STBY, regardless of radar mode selected. The system also operates in the windshear mode below 1500' AGL using an alternate scan technique if the radar is operating in any mode (WX/TURB, WX, MAP). The windshear mode is activated at 2300' AGL; however, no alerts or displays are annunciated above 1500' AGL.

❼❽❾ The weather radar automatically begins scanning for windshear when:

- Thrust levers set for takeoff, or
- In flight below 2,300 feet RA (predictive windshear alerts are issued below 1,200 feet RA).

Alerts are available approximately 12 seconds after the weather radar begins scanning for windshear. Predictive windshear alerts can be enabled prior to takeoff by pushing the EFIS control panel WXR switch.

Alternate Scan

When radar is operated in weather mode and conditions for windshear mode operations are satisfied, the weather radar switches to an alternate scan function. In alternate scan operation, one sweep is for weather, the next sweep for windshear. On the weather sweep, gain and tilt are controlled by settings on radar control panel. On the windshear sweep gain and tilt are automatically set for optimum windshear detection.

The windshear mode is transparent unless an alert is generated. Therefore, weather radar displays are delayed for up to 12 seconds when both radar and windshear modes are active. The delay is caused by sharing of the radar antenna by weather and windshear modes.

Warning: Failure to return the transponder to STBY after landing or selecting any mode except STBY prior to leaving the ramp area allows the radar to operate in the windshear mode creating a radiation hazard to personnel on the ground. The radiation hazard area extends 13.4 feet from the radar antenna in a 120 degree are left and right of the aircraft centerline. This hazard exists even if the radar mode is selected OFF or TEST.

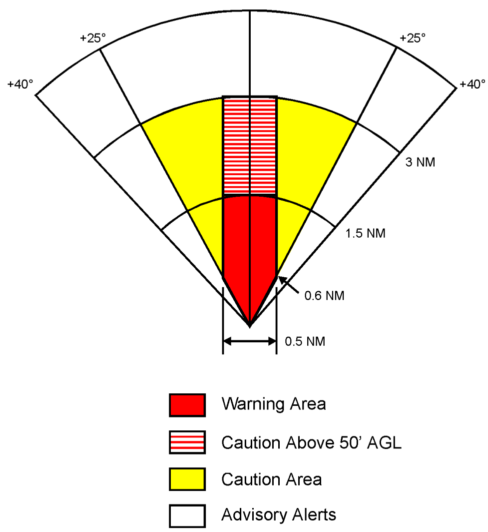
Windshear Display

The display is red and black bands with straight sides formed by the radials from the aircraft which bound the windshear event. The arcs closest and furthest from the aircraft depict the minimum and maximum range of the detected windshear.

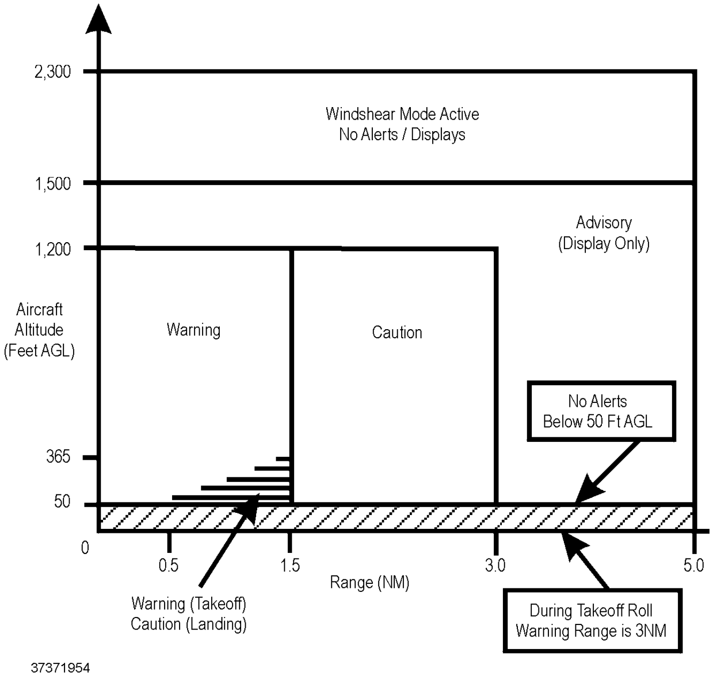
Yellow radial lines appear at the edges beyond the windshear and extend to the edge of the display to provide directional information.

Prior to flight, a test of the radar system should be performed. On the control panel, select TEST, GAIN TO AUTO, RANGE TO 40 and verify the indications shown in the Test Mode table occur.

③



LANDING
WINDSHEAR ALERT / WARNING AREAS DURING LANDING



WINDSHEAR ALERT RANGES AND ALTITUDES

Predictive Windshear Warning

Takeoff

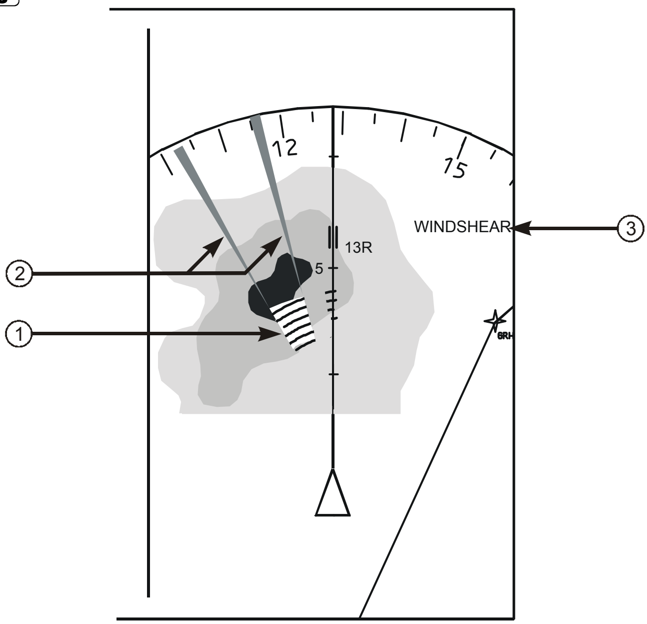
Red **WINDSHEAR** annunciator lights illuminate on both forward instrument panels and "WINDSHEAR AHEAD, WINDSHEAR AHEAD" sounds during takeoff below 100 knots. Between 100 knots and 50 feet, there are no new windshear warnings.

Landing

The **WINDSHEAR** lights illuminate and 'GO AROUND WINDSHEAR AHEAD" sounds when windshear is detected on approach.

PREDICTIVE WINDSHEAR DISPLAY AND ANNUNCIATIONS

7 8 9



737190010 NAVIGATION DISPLAY

Note: The windshear display on the ③ will be shown on the radar screen.

① Predictive Windshear Symbol

Displayed (red and black) – Predictive windshear alert active.

Shows windshear location and approximate geometric size (width and depth).

Symbol, radials, and weather radar returns automatically show when:

- Predictive windshear alert occurs, and
- Neither pilot has **WXR** display selected, and
- In expanded MAP, center MAP, VOR, or APP modes.

When terrain display is active, weather radar display replaces terrain display.

② Predictive Windshear Symbol Radials

Displayed (amber) – Predictive windshear alert active.

Extend from predictive windshear symbol to help identify location of windshear event.

③ **WINDSHEAR** Annunciation

WINDSHEAR (amber) – predictive windshear caution active.

WINDSHEAR (red) – predictive windshear warning active.

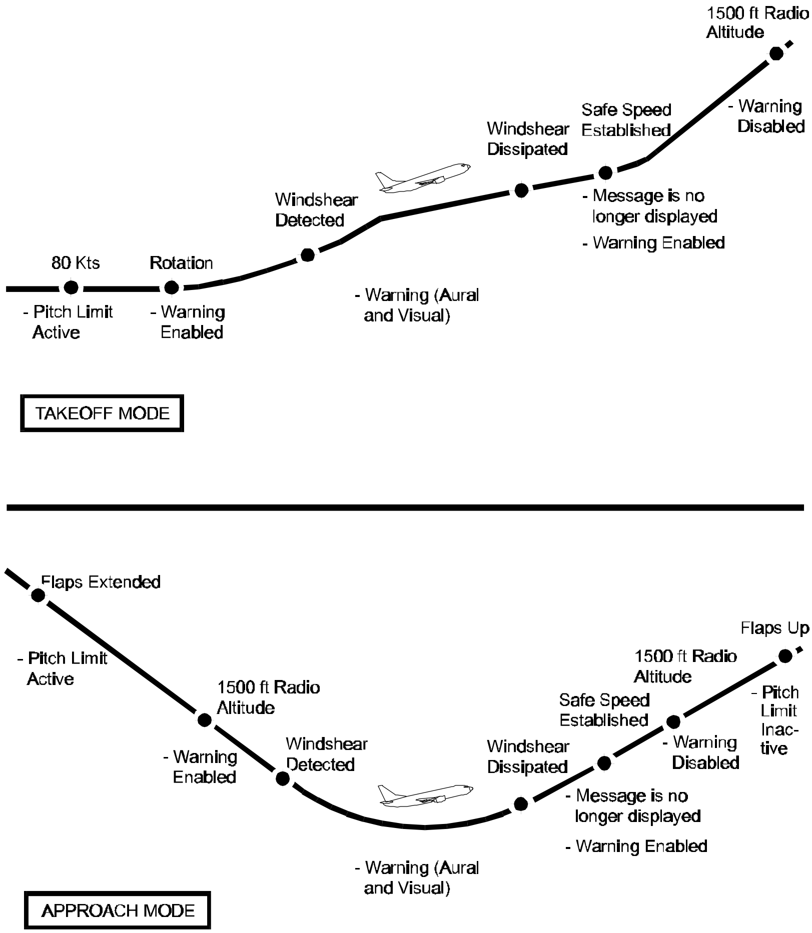
Shows in all navigation display modes.

Predictive Windshear System Test

The following table shows satisfactory test indications. Select TEST, GAIN TO AUTO, RANGE TO 40 and test.

VISUAL AND AURAL TEST TIMING	FIRST 2 SECONDS	10 SECONDS		
Presentation	**Initial Indications**	**Normal Indications**	**Failure**	
Caution Lamp	ON	OFF	OFF	
W/S Fail Lamp	ON	OFF	ON	
W/S Warning Lamp	OFF	ON	Internal OFF	External ON
Aural	Chime	"GO AROUND WINDSHEAR AHEAD" (pause) "WINDSHEAR AHEAD, WINDSHEAR AHEAD"	None	"GO AROUND WINDSHEAR AHEAD" (pause) "WINDSHEAR AHEAD, WINDSHEAR AHEAD"
Display	Test Pattern	Test Pattern	RT Fault	Test Pattern with Labeled EXT W/S FAULT (Unless Radar Failure)
(Upper Left Corner)	No W/S Displayed	No W/S Displayed	No W/S Remains Displayed	

TEST MODE



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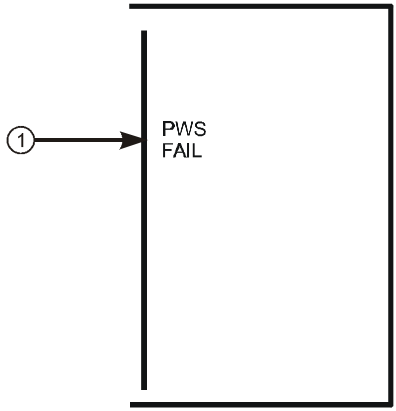
WINDSHEAR ENCOUNTER PROFILES

PREDICTIVE WINDSHEAR SYSTEM (PWS) MESSAGE



737190015

1 **PWS FAIL** Annunciation (amber)

Predictive windshear alerting and display have failed.

SYSTEM FAILURE ANNUNCIATION

A system failure is annunciated on the Radar Indicator (PPI-4B), Electronic Displays and/or dedicated annunciator lamp.

- **PWS INOP**: Amber annunciator is located on the center instrument panel.

Note: Windshear System Failure is considered a Soft Failure and may not impact other radar modes.

If the self-test detects a failure condition, the **PWS INOP** annunciation stays on while the caution alert annunciation is turned off. The windshear warning annunciations and the aural output would not be activated. If the detected failure does not affect the weather detection capability of the radar, the normal test pattern would be displayed. If the radar detection capability is affected, there would be no radar test pattern.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)

The TCAS interrogates transponders on other aircraft in the vicinity and determines their range, bearing and altitude. Traffic Advisories (TAs) occur when another aircraft is approximately 40 seconds from the point of closest approach (PCA). If the other aircraft continues to close, a Resolution Advisory (RA) is generated approximately 25 seconds from the PCA. TCAS coordinates RAs between TCAS equipped aircraft.

Traffic Displays

③ TCAS displays appear on the weather radar display.

3 5 7 8 9 TCAS displays appear on the EHSI.

Advisories

Traffic advisories sound a "TRAFFIC, TRAFFIC" aural, and a message is annunciated on the traffic display. The range and relative bearing of the other aircraft also appears. If the other aircraft transponder is in Mode C or S, altitude and vertical motion, if appropriate, are displayed.

Resolutions advisories sound RA aurals as found in the RA aurals table and range, relative bearing and altitude appear on the traffic display. RAs always provide a pitch restriction or maneuver on the:

③ Vertical Speed Indicator.

3 5 7 8 9 EADI.

If the other aircraft position is outside of the selected range on **OFFSCALE** annunciation appears during a TA or RA.

If the bearing of other aircraft cannot be determined, with a TA or RA, the range, altitude and vertical motion arrow (if applicable) still appear on the traffic display.

Non-transponder equipped aircraft are invisible to TCAS and RAs are not provided for aircraft operating in A mode.

Inhibits

TCAS advisories are inhibited when GPWS / EGPWS and windshear warnings occur or at low aircraft altitudes when avoidance maneuvers would be inappropriate.

If inhibit occurs, RA aurals are silenced, the command is removed from the applicable instrument / display and the RA traffic display symbol reverts to a TA symbol. If inhibit occurs during a TA, the TA aural is silenced.

Mode Control

TCAS modes are selected on the transponder panel. TCAS is normally operated in the TA/RA mode. However, operation in TA only mode may be required to prevent undesired RAs.

TA mode is used during engine out operation to prevent RAs when adequate thrust is not available to follow the RA commands. TA mode may also be used when operating near aircraft that may cause undesired RAs, i.e. parallel approaches and VFR operations.

TCAS Test

A test pattern on the display provides verification of the intruder symbols. If weather radar is tested at the same time, **TEST** annunciates with the display test pattern. If the radar display is operating in a weather function, this test appears over weather.

Test Symbols

Resolution advisory (red filled square) appears at 3 o'clock, range of 2 miles, 1000 feet below and flying level.

Traffic advisory (yellow filled circle) appears at 9 o'clock, range of 2 miles, 200 feet below and climbing.

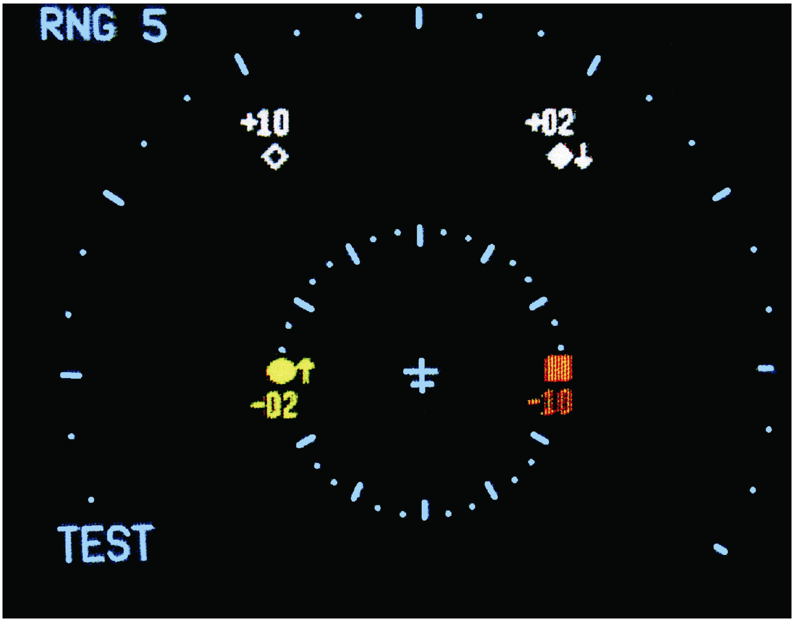
Non-threat proximity traffic (white filled diamond) appears at 11 o'clock, range of 3.6 miles, 200 feet above and descending.

Non-threat traffic (open white diamond) appears at 11 o'clock, range of 3.6 miles, 1000 feet above and flying level.

If the self-test is satisfactory "TCAS SYSTEM TEST OK" sounds.

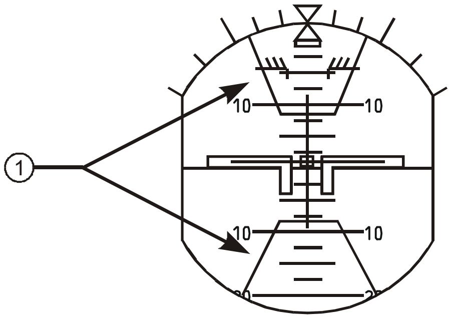
If a failure is detected, the display indicates the failed system component, and "TCAS SYSTEM TEST FAIL" sounds.

③



- A Resolution Advisory (red square) will appear at the 3 0’clock, range of two miles, 1000 feet below and flying level.
- A Traffic Advisory (yellow circle) will appear at 9 o’clock, range of two miles, 200 feet below and climbing.
- Proximity Traffic (solid white diamond) will appear at 1 o’clock, range 3.6 miles, 200 feet above and descending.
- Non-Threat Traffic (open white diamond) will appear at 11 o’clock, range of 3.6 miles flying level 1000 feet above.

3 5 7 9 TCAS Display Test Pattern



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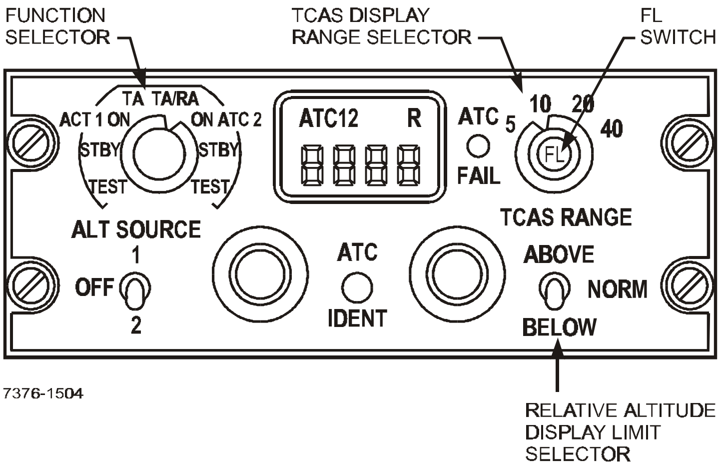
① Traffic Alert and Collision Avoidance System Pitch Command (red)

The area(s) inside the red lines indicate(s) the pitch region(s) to avoid in order to resolve the traffic conflict. The aircraft symbol must be outside the TCAS pitch command area(s) to ensure traffic avoidance.

TCAS Controls (Transponder Panel)

③



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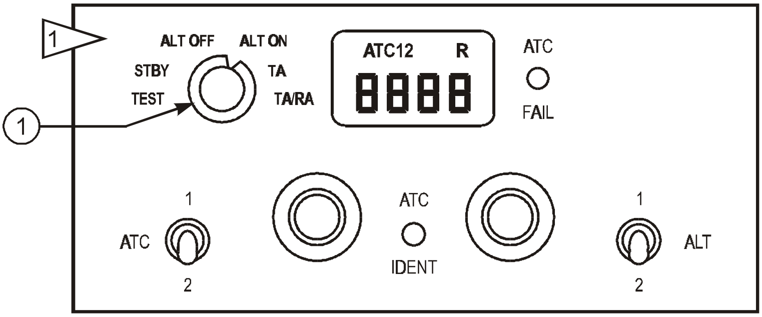

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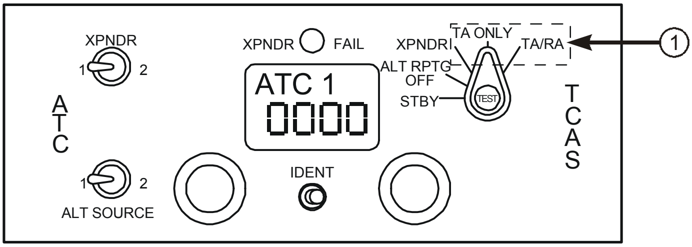


AFT ELECTRONIC PANEL

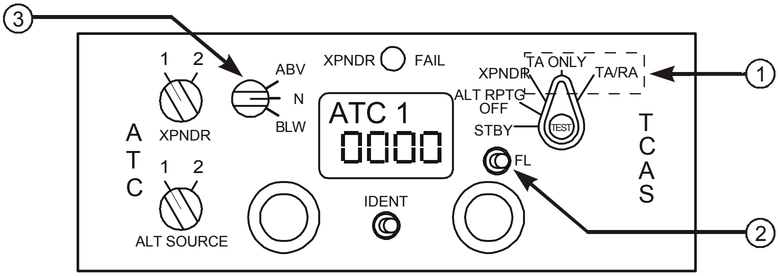
737190011

① Transponder Mode Selector

TA (traffic advisory) ONLY – Enables the display of traffic advisory (TA) targets.

TA/RA (resolution advisory) – Enables the display of traffic advisory (TA) and resolution advisory (RA) targets.

7 8 9



AFT ELECTRONIC PANEL

737190012

① Transponder Mode Selector

TA (traffic advisory) ONLY – Enables the display of traffic advisory (TA) targets.

TA/RA (resolution advisory) – Enables the display of traffic advisory (TA) and resolution advisory (RA) targets.

② Absolute Altitude Display Selector

PRESS – Displays absolute altitudes of TCAS targets while switch is pressed.

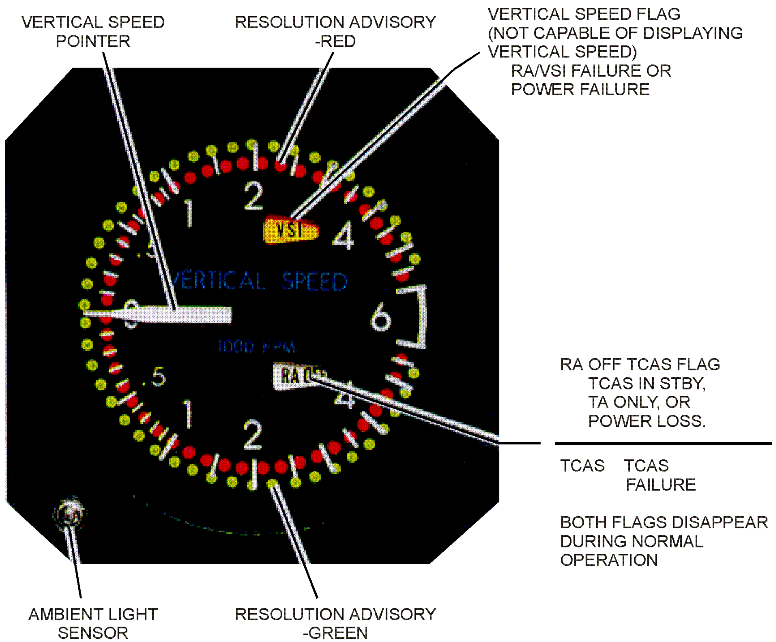
③ Altitude Range Switch

Allows shifting of TCAS coverage up and down from baseline:

- Above (**ABV**) – Sets TCAS display from 2700 feet below to 7000 feet above own aircraft
- Normal (N) – Sets TCAS display from 2700 feet below to 2700 feet above own aircraft
- Below (BLW) – Sets TCAS display from 7000 feet below to 2700 feet above own aircraft.

③ VERTICAL SPEED INDICATOR

Two electric vertical speed indicators display instantaneous vertical speed derived from the respective air data computer.



(NON-EFIS)

RESOLUTION ADVISORY AURALS AND CORRESPONDING FLIGHT RESTRICTIONS / MANEUVERS

③ 3 5

RESOLUTION ADVISORY	AURAL ALERTS	VERTICAL RESTRICTION / MANEUVER
PREVENTATIVE ADVISORY	"MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED"	Promptly and smoothly maneuver to the new vertical speed depicted.
CLIMB	"CLIMB, CLIMB"	Initiate required vertical maneuver within 5 seconds from the time the RA is posted.
DESCENT	"DESCEND, DESCEND"	Promptly and smoothly establish the descent vertical speed depicted.
VERTICAL SPEED RESTRICTED (climbing or descending)	"ADJUST VERTICAL SPEED, ADJUST"	Promptly and smoothly adjust to the new vertical speed indicated.
ANY WEAKENING OR SOFTENING OF AN RA	"ADJUST VERTICAL SPEED"	Any weakening or softening of an RA.
CROSSOVER CLIMB	" CLIMB, CROSSING CLIMB" " CLIMB, CROSSING CLIMB"	Directs a climb and informs pilot that a safe vertical separation will result in climbing through intruder's altitude.
CROSSOVER DESCENT	"DESCEND, CROSSING DESCEND" "DESCEND, CROSSING DESCEND"	Directs a descent and informs pilot that a safe vertical separation will result in descending through intruder's altitude.
PREVENTATIVE ADVISORY	"MONITOR VERTICAL SPEED"	Preventative advisory
MAINTAIN EXISTING VERTICAL SPEED	"MAINTAIN VERTICAL SPEED, MAINTAIN"	Maintain existing vertical speed.
MAINTAIN EXISTING VERTICAL SPEED WHILE CROSSING THREAT'S ALTITUDE	"MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN"	Maintain depicted vertical speed while crossing threat's altitude.

(Continued)

CHANGE FROM A DESCENT TO A CLIMB	"CLIMB – CLIMB NOW" "CLIMB – CLIMB NOW"	Initiate the change from a descent to a climb maneuver within 2.5 seconds.
CHANGE FROM A CLIMB TO A DESCENT	"DESCEND – DESCEND NOW" "DESCEND – DESCEND NOW"	Initiate the change from a climb to a descent maneuver within 2.5 seconds.
RA CLEARED	"CLEAR OF CONFLICT"	Return promptly to the previous ATC clearance.

7 8 9

AURAL ALERTS	VERTICAL RESTRICTION / MANEUVER
"MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED"	Avoid certain deviations from current vertical speed.
"CLIMB, CLIMB, CLIMB"	Climb at the pitch required.
"DESCEND, DESCEND, DESCEND"	Descend at the pitch required.
"REDUCE CLIMB, REDUCE CLIMB"	Reduce climb pitch as required.
"REDUCE DESCENT, REDUCE DESCENT"	Reduce descend pitch as required.
"CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB"	Directs a climb and informs pilot that safe vertical separation will result in climbing through intruders altitude.
"DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND"	Directs a descent and informs pilot that safe vertical separation will result in descending through intruders altitude.
"INCREASE CLIMB, INCREASE CLIMB"	Increase climb rate after an initial "CLIMB" RA is received.
"INCREASE DESCENT, INCREASE DESCENT"	Increase descent rate after an initial "DESCEND" RE is received.
"CLIMB – CLIMB NOW, CLIMB – CLIMB NOW"	Reversal maneuver after an initial "DESCEND" RA is received.
"DESCEND – DESCEND NOW, DESCEND – DESCEND NOW"	Reversal maneuver after an initial "CLIMB" RA is received.
"CLEAR OF CONFLICT"	The RA encounter is terminated.

EHSI SYMBOLOGY (TCAS)

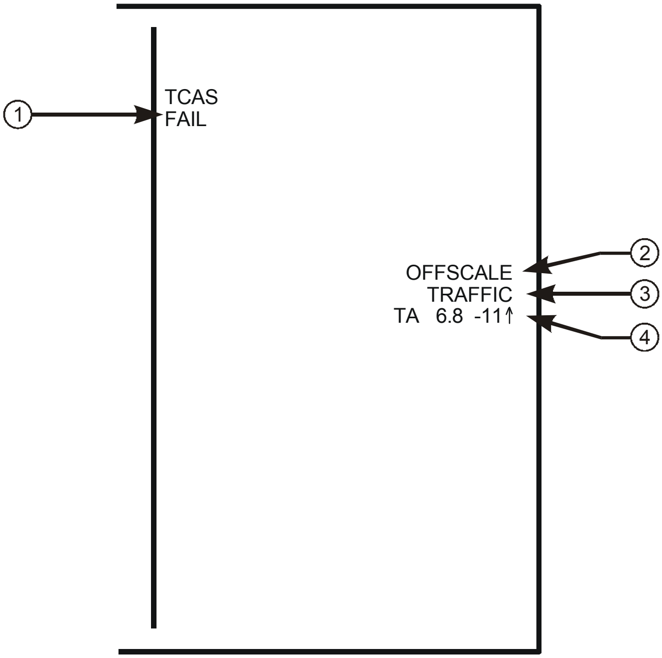
Symbol	Name	Applicable Mode(s)	Applicable Aircraft	Remarks
■	RA TRAFFIC SYMBOL (R)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	Displayed during TCAS Resolution Advisory when TFC selected on EFIS Control Panel.
		MAP, MAP CTR, VOR, APP	7 8 9	
●	TA TRAFFIC SYMBOL (A)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	Displayed during TCAS Traffic Advisory when TFC selected on EFIS Control Panel.
		MAP, MAP CTR, VOR, APP	7 8 9	
◆	PROXIMATE TRAFFIC SYMBOL (W)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	Displayed when TFC selected on EFIS Control Panel and traffic is within 1200 feet vertical and 6 miles horizontal from present position.
		MAP, MAP CTR, VOR, APP	7 8 9	
◇	OTHER TRAFFIC SYMBOL (W/ OUTLINED)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	Displayed when TFC selected on EFIS Control Panel and traffic is greater than 1200 feet vertical or 6 miles horizontal from present position.
		MAP, MAP CTR, VOR, APP	7 8 9	
+ 05 - 05	RELATIVE ALTITUDE (R,A,W)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	With TFC selected on EFIS Control Panel, displays relative traffic altitude in hundreds of feet.
		MAP, MAP CTR, VOR, APP	7 8 9	

(Continued)

Symbol	Name	Applicable Mode(s)	Applicable Aircraft	Remarks
050	ABSOLUTE ALTITUDE (R,A,W)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	With TFC selected on EFIS Control Panel, displays absolute traffic altitude (referenced to QNH or QNE). First two digits denotes thousands of feet, and third digit denotes hundreds of feet.
		MAP, MAP CTR, VOR, APP	7 8 9	
↑	VERTICAL MOTION ARROW (R,A,W)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	Displayed when traffic vertical speed is greater than 500 feet per minute and TFC selected on HSI Control Panel.
		MAP, MAP CTR, VOR, APP	7 8 9	
TA 6.8-11 RA 3.6 +04	NO BEARING DATA (Red for RA) (Amber for TA)	EXP VOR/ILS, EXP NAV, MAP, MAP CTR	3 5	Displayed when no bearing information is available. Displays distance and altitude.
		MAP, MAP CTR, VOR, APP	7 8 9	

TCAS MESSAGES

3 5 7 8 9



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① TCAS Annunciations

TFC (cyan) – **TFC** selected on the EFIS control panel in Expanded MAP, Center MAP, Expanded APP or Expanded VOR modes.

TCAS TEST (cyan) – TCAS in test mode.

TCAS FAIL (amber) – TCAS has failed.

TA ONLY (cyan) – TCAS TA only mode.

② **OFFSCALE** (red or amber)

TA (amber) or **RA** (red) is beyond the display range.

③ **TRAFFIC** (red or amber)

Displayed during a **TA** (amber) or **RA** (red) condition.

④ No Bearing Message (red or amber)

Displayed when no bearing information is available for traffic.

WARNING AND CAUTIONS SUMMARY

System	Condition	Indication
Aircraft General	Exterior Door Unlocked	Amber Light
	Cabin Door Unlocked	Amber Light
	Over Wing Door Unlocked	Amber Light
Air Conditioning and Pressurization	Auto Mode Failure	Amber Light
	Bleed Trip Off	Amber Light
	Dual Bleed	Amber Light
	Duct Overheat	Amber Light
	Off Schedule Descent	Amber Light
	Pack Trip Off / Pack	Amber Light
	Wing-Body Overheat	Amber Light
	Cabin Altitude Above 10,000 ft.	Intermittent Horn
	Equip Cooling Exhaust Fan Off	Amber Light
	Equip Cooling Supply Fan Off	Amber Light
	Zone Temp	Amber Lights
Autoflight Systems	Autopilot Disengaged	Flashing Red Lights/Intermittent Tone
	Stabilizer Out of Trim	Amber Light
	Altitude Alert	Amber Lights-Tone
	Autothrottle disengage	Flashing Red Lights
Auxiliary Power Unit	Low Oil Pressure	Amber Light
	High Oil Temperature / Fault	Amber Light
	Overspeed	Amber Light
Electrical Power	Bus Off / Source Off	Amber Light
	CSD - High Oil Temperature	Amber Light
	CSD - Low Oil Pressure	Amber Light
	Drive	Amber Light
	Standby Power Off	Amber Light
	Transfer Bus Off	Amber Light

(Continued)

System	Condition	Indication
Fire Protection	Bottle Discharge Lights	Amber Lights
	APU Detection Inoperative	Amber Lights
	APU Fire	Red Light-Steady Bell
		On Ground: Horn In Wheel Well
	Engine Fire	Red Lights - Steady Bell
	Engine Overheat	Amber Light
	Wheel Well Fire	Red Light - Steady Bell
	Fault	Amber Light
Flight Controls	Speed Brake Do Not Arm	Amber Light
	Elevator Feel Differential Pressure	Amber Light
	Mach Trim Failure	Amber Light
	Flight Control Low Pressure	Amber Light
	Takeoff Configuration Unsafe	Intermittent Horn
	LE Flaps Transit	Amber Light/s
	Speed Trim Fail	Amber Light
	Auto Slat Fail	Amber Light
	Yaw Damper	Amber Light
Flight Instruments ③	Electric Altimeter Inop	Flag
	Vertical Speed Indicator Inop	Flag
	V_{MO}/M_{MO} Speed Exceeded	Clacker
	Mach Indicator Inop	Flag
	Flight Recorder Off	Amber Light
	Standby Horizon	Flag

(Continued)

System	Condition	Indication
Flight Instruments 3 5 7 8 9	Flight Director Failure	EFIS Caution
	Attitude Display Failure	EFIS Caution
	Attitude Comparator Failure	EFIS Caution
	Decision Height Display Failure	EFIS Caution
	Radio Altitude Display Failure	EFIS Caution
	Localizer Deviation Display Failure	EFIS Caution
	Mach Number Display Failure	EFIS Caution
	Speed Display Failure	EFIS Caution
	Localizer Deviation	Flashing Pointer
	Glideslope Deviation	Flashing Pointer
	Electric Altimeter Inop	Flag
	Vertical Speed Indicator Inop	Flag
	V_{MO}/M_{MO} Speed Exceeded	Clacker
	Mach Indicator Inop	Flag
	Flight Recorder Off	Amber Light
	Standby Horizon	Flag
Fuel	Filter Bypass	Amber Light
	Pump Low Pressure	Amber Light
Hydraulic power	Pump Low Pressure	Amber Light
	Standby System Low Pressure	Amber Light
	Standby System Low Quantity	Amber Light
	Pump Overheat	Amber Light
Ice and Rain Protection	Cowl Anti-Ice	Amber Light
	Window Overheat	Amber Light
	Pitot Heat Inoperative	Amber Light
Landing Gear	Anti-Skid Inoperative	Amber Light
	Auto Brake Disarm	Amber Light
	Unsafe Landing Configuration	Red Lights / Steady Horn
	Parking Brake Set	Red Light
	Tire Burst Screen Not In Position 3	Amber Light

(Continued)

System	Condition	Indication
Navigation Equipment	Attitude Indication(s) Invalid	Flag(s) Comparator Lights
	Compass Signal(s) Invalid	Flag(s) Comparator Lights
	DME Signal(s) Invalid	Flag(s)
	FMC	Amber Light
	Radio Altimeter Failure	Flag
	VHF Navigation Signal(s) Invalid	Flag(s) Comparator Lights
	IRS Fault	Amber Light
	IRS on DC	Amber Light
	IRS on DC Fail	Amber Light
	FMC/CDU Fail	Amber Light
Power Plant	Impending Oil Filter Bypass	Amber Light
	Low Oil Pressure	Amber Light
	Reverser Door Unlocked	Amber Light
	Reverser Autostow/Asymmetric Sleeves/Valve Disagreement	Amber Light
	Start Valve Open	Amber Light
	PMC Inoperative	Amber Light
	Low Idle	Amber Light
	EEC Altn Mode	Amber Light
	7 8 9 Engine Controls	Amber Lights
Emergency Equipment	Emergency Exit Lights Not Armed	Amber Light
	Passenger Oxygen On	Amber Light
Warnings	Approaching a Stall	Stick Shaker
	Ground Proximity Below G/S	Amber Lights - Voice
	Pull Up	Red Lights - Voice Amber Light

RADIO ALTITUDE BASED ALERTS

AURAL ALERT	VISUAL ALERT	DESCRIPTION
“SINK RATE”	PULL UP on both attitude indicators.	Excessive descent rate.
“WHOOP, WHOOP, PULL UP”	PULL UP on both attitude indicators.	Follows SINK RATE alert if descent rate becomes severe.
“TERRAIN”	PULL UP on both attitude indicators.	Excessive terrain closure rate.
“PULL UP”	PULL UP on both attitude indicators.	Follows radio altitude based TERRAIN alert if excessive terrain closure rate continues and landing gear and/or flaps are not in landing configuration.
“DON’T SINK”	PULL UP on both attitude indicators.	Excessive altitude loss after takeoff or go-around.
“TOO LOW, FLAPS”	PULL UP on both attitude indicators.	Unsafe terrain clearance at low airspeed with flaps not in a normal landing position. Pushing the ground proximity flap override switch to GEAR INHIBIT inhibits the alert.
“TOO LOW, GEAR”	PULL UP on both attitude indicators.	Unsafe terrain clearance at low airspeed with landing gear not down. Pushing the ground proximity gear override switch to GEAR INHIBIT inhibits the alert.
“TOO LOW, TERRAIN”	PULL UP on both attitude indicators.	Unsafe terrain clearance at high airspeed with either landing gear not down or flaps not in landing position. Follows “DON’T SINK” if another descent is initiated after initial alert, before climbing to the altitude where the initial descent began.
“GLIDE SLOPE”	BELOW G/S P-INHIBIT lights.	Deviation below glide slope. Volume and repetition rate increase as deviation increases. Pushing the ground proximity BELOW G/S P-INHIBIT light cancels or inhibits the alert below 1000 feet RA.

LOOK AHEAD TERRAIN ALERTS

AURAL ALERT	VISUAL ALERT	DESCRIPTION
"TERRAIN, TERRAIN, PULL UP"	Pull Up on both attitude indicators. Red TERRAIN message on navigation display (all modes). Solid red terrain on navigation display.	20 to 30 seconds from projected impact with terrain shown solid red on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
"CAUTION TERRAIN"	Amber TERRAIN message on navigation display (all modes). Solid amber terrain on navigation displays.	40 to 60 seconds from projected impact with terrain shown solid amber on the navigation display (in expanded MAP< center MAP, expanded VOR, or expanded APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
"TOO LOW, TERRAIN"	PULL UP on both attitude indictors.	Descent below unsafe radio altitude while too far from any airport in the terrain database. Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.

WINDSHEAR WARNING (AIRCRAFT IN WINDSHEAR)

AURAL ALERT	VISUAL ALERT	DESCRIPTION
Two-tone siren followed by "WINDSHEAR"	Red WINDSHEAR on both attitude indicators.	Excessive windshear at the current aircraft position detected by GPWS. Enabled below 1500 feet RA. GPWS Windshear detection begins at rotation.

PREDICTIVE WINDSHEAR ALERTS

AURAL ALERT	VISUAL ALERT	DESCRIPTION
“WINDSHEAR AHEAD”	Red WINDSHEAR on both attitude indicators. RED windshear symbol on navigation display. Red Windshear message on navigation display (all modes).	Windshear close to and directly ahead of the aircraft detected by the weather radar. Enabled during takeoff, below 1200 feet RA. Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, and expanded VOR or APP modes only).
“GO AROUND, WINDSHEAR AHEAD”	Red WINDSHEAR on both attitude indicators. RED windshear symbol on navigation display. Red WINDSHEAR message on navigation display (all modes).	Windshear within 1.5 miles and directly ahead of the aircraft detected by the weather radar. Enabled during approach, below 1200 feet RA. Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, and expanded VOR or APP modes only).
“MONITOR RADAR DISPLAY”	RED windshear symbol on navigation display. Amber WINDSHEAR message on navigation display (all modes).	Windshear within 3 miles and ahead of the aircraft detected by the weather radar. Enabled during takeoff and approach, below 1200 feet RA. Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, and expanded VOR or APP modes only).

LIST OF EFFECTIVE PAGES

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* TOC-2	11/15/02	* 32	11/15/02	* LEP-2	11/15/02
		* 33	11/15/02		
* 1	11/15/02	* 34	11/15/02		
* 2	11/15/02	* 35	11/15/02		
* 3	11/15/02	* 36	11/15/02		
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* 27	11/15/02	* 60	11/15/02		
* 28	11/15/02				
* 29	11/15/02	* 61	11/15/02		
* 30	11/15/02	* 62	11/15/02		

* Asterisk indicates page(s) revised or added by the current revision.

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FUEL

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FUEL SYSTEM DESCRIPTION

GENERAL

Fuel is contained in three tanks located within the wings and wing center section. Main tanks No. 1 and No. 2 are integral with the wing structure.

③[3][5] The center tank lies between the wing roots within the fuselage area.

[7][8][9] The center tank lies between the wing roots within the fuselage area and extends out into the wing structure.

③ Approximately 15 aircraft are equipped with an auxiliary fuel tank. The additional fuel is contained in a rubber bladder cell located at the forward end of the aft cargo compartment.

Each tank is equipped with electrical fuel boost pumps, which supply fuel directly to the respective engine through the engine fuel shutoff valve or to either or both engines through the fuel crossfeed valve and engine fuel shutoff valve.

FUEL PUMPS

Each fuel tank uses two AC-powered fuel pumps, which are fuel cooled and lubricated. A single failure in the electrical system will not affect more than one pump in each tank. Individual pressure sensors monitor the output pressure of each pump.

③[3][5] All of the pumps are located in the wings. The center tank pumps siphon fuel from the center tank through a long draw line.

[7][8][9] All fuel pumps are physically located in the center tank.

CHECK VALVES

Check valves are located throughout the fuel system to ensure the proper direction of fuel flow and to prevent transfer of fuel between tanks.

③[3][5] Center tank check valves open at a lower differential pressure than the check valves in the No. 1 and No. 2 main tanks.

③ With an auxiliary fuel tank installed, auxiliary fuel pumps have a higher output pressure. This ensures that aux tank fuel is used by engine No. 1 before center tank fuel, even though the left center tank fuel pump is operating.

[7][8][9] Center tank pumps produce higher pressure than main tank pumps. This ensures that center tank fuel is used before main tank fuel, even though all fuel pumps are operating.

SUCTION FEED

The engine-driven fuel pumps will provide suction feed in the event normal electrical fuel pump operation is not available. The engine pumps draw fuel through bypass valves located in main tanks No. 1 or No. 2. No bypass valve is available in the center tank. The main tank bypass valves may also be used for suction defueling.

FUEL SHUTOFF VALVES

③ 3 5

Engine fuel shutoff valves are located at each engine-mounting wing station. The valves are DC motor-operated from the hot battery bus. They close whenever the respective fire switch is pulled or the engine start lever is placed to CUTOFF.

7 8 9

Spar fuel shutoff valves are located at the engine-mounting wing stations. The valves are DC motor-operated from the hot battery bus. The engine fuel shutoff valves are fuel actuated, solenoid controlled valves powered from the battery bus. Both the spar fuel shutoff valve and the engine fuel shutoff valve close whenever their respective engine fire warning switch is pulled or engine start lever is placed to CUTOFF.

FUEL CROSSFEED

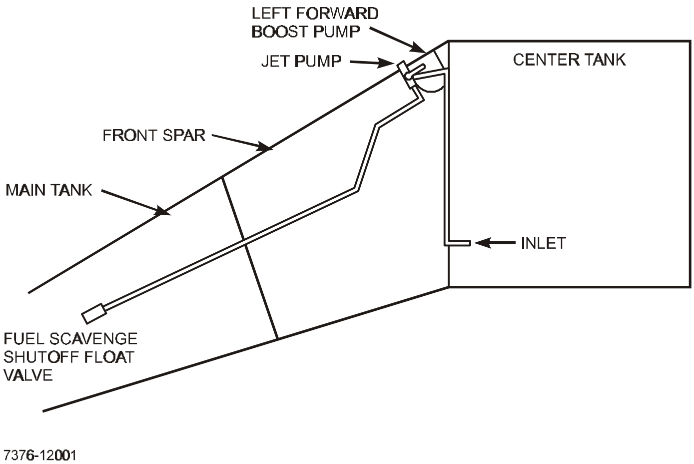
The engine fuel manifolds are interconnected by use of the crossfeed valve. The valve is DC motor-operated from the battery bus. The valve provides the means of directing fuel to both engines from any tank. Continued crossfeed use will result in a progressive fuel imbalance.

CENTER TANK SCAVENGE JET PUMP

③ 3 5 When both center tank fuel pump switches are turned OFF, the fuel scavenge shutoff valve opens. This allows fuel pressure from the main tank No. 1 forward pump to operate the center tank scavenge jet pump, which transfers a maximum of 200 pounds of fuel and/or water from the center tank fuel to main tank No. 1. After 20 minutes, the fuel scavenge shutoff valve automatically closes.

7 8 9

The center tank fuel scavenge jet pump begins to operate when the main tank No. 1 is about one-half full and the main tank No. 1 forward pump is operating. The center tank scavenge jet pump transfers remaining fuel from the center tank to main tank No. 1 at a rate of approximately 177 lb/hr (80 kg/hr), depending upon altitude. Once the fuel scavenging process starts, it continues for the remainder of the flight.



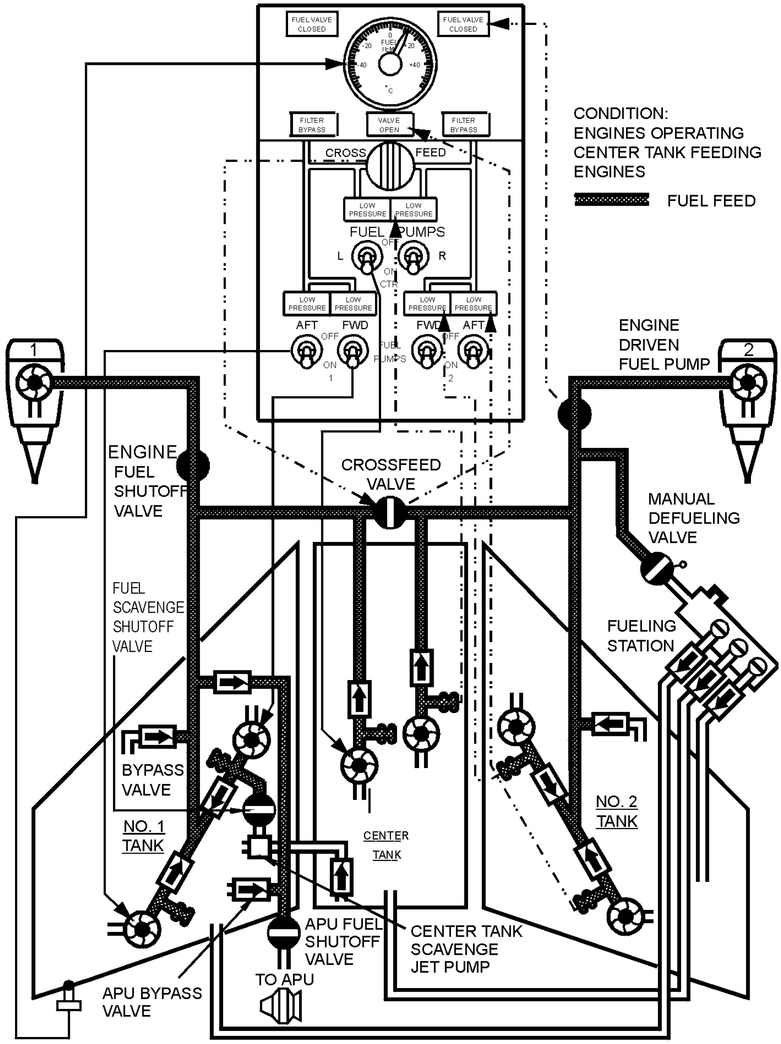
APU FUEL FEED

When AC fuel pumps are operating, fuel for the APU is normally supplied from the left fuel manifold, however, fuel can be supplied from any tank if the crossfeed valve is open. If the AC pumps are not operating, fuel is suction fed from main tank No. 1.

FUEL TEMPERATURE

A sensor is main No. 1 tank allows monitoring of fuel system temperature. The temperature indicating system uses AC electrical power.

③ 3 5 FUEL SCHEMATIC



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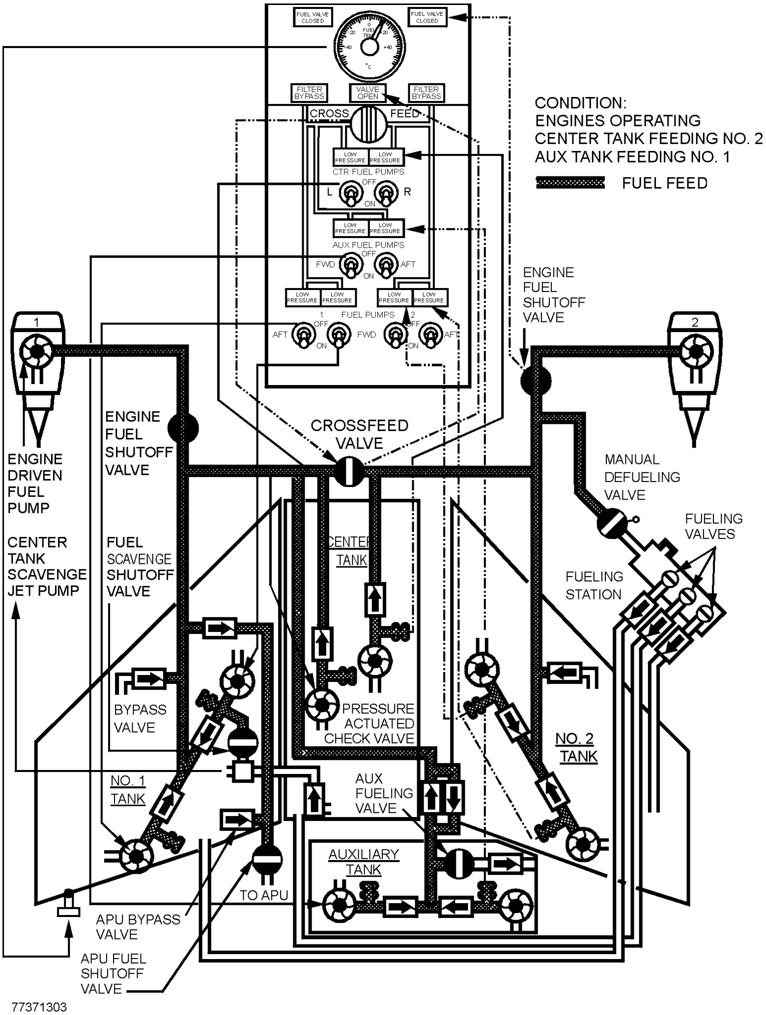
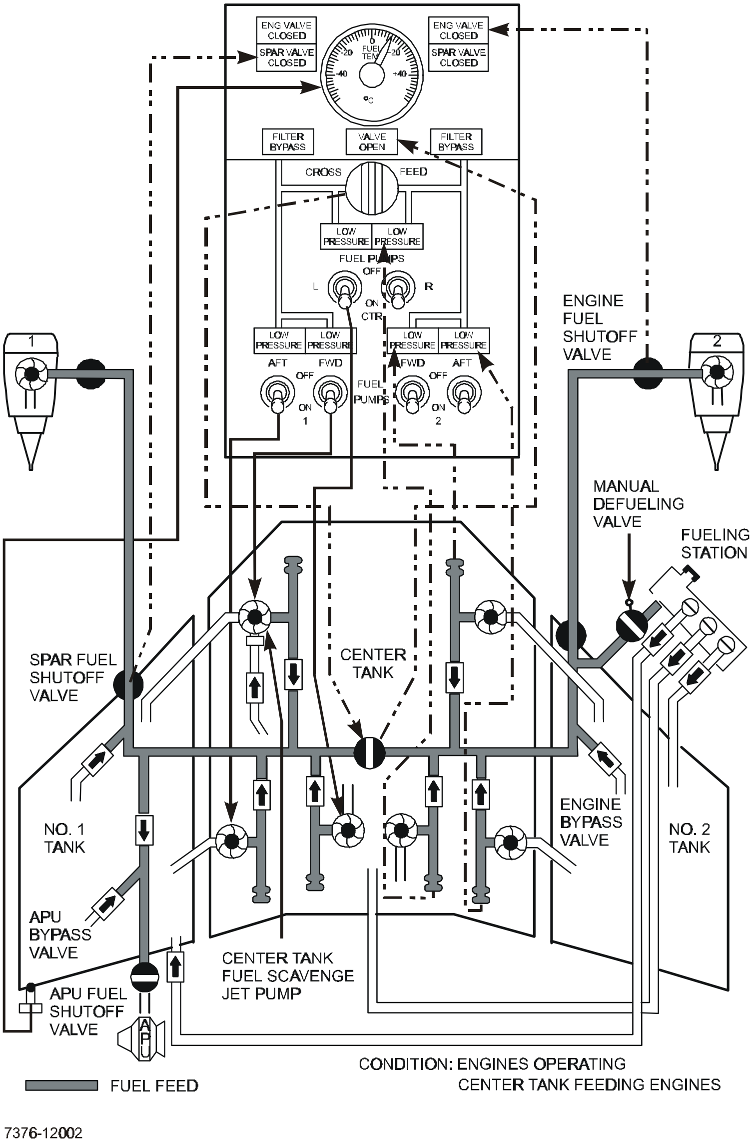
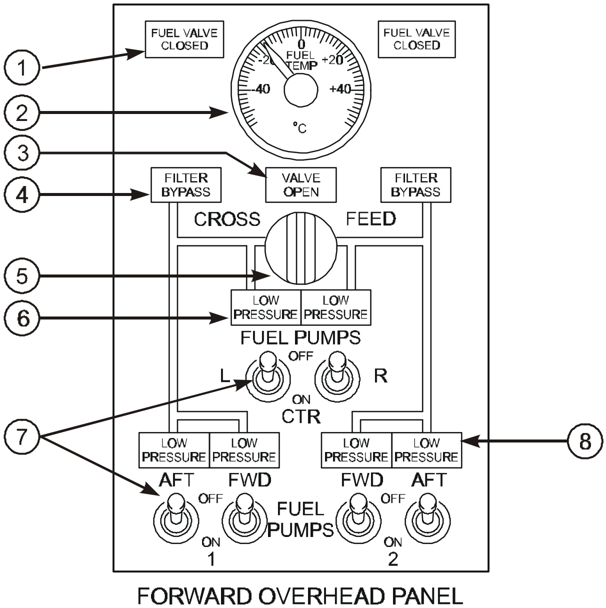
③ FUEL SCHEMATIC (Auxiliary Tank Installed)



7 8 9 FUEL SCHEMATIC



FUEL CONTROL PANEL



7376-12003

① Engine Fuel Shutoff Valve Closed (**ENG VALVE CLOSED**) Light

Extinguished – Related engine fuel shutoff valve is open.

Illuminated (blue) –

- Bright – Related engine fuel shutoff valve is in transit, or valve position and engine start lever or engine fire warning switch disagree.
- Dim – Related engine fuel shutoff valve is closed.

② FUEL Temperature (TEMP) Indicator

Indicates fuel temperature in No. 1 tank.

③ Crossfeed **VALVE OPEN** Light

Extinguished – Crossfeed valve is closed.

Illuminated (blue) –

- Bright – Crossfeed valve is in transit, or valve position and CROSSFEED selector disagree.
- Dim – Crossfeed valve is open.

④ **FILTER BYPASS** Lights

- Extinguished – Fuel filter operating normally.
- Illuminated (amber) – Impending fuel filter bypass due to a contaminated filter.

⑤ CROSSFEED Selector

- Controls fuel crossfeed valve.
- Closed – Isolates engine No. 1 and No. 2 fuel feed lines.
- Open – Connects engine No. 1 and No. 2 fuel feed lines.

⑥ Center Tank **FUEL PUMP LOW PRESSURE** Lights

Illuminated (amber) – Fuel pump output pressure is low and FUEL PUMP switch is ON.

Note: With both center (CTR) tank FUEL PUMP switches ON, illumination of both **LOW PRESSURE** lights illuminate **MASTER CAUTION** and **FUEL** system annunciator lights. Illumination of one **LOW PRESSURE** light illuminates **MASTER CAUTION** and **FUEL** system annunciator lights on **MASTER CAUTION** light recall.

Note: With one (CTR) tank FUEL PUMP switch OFF, illumination of opposite **CTR** tank **LOW PRESSURE** light illuminates the **MASTER CAUTION** and **FUEL** system annunciator lights.

Extinguished – Fuel pump output pressure is normal, or FUEL PUMP switch is OFF.

⑦ FUEL PUMP Switches

- ON – Activates fuel pump.
- OFF – Deactivates fuel pump.

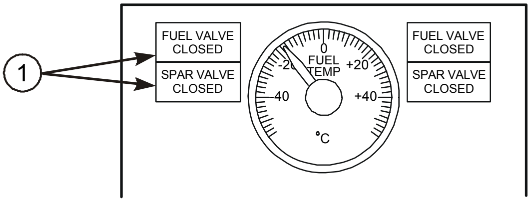
⑧ Main Tank **FUEL PUMP LOW PRESSURE** Lights

Illuminated (amber) – Fuel pump output pressure is low, or FUEL PUMP switch is OFF.

Note: Two **LOW PRESSURE** lights illuminated in same tank illuminate **MASTER CAUTION** and **FUEL** system annunciator lights. One **LOW PRESSURE** light causes **MASTER CAUTION** and **FUEL** system annunciator lights to illuminate on **MASTER CAUTION** light recall.

Extinguished – Fuel pump output pressure is normal.

7 8 9 FUEL CONTROL PANEL



7376-12004

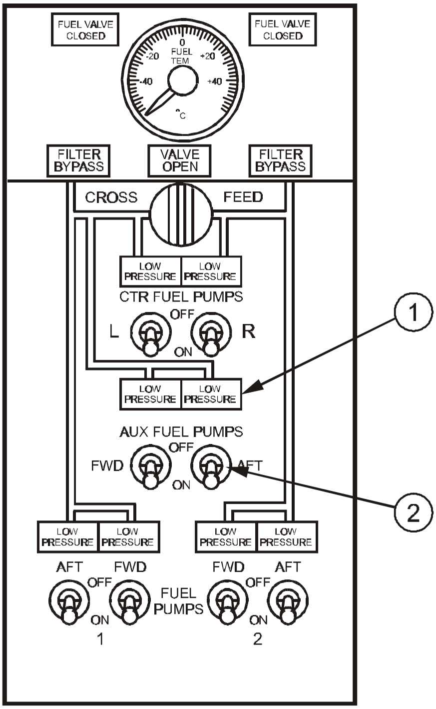
① Engine Valve Closed **ENG VALVE CLOSED** and **SPAR VALVE CLOSED** Lights

Extinguished – Related engine or spar fuel shutoff valve is open.

Illuminated (blue) –

- Bright – Related engine or spar fuel shutoff valve is in transit, or valve position and engine start lever or engine fire warning switch disagree.
- Dim – Related engine or spar fuel shutoff valve is closed.

③ FUEL CONTROL PANEL (Auxiliary Tank Installed)



FORWARD OVERHEAD PANEL

7376-12004

① **AUX TANK FUEL PUMP LOW PRESSURE** Light (amber)

Illuminated – Fuel pump output pressure is low and the Fuel Pump Switch is ON.

Extinguished – Pressure is normal, or Fuel Pump Switch is OFF.

② FUEL PUMP Switch

ON – Activates the pump.

FUEL VENT SYSTEM

The purpose of the fuel vent system is to prevent damage to wings due to excessive buildup of positive or negative pressures inside the fuel tanks, and to provide ram air pressure within the tanks. The tanks are vented into surge tanks, which vent through a single opening at each wing tip.

FUEL QUANTITY INDICATION

③ [3] [5]

The fuel quantity indication system calculates the usable fuel quantity in each tank. The fuel quantity in each tank is displayed in digital and analog format on the center instrument panel and digitally on the fueling station panel.

[7] [8] [9]

The fuel quantity indication system calculates the usable fuel quantity in each tank. The fuel quantity in each tank is displayed in digital and analog format on the upper display unit and digitally on the fueling station panel.

ELECTRICAL POWER FOR FUEL QUANTITY INDICATORS AND FUEL VALVES

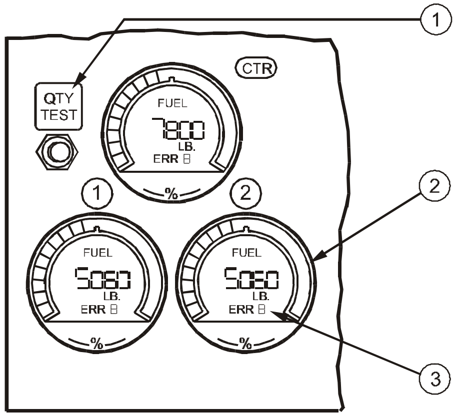
③ [3] [5] The flight deck and fueling panel indicators are powered from either AC standby bus or 115V AC external power receptacle.

The fueling panel valves receive power from either the DC ground service bus or hot battery bus.

[7] [8] [9] The flight deck indicators, illustrated on the engine display, are powered by the DC standby bus.

Power for the fueling panel indicators and fueling valves comes from the hot battery bus.

③ 3 5



CENTER INSTRUMENT PANEL

7376-12006

① Fuel Quantity Test Switch

Press – Indicator test is described in Section 3, Normals.

② Fuel Quantity Indicator

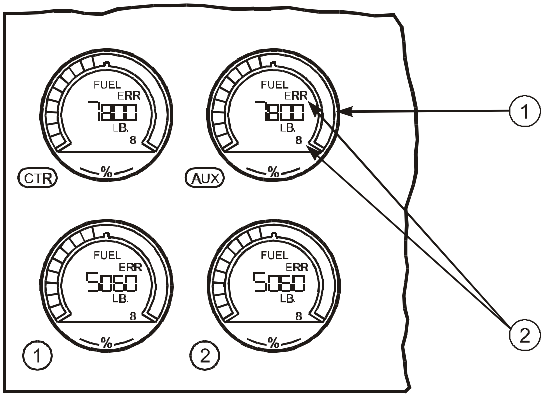
- Indicates usable fuel in the respective tank.
- Accuracy is ± 2 ½% of full scale reading.
- Standby AC power is required.

③ Fuel Gauge Error Codes

ERR – Appears with associated error codes whenever a malfunction occurs.

- Used for maintenance purposes only.

③ FUEL QUANTITY INDICATORS



CENTER INSTRUMENT PANEL

7376-12007

① Fuel Quantity Indicator

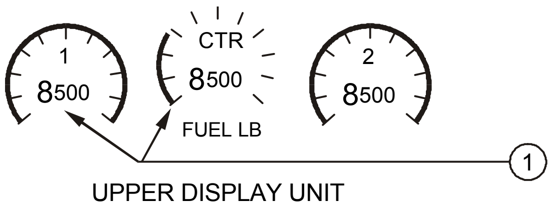
- Indicates usable fuel in the respective tank.
- Accuracy is ± 2 ½% of full scale reading.
- Standby AC power is required.

② Fuel Gauge Error Codes

ERR – Appears with associated error codes whenever a malfunction occurs.

- Used for maintenance purposes only.

7 8 9 FUEL QUANTITY INDICATORS

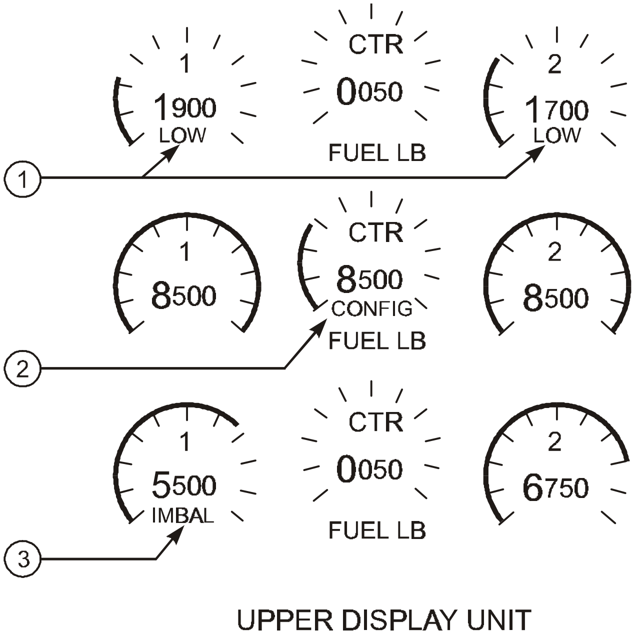


① Fuel Quantity Indicators

Illuminated (white) - Indicates usable fuel in related tank:

- Accuracy is ± 2 ½% of full scale reading.
- Standby DC power is required.

7 8 9 FUEL ALERT INDICATIONS



7379-12009

① Fuel (**LOW**) Indication

Illuminated (amber) – Fuel quantity less than 2000 lbs. in related main tank:

- Fuel quantity arc and digits on tank(s) with low fuel quantity turn amber.
- Displayed until quantity is increased to 2500 lbs.

② Fuel Configuration (**CONFIG**) Indication

Illuminated (amber) – Center tank quantity greater than 1600 lbs., both center tank pumps are producing low or no pressure and either engine is running:

- Fuel quantity arc and digits on center tank turn amber.
- When illuminated, the indications will remain amber until center tank quantity is less than 800 lbs., one center tank pump is producing high pressure or both engines are not running.

③ Fuel Imbalance (**IMBAL**) Indication

Illuminated (amber) – Main tanks differ by more than 1000 lbs.:

- Displayed below main tank with lower fuel quantity.
- Fuel quantity arc and digits on tank with lower fuel quantity turn amber.
- Inhibited when aircraft is on ground.
- Inhibited by fuel **LOW** indication when both indications exist.
- Displayed until imbalance is reduced to 200 lbs.

FUELING / DEFUELING / GROUND TRANSFER

Rapid fueling and defueling is accomplished at the single-point pressure fueling station in the right wing. The fueling station is also used for the ground transfer of fuel between tanks.

The manual defueling valve, located outboard of the No. 2 engine, interconnects the engine feed system and the fueling station. It is opened for defueling, refueling the auxiliary tank, (if installed), and for tank to tank transfer operations.

The auxiliary tank, if installed, is pressure fueled through the pressure actuated check valve in the auxiliary fuel feed line. Opening the auxiliary fueling valve allows the fuel to flow into the auxiliary tank.

A shutoff system is used during fueling to automatically close the fueling valve in each fuel tank when the tank is full.

③ 3 5 Standard overwing fueling receptacles for main tanks No. 1 and No. 2 are provided for gravity fueling.

7 8 9 No overwing fueling is provided.

③ FUEL MEASURING DRIPSTICK

Allows a comparison of fuel quantity or weight determined from the dripstick reading with the fuel weight indicated by the Fuel Quantity Indicators.

A dripstick reading is obtained by withdrawing the dripstick from the tank until a steady drip of fuel commences at the drip hole near the base.

Five fuel measuring sticks are installed in each main tank.

3 5 FUEL MEASURING STICK FLOATSTICK

Allows a comparison of fuel quantity or weight determined from the floatstick reading with the fuel weight indicated by the Fuel Quantity Indicators.

A floatstick reading is obtained by withdrawing the flexible floatstick scale from the tank until it latches magnetically to an internal float.

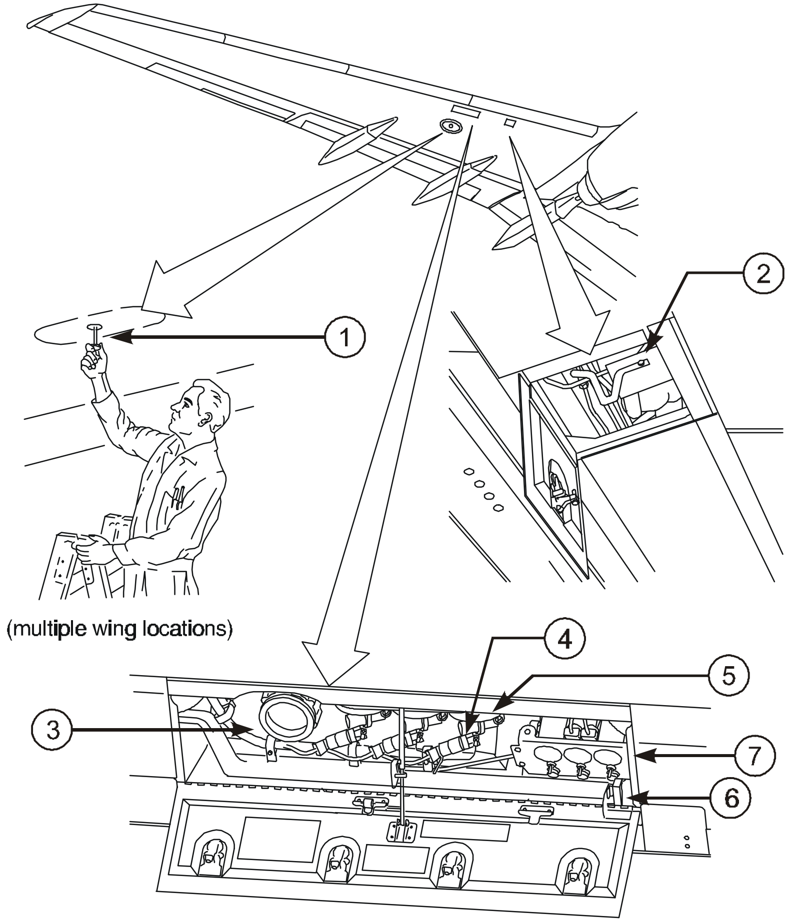
The floatstick indication is read from the floatstick scale level with the lower wing skin and corrected for aircraft attitude via conversion / correction tables.

Five fuel measuring sticks are installed in each main tank.

7 8 9 FUEL MEASURING STICK

Six fuel floatsticks are installed in each main tank and four are located in the center tank.

FUELING / DEFUELING / MEASUREMENT



RIGHT WING LEADING EDGE

① Fuel Measuring Stick

Allows comparison of fuel quantity or weight as determined from measuring stick reading and fuel weight indicated by fuel quantity indicators.

② Manual Defueling Valve

Open – Interconnects engine feed system and fueling station for:

- Defueling
- Ground transfer of fuel.

Closed – Isolates engine feed system from fueling station.

③ Fueling Receptacle

Hose connection receptacle for single point fueling.

④ Solenoid Override

Mechanically opens solenoid operated valve. Fuel valve opens if fuel pressure is available.

⑤ Fueling Valves

With the battery switch ON, and the refueling door open, fuel pressure opens valve.

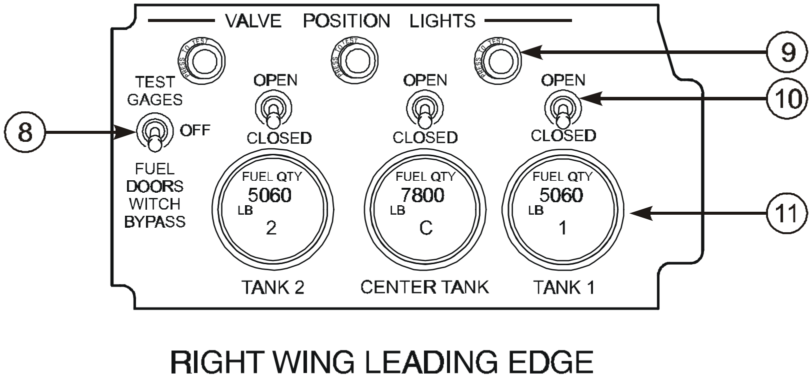
⑥ Refueling Power Control Relay

Door closed – Proximity sensor deactivates power to fueling system.

Door open – The fueling system is powered and panel lights illuminate.

⑦ Test Gages & Fueling Panel

TEST GAGES AND FUELING PANEL



7376-12011

⑧ Fueling Indication Test Switch

(Spring-loaded to OFF position)

TEST GAGES – Checks operation of fuel quantity indicators.

FUEL DOOR SWITCH BYPASS – Energizes fueling panel if refueling power control relay fails.

⑨ Fueling **VALVE POSITION LIGHTS**

Extinguished:

- Fueling valve switch is OPEN and related tank is full.
- Fueling valve switch is CLOSED.

Illuminated (blue) – Fueling valve switch is OPEN and related tank is not full.

⑩ Fueling Valve Switches

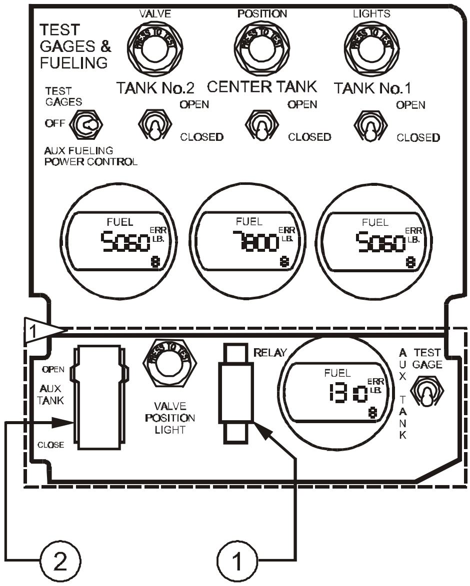
OPEN – Energizes fueling valve in related tank.

CLOSED – De-energizes fueling valve in related tank.

⑪ **FUEL** Quantity (**QTY**) Indicators

Indicates total usable fuel tank quantity in related tank.

③



7376-12012

① Aux Fueling Power Control

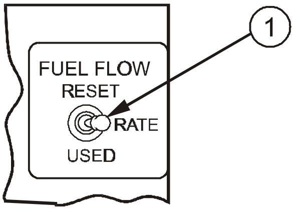
- Energizes the fueling system if the fueling power control switch fails to activate the system when the door is open.

② Aux Tank Fueling Valve Switch (Non-EFIS)

- Controls refueling of the aft body auxiliary tank.
- The crossfeed valve opens. (The crossfeed selector is overridden.)

FUEL FLOW / FUEL USED

③ 3 5



7376-12013

① FUEL FLOW Switch

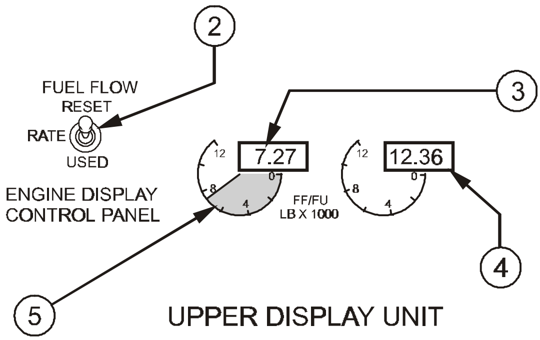
(Spring-loaded to the RATE position)

RESET – Resets the fuel used display on both fuel flow indicators to zero.

RATE – The digital display on both fuel flow indicators shows rate of fuel consumption.

USED – The digital display on both fuel flow indicators shows total fuel consumed per engine since last reset.

7 8 9



7376-12014

② FUEL FLOW Switch (Spring loaded to RATE)

RATE – Displays fuel flow to engine.

USED –

- Displays fuel used since last reset.
- After 10 seconds, display automatically reverts to fuel flow.

Note: If switch is activated longer than 30 seconds, fuel used readout is deactivated for remainder of flight.

RESET –

- Resets fuel used to zero.
- Displays fuel used for 1 second, decreases to zero, then displays fuel flow.

③ Fuel Flow Readout

Illuminated (white) – Displays fuel flow to engine with FUEL FLOW switch in RATE position (pound per hour x 1000).

④ Fuel Used Readout

Illuminated (white) – Displayed by activating FUEL FLOW switch to USED or RESET position.

USED – Displays fuel used since last reset. After 10 seconds, display automatically reverts to fuel flow.

RESET – Displays fuel used for 1 second, decreases to zero, then displays fuel flow.

⑤ Fuel Flow Dial / Index Marker & Digits

Illuminated (white) – Displays fuel flow to engine with FUEL FLOW switch in RATE position (pound per hour x 1000).

- Pointer and shading removed when FUEL FLOW switch positioned to USED or RESET.

③ 3 5 TANK CAPACITY – USABLE FUEL

TANK	U.S. GALLONS	WEIGHT LBS.
NO. 1 NO. 2	1,499 1,499	10,118 LBS. 10,118 LBS.
CENTER TANK	2,313	15,613 LBS.
TOTAL	5,311	35,849 LBS.

③ AUXILIARY TANK INSTALLED

AUXILIARY TANK	390	2,632 LBS.
TOTAL	5,701	38,481 LBS.

The above figures are approximate amounts of fuel. The Fueling Manual gives exact figures for all configurations.

- Fuel density used – 6.75 lb. / U.S. gallon.
- Conversion factors – U.S. gallons x fuel density = pounds.

7 8 TANK CAPACITY – USABLE FUEL

TANK	U.S. GALLONS	WEIGHT LBS.
NO. 1 NO. 2	1,263 1,263	8,525 LBS. 8,525 LBS.
CENTER TANK	4,181	28,222 LBS.
TOTAL	6,707	45,272 LBS.

9 TANK CAPACITY – USABLE FUEL

TANK	U.S. GALLONS	POUNDS *
NO. 1	1,288	8,630
NO. 2	1,288	8,630
CENTER	4,299	28,803
TOTAL	6,875	46,063

* Usable fuel at level attitude, fuel density = 6.7 pounds per U.S. Gallon

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/15/02				
* TOC-2	11/15/02				
* 1	11/15/02				
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* Asterisk indicates page(s) revised or added by the current revision.

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FLIGHT MANAGEMENT, NAVIGATION

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FLIGHT MANAGEMENT SYSTEM DESCRIPTION

INTRODUCTION

The Flight Management System (FMS) aids the flight crew in managing automatic navigation, in-flight performance optimization, fuel monitoring, and flight deck displays. Automatic flight functions manage the aircraft lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for aircraft orientation and command markers (bugs) (as installed) on the airspeed and N1 indicators to assist in flying efficient profiles.

The flight crew enters the desired route and flight data into the CDUs. The FMS uses its navigation database, aircraft position and supporting system data to calculate commands for manual or automatic flight path control.

The FMS can automatically tune the navigation radios for accuracy updating and determine LNAV courses. The FMS navigation database provides the necessary data to fly routes, SIDs, STARs, instrument approaches, holding patterns, and procedure turns. Lateral offsets from the programmed route can be calculated and commanded.

Vertical navigation computations include fuel burn data, optimum speeds, and recommended altitudes. Cruise altitudes and crossing altitude constraints are used to compute VNAV commands.

FLIGHT MANAGEMENT COMPUTER (FMC)

The basis of the flight management system is the flight management computer. The FMC uses flight crew-entered flight plan information, aircraft systems data, and data from the FMC navigation database to calculate aircraft present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to the display units of symbol generators (as installed). The EFIS control panels are used to select the desired information for the navigation displays. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes.

③ The HSI switch is used to select the desired information for the HSI display.

The FMC and CDU are used for enroute and terminal area navigation and to supplement primary means navigation when conducting other types of non-precision approaches with a single FMC configuration.

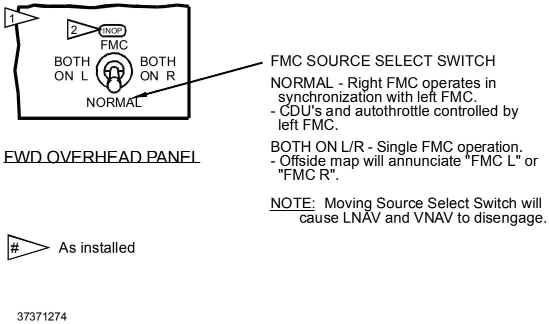
The dual FMC installation (as installed) is certified as a “sole source” navigation system. Aircraft equipped with two FMCs are certified to operate outsidem ground-based navaid coverage for extended range operation. The second FMC serves as a backup and comparison platform.

Dual FMC operation is controlled by the FMC source select switch on the overhead panel. With the switch in the NORMAL position, both CDUs are controlled by the left FMC, however navigation displays and autopilot operation are coordinated on respective sides (e.g. left FMC / left navigation display / autopilot A). This represents the standard operating configuration. Selecting BOTH ON L or BOTH ON R isolates FMC operation to use of only left or right FMC.

When external position updating is not available, the FMC uses the IRS position as reference. When the IRS is the only position reference, the FMC applies an automatic correction to the IRS position to determine the most probable FMC position. This correction factor is developed by the FMC’s monitoring IRS performance during periods of normal position updating to determine the typical IRS error value. When external position updating is not available, navigation accuracy may be less than required. Flight crews should closely monitor FMC navigation, and Actual vs. RNP especially when approaching the destination.

Inaccurate position updating may cause the aircraft to deviate from the desired track.

3 5 7 8 9 FMC Source Select Switch



Control Display Units (CDUs)

Two independent CDUs provide the means to communicate with the FMC. The crew may enter data into the FMC using either CDU; however, simultaneous entries may cause errors and should be avoided. The same FMC data and computations are available on both CDUs; but each pilot has control over what is displayed on an individual CDU.

FLIGHT MANAGEMENT SYSTEM OPERATION

Introduction

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically transitions to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

Preflight

During preflight, flight plan and Accuload information are entered into the CDU. The flight plan defines the route of flight from origin to destination and initializes LNAV. Flight plan and Accuload information provides performance information to initialize VNAV.

Required preflight information consists of:

- initial position
- route of flight
- performance data
- takeoff data.

Optional preflight data includes:

- navigation database
- SID
- STAR
- RTA data
- cruise wind
- reduced takeoff and climb thrust limits.

Each required or optional data item is entered on specific preflight pages.

Preflight begins with the IDENT page. If the IDENT page is not displayed, it can be selected from the **IDENT** prompt on the INIT/REF INDEX page. Visual prompts provide assistance in selecting appropriate CDU pages. Preflight pages can be manually selected in any order.

After entering and checking necessary data on each preflight page, the lower right line select key is pushed to select the next page. When ACTIVATE is selected on the RTE page, the execute light illuminates. The EXEC key is then pushed to complete the task of making the route active before continuing with the preflight.

If a standard instrument departure (SID) is required the departure / arrival (DEP/ARR) page is selected. After selecting the desired SID, the resulting modification must be appropriately linked to the existing route and executed. This can be accomplished on the RTE or RTE LEGS page.

When all required preflight entries are complete, the preflight status prompts on the TAKEOFF REF page are no longer displayed.

Takeoff

The takeoff phase begins with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected.

Climb

The climb phase begins at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the aircraft reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase begins at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase begins at the T/D point or when either a level change or vertical speed descent is initiated. The descent phase extends to the beginning of the approach phase.

Approach

The approach phase begins two miles from the first waypoint of a published approach or approach transition selected from the ARRIVALS page.

Flight Complete

After landing, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

FMC And CDU Terminology

The following paragraphs describe FMC and CDU terminology.

Active – Flight plan information currently being used to calculate LNAV or VNAV guidance commands.

Activate – Designating an entered route as the active route for navigation. It is a two step process:

- Push the **ACTIVATE** prompt
- Push the execute (EXEC) key.

Altitude Restriction – A crossing restriction at a waypoint.

Delete – Remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

Econ – A speed schedule calculated to minimize operating cost. The economy speed is based on the flight crew CDU-entered cost index. A low cost index reflects high fuel costs and results in a lower cruise speed.

Enter – Placing an entry into the CDU scratchpad and then line selecting the information to the desired location. New characters can be typed, or existing data can be line selected into the scratchpad.

Erase – Removing flight crew-entered information, which has resulted in a modification, by pushing the **ERASE** prompt.

Execute – Making modified information part of the active flight plan by pushing the EXEC key.

Inactive – Route, climb, cruise, or descent information not currently being used to calculate LNAV or VNAV commands.

Initialize – Entering information required to make the system operational.

Message – Information the FMC automatically writes in the scratchpad to inform the flight crew of a system condition.

Modify – Active data that is changed but not yet executed. When a modification is made to the active route or performance mode, **MOD** is displayed in the page title, **ERASE** appears next to line select key 6 left, and the execute key illuminates.

Prompt – CDU displays that aid the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a careted (< or >) line to remind the flight crew to enter or validate information.

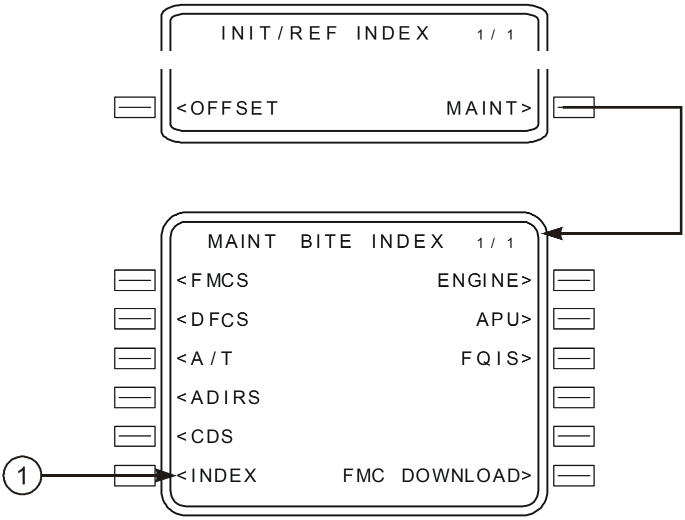
Select – Pushing a key to obtain the desired information or action, or to copy selected data to the scratchpad.

Speed Restriction – An airspeed limit associated with a specified altitude or waypoint.

Waypoint – A point on the route. It can be a fixed point such as a latitude and longitude, VOR or ADF station, airway intersection, or a non-fixed point such as a conditional waypoint. A conditional waypoint is not necessarily associated with a land reference; it reflects a time position, or altitude requirement. An example of a conditional waypoint is “when reaching 1000 feet.”

Maintenance Index Page

The MAINT BITE INDEX page is available only on the ground and provides access to data normally used by maintenance personnel.



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① Displays the INIT/REF INDEX page.

Navigation Position

The FMC determines present position from the IRS, GPS (as installed), and navigation radios. The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint.

FMC Position Update

On the ground, the FMC calculates present position based on GPS or IRS (as installed) data. If GPS data is not available, the FMC calculates present position based on IRS data. Radio updating is inhibited until airborne.

③ The FMC updates position to the takeoff runway threshold after line selection of the FMC POS UPD RW XXX followed by execution. Depressing TO/GA on this series of B737 will not update aircraft position.

3 5 The FMC updates position to the takeoff runway threshold when a TO/GA switch is pushed. When making an intersection takeoff, the intersection data must be entered on the TAKEOFF REF page.

7 8 9

If GPS UPDATE is OFF (as installed), the FMC updates position to the takeoff runway threshold when a TO/GA switch is pushed. When making an intersection takeoff, the intersection data must be entered on the TAKEOFF REF page. If GPS UPDATE is ON, the TO/GA update is inhibited. G PS UPDATE is on the NAV OPTIONS page.

In flight, the FMC position is continually updated from the GPS (as installed), navigation radios, and IRS. Updating priority is based on the availability of valid data from the supporting systems.

FMC position updates from navigation sensor positions are used in the following priority order:

- GPS (as installed)
- Two or more DME stations
- One VOR with a collocated DME
- One localizer and collocated DME
- One localizer.

The station identifiers and frequencies of the selected radio navigation aids are displayed on the NAV STATUS page 1/2.

FMC logic selects the GPS position (as installed) as the primary update to the FMC position. If all GPS data becomes unavailable, the FMC reverts to radio updating or reference to IRS position.

The navigation radios are automatically tuned by the FMC(s) for the purpose of radio updating (in AUTO, if applicable). The stations to be tuned are selected based upon the best available signals (in terms of geometry and strength) for updating the FMC position, unless a specific station is required by the flight plan. Radio position usually is determined by the intersection of two DME arcs.

If the DME radios fail, or if suitable DME stations are not available, FMC navigation is based on IRS position information only. The two VHF Nav radios are used by the FMC for updating from the localized during an ILS approach and by the crew for navigation monitoring, if necessary.

The FMC is designed to automatically reject unreliable navaid data during FMC position updating. However, in certain conditions, navaids, which are in error may satisfy the reasonableness criteria and provide the FMC with an inaccurate radio position. One of the most vulnerable times is when an erroneous radio position update occurs just after takeoff. This is usually manifested in an abrupt heading correction after engaging LNAV. The position shift can be seen on the map, which shifts the desired track and runway symbol to a position significantly different from that displayed during ground roll.

If either of these indications, occurs the FMC should be carefully monitored.

When adequate radio updating is not available, navigation display map mode may display a shift error. This error results in the displayed position of the aircraft, route, waypoints, and navigation aids shifted from their actual positions.

An across track, undetected map shift may result in the aircraft flying a ground track that is offset from the desired track. An along track, undetected map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the aircraft on the navigation display map mode with data from the ILS, VOR, and DME systems.

Map shift errors may be anticipated by noting an increasing actual (ANP) value as the aircraft enters areas of infrequent radio updating.

Navigation Performance

The FMC uses data from the navigation systems to accurately calculate the position of the aircraft. The current FMC position is shown on line 1 of the POS REF page 2/3.

The FMC position is derived from a mathematical combination of the positions determined by the IRS, radio, and GPS systems. It represents the FMC's estimate of the actual position of the aircraft. Its accuracy depends upon the accuracy of the position determining systems.

Actual Navigation Performance (ANP)

Actual Navigation Performance (ANP) is the FMC's estimate of the quality of its position determination. It is shown on POS SHIFT page 3/3 and on RTE LEGS pages as actual. It is expressed in terms of nautical miles and represents the radius of a circle centered around the computed FMC position where the probability of the actual aircraft position being inside the circle is 95%. The lower the ANP value, the more confident the FMC is of its position estimate.

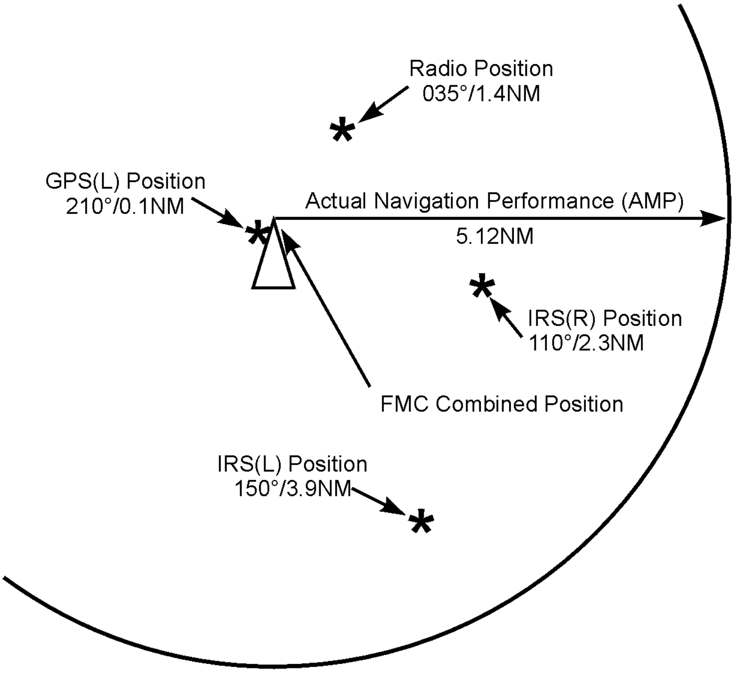
Required Navigation Performance (RNP)

The FMC supplies a default required navigation performance (RNP) value for takeoff, en route, oceanic, terminal, and approach phases of flight. RNP can also be supplied by the navigation database or may be entered by the crew. When relying upon the FMC for navigation, ANP should not exceed RNP.

If ANP exceeds RNP value, the message **UNABLE REQD NAV PERF-RNP** appears.

RNP/ACTUAL is shown on POS SHIFT page 3/3 and on RTE LEGS pages.

Actual Navigation Performance



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Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint. If selected, LNAV engages when laterally within 3 nautical miles of the active route leg. If outside of 3 nautical miles of the active route leg, LNAV engages if on an intercept heading of 90 degrees or less and the intercept occurs before the active waypoint. FMC LNAV guidance normally provides great circle courses between waypoints. However, when an arrival or approach from the FMC database is entered into the active route, the FMC can supply commands to fly a constant heading, track, or follow an arc, as required by the procedure.

Waypoints

Waypoint (navigation fix) identifiers are displayed on the CDU and navigation display.

The CDU message **NOT IN DATABASE** is displayed if a manually entered waypoint identifier is not stored in the database. The waypoint can still be entered as a latitude / longitude, place-bearing / distance or place-bearing / place-bearing waypoint.

FMC-generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoint Names

VHF – Waypoints located at VHF navaids (VOR/DME/LOC) are identified by the official one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC - LAX
- Tyndall TACAN - PAM
- Riga, Latvia - RIX.

NDB – Waypoints located at NDBs are identified by use of the station identifier. Example:

- Fort Nelson, CAN - YE.

Fix Waypoint Names

Fixes with one-word names – Waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Names with more than five characters are abbreviated using the following rules sequentially until five characters remain. Double letters are deleted. Examples:

- KIMMEL becomes KIMEL
- COTTON becomes COTON
- RABBITT becomes RABIT.

Duplicate Waypoint Names

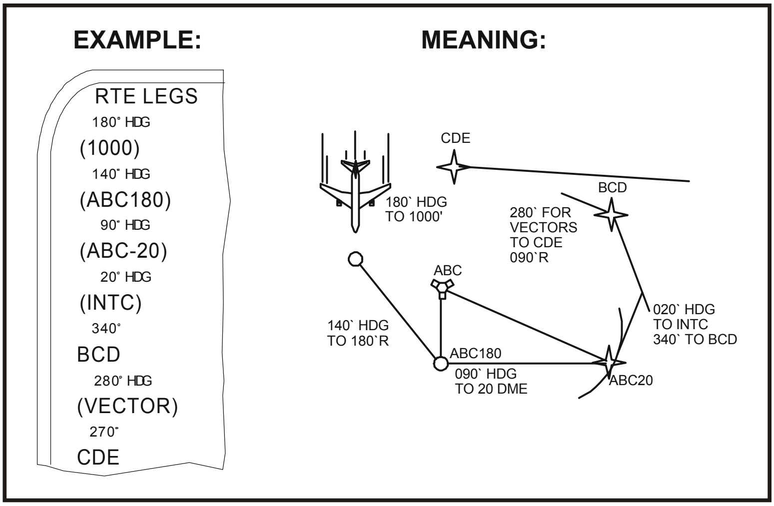
Duplicate Identifiers – Should application of these rules result in more than one waypoint having the same identifier, then a CDU page change occurs when an attempt is made to enter the duplicated identifier. The page title is SELECT DESIRED WPT. The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Selecting the latitude / longitude of the desired waypoint enters the correct waypoint on the original page.

Conditional Waypoint Names

Conditional waypoints are automatically entered into a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Conditional waypoints cannot be manually entered on a ROUTE or LEGS page. These waypoints are events when a condition occurs and are not at a geographically-fixed position. The types of conditions are:

- Passing through an altitude
- Flying a heading to a radial or DME distance
- Intercepting a course
- Heading vector to a course or fix.

Altitude and course intercept conditional waypoints are displayed on the CDU inside (parenthesis) marks. The following diagram depicts conditional waypoints.



NOTE: All way points except BCD and CDE are examples of conditional waypoints.

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When (VECTOR) is the active leg and LNAV is not engaged, the FMC automatically sequence to the next waypoint when within 3 NM of the next leg. If (VECTOR) is the active waypoint and LNAV is engaged, the FMC does not automatically sequence to the next waypoint. The next waypoint becomes active only upon EXECution of the procedures for proceeding direct to a waypoint or intercepting a leg to a waypoint.

Manually Entered Latitude / Longitude Waypoint Names

Pilot defined waypoints entered as a latitude and longitude are displayed in a five-character format. The first three characters are WPT followed by a two-digit sequence number. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude is full degrees. Examples:

- N47° W008° is entered as N47W008 and displayed as WPT01
- N47° 15.4’ W008° 3.4’ is entered as N4715.4W00803.4 and displayed as WPT02.

Manually Entered Place-Bearing / Distance or Place-Bearing / Place-Bearing Waypoint Names

Waypoints entered as a place-bearing / istance or place-bearing / place-bearing are identified by the first three characters of the entry followed by a two-digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

Manually Entered Along-Track Waypoint Names

Along-track waypoints are a special case of place-bearing / distance waypoints applied to the current route. When a waypoint is desired on the route where none exists, the along-track waypoint feature creates the desired waypoint without creating a route discontinuity.

Along-track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The route course takes the place of the bearing, which is not entered. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route, and is displayed as VAM01
- ELN/–30 is 30 miles before ELN on the present route, and is displayed as ELN01.

Latitude and longitude waypoints cannot be used to create along-track waypoints.

Navigation Displays

The route is displayed on the navigation display in the map, map center, and plan modes. The display color and format represent the following status:

- An inactive route is displayed as a cyan dashed line
- An activated but not yet executed route is displayed as a cyan dashed line
- The active route is displayed in magenta
- Modifications to an active route are displayed as dashed white lines
- Modified waypoints are displayed in white
- Executed route offsets are displayed as a dashed magenta line.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed / Altitude Constraints

VNAV controls the path and speed to comply with waypoint crossing constraints. Waypoint crossing constraints are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Altitude restrictions must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered constraints are shown in large font. FMC predicted values do not act as constraints, and are shown in small font.

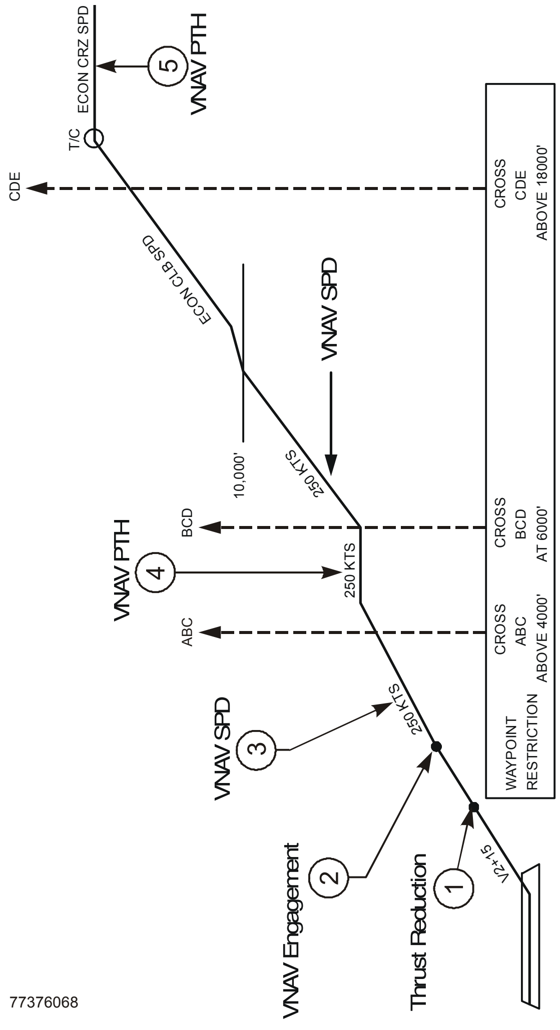
Waypoints can have altitude, airspeed or both airspeed / altitude constraints.

All speed constraints are considered by the FMC as at or below constraints.

At or above altitude constraints are entered with a suffix letter A (example: 220A). At or below altitude constraints are entered with a suffix letter B (example: 240B). Mandatory altitude constraints are entered without any suffix letter (example: 270).

Altitude constraints that are between two altitudes are displayed with the lower limit first, followed by a suffix letter A, then the upper limit, followed by a suffix letter B (example: 220A240B).

Takeoff and Climb



① Thrust Reduction

Climb thrust is selected by pushing the N1 switch at 1000 feet AGL or automatically upon reaching the thrust reduction altitude.

② VNAV Engagement

VNAV commands an airspeed increase to the planned climb speed profile, limited by configuration.

③ VNAV Climb

The VNAV climb profile uses VNAV SPD at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

Selection of ENG OUT on the CLB page provides the crew with advisory engine out performance information.

If the climb speed profile cannot achieve an altitude constraint, the **UNABLE NEXT ALTITUDE** scratchpad message is shown.

④ Climb Restrictions

VNAV enters the VNAV PTH mode to remain within departure or waypoint restrictions. Speed maintained during this time can be:

- Procedure based speed restriction
- Waypoint speed constraint
- Default VNAV climb speed
- Manually entered climb speed.

⑤ Top Of Climb (T/C)

The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from the climb phase to the cruise phase. The T/C is shown any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is shown on the map as a green open circle with the label T/C.

Cruise

At cruise altitude, the FMC sets cruise speed at the default or pilot entered speed until reaching the top-of-descent (T/D) point. Alternate cruise speed options are:

- Long range (LRC)
- Flight crew entered speed.

Cruise thrust is set as required to maintain level flight at the target speed, with the autothrottle engaged. The FMC uses maximum range cruise speed if cost index is set to zero.

Fuel and ETA predictions are based on a constant altitude cruise unless a step climb altitude is entered.

Step Climb

If a step climb altitude is entered in the CRZ page STEP altitude, the FMC calculates the point where the step climb should begin.

The distance and ETA to the next step point are shown on the CRZ and PROGRESS pages. The next step point is shown on the map as a green open circle with the label **S/C**.

Descent

VNAV can perform a descent in either of two modes - path descent or speed descent. During a path descent, the FMC uses idle thrust and pitch control to maintain a vertical path, similar to a glideslope in three dimensions. During a speed descent, the FMC uses idle thrust and pitch control to maintain a target descent speed, similar to a level change descent.

Top Of Descent (T/D)

The point where the cruise phase changes to the descent phase is the top of descent. The T/D point is shown on the map as a green open circle with the label **T/D**. T/D is calculated from an end of descent (E/D) point.

Intermediate T/D points show on the map as green open circles with the label **T/D–XXXXX** (altitude). Intermediate T/D points exist when path segments between altitude restricted waypoints produce a level path segment. The intermediate T/D point shows where the descent will resume.

End of Descent (E/D)

The FMC calculates a descent path based on airspeed restrictions, altitude restrictions and the end of descent (E/D) point. The E/D point is shown on the map as a green open circle with the label E/D. The E/D is the last of the following, which is not preceded by a lateral discontinuity:

- The runway threshold for approaches with a runway waypoint on the RTE LEGS page, or
- The missed approach point for approaches not showing a runway waypoint on the RTE LEGS page, or
- The lowest "at" altitude restriction if no arrival procedure is entered.

Entering an instrument arrival procedure provides an E/D point.

If there is no E/D point, FMC predictions assume a computed profile to 1000 feet above the destination field elevation at a position, which varies according to selection of arrival procedures. The FMC provides a slowdown profile for approach. VNAV path descent is not available if there is no E/D point.

VNAV Descent and Approach Path

The descent path starts at the calculated top of descent (T/D) point and includes waypoint altitude restrictions. The path is based on:

- Idle thrust
- Speedbrakes retracted
- Descent wind speed decreasing with decreasing altitude
- Applicable target speed.

When passing top of descent following high speed cruise operation (within approximately 6 knots of Vmo/Mmo, cost index of 100 or higher), VNAV may revert to LVL CHG to prevent overspeed. Reduce airspeed to the VNAV target descent speed prior to reengaging VNAV.

When descending in VNAV PTH, the FCC will disengage VNAV and switch to LVL CHG if actual speed becomes equal to or slightly less than the minimum speed, denoted by the underspeed limiting symbol in the MCP IAS/Mach window. This can also happen in turbulence or gusty conditions when the minimum speed may momentarily increase due to G loading.

After the first "at" or "at or below" restriction, the path angle is level until intercepting the idle thrust descent path to the next altitude constrained waypoint.

Normally, the target speed is economy speed above the airspeed restriction altitude and 240 knots below that altitude, until deceleration for approach. VNAV does not permit descent below the airspeed restriction altitude until the airspeed is at or below the restricted value plus ten knots. The start and end of the airport speed restriction deceleration segment is shown on the map as green open circles with no labels.

The descent path assumes deceleration to reach the final approach fix (FAF), or the glideslope intercept point at VREF 40+20 knots.

Target speeds are changed by entries on the LEGS or DESCENT pages. Wind and thrust assumptions are changed on the DES FORECASTS page.

Deceleration points show on the map as green open circles with the label **DECEL**. Deceleration points show prior to:

- Airspeed constrained waypoints
- Holding patterns
- Approach flap extension.

If more than one deceleration segment exists in the flight plan, only the next deceleration point shows. Deceleration points can also show prior to cruise holding patterns or other speed reductions.

VNAV Path Descent

An E/D point must be defined in order to accomplish a path descent. It may be defined manually or by the selection of an arrival procedure.

The FMC defaults to the path descent mode for planning purposes. If the necessary information for a path descent is not available by the time the aircraft reaches the T/D point, the FMC reverts to the speed descent mode.

The path descent normally begins automatically at the calculated T/D point, provided the MCP altitude is reset for the descent. If descent is not initiated by the T/D, a path descent may not be available. At the T/D, the FMC commands idle thrust and pitch to follow the descent path.

The descent complies with waypoint altitude restrictions by following the calculated vertical path.

A path descent uses the target speed for planning purposes only. There is no attempt to maintain the target speed.

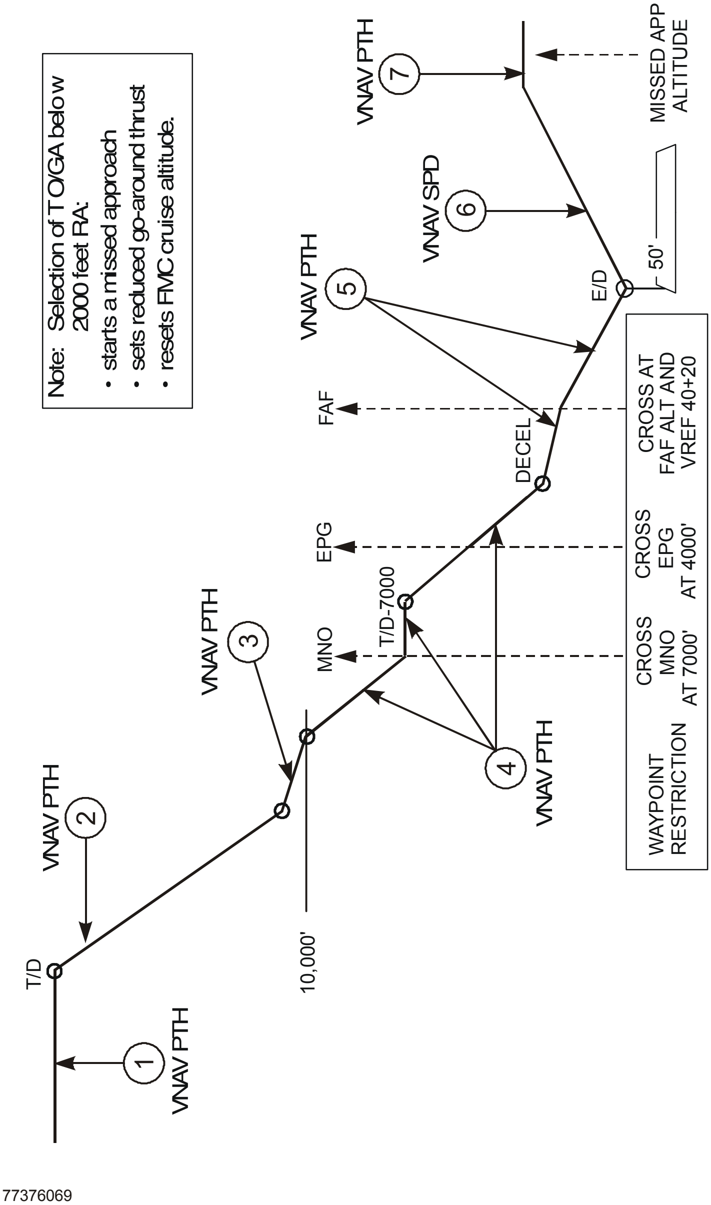
VNAV may disengage if all required parameters are not maintained during descent.

The FMC uses a special program called "Energy Compensation" at certain times during an ACT PATH DES. This program goes into effect when the MCP has been temporarily set to an altitude above the planned descent path. The airspeed cursor slowly moves toward a slower airspeed while the "TARGET" speed on the FMC remains constant. The airspeed reduction improves the capability of recapturing the planned descent path. When the aircraft is cleared to resume the descent, the airspeed slowly builds to the FMC target speed as the aircraft recaptures the planned descent path.

The CDU message **DRAG REQUIRED** is displayed if target airspeed is exceeded while maintaining the path. The CDU message **DES PATH UNACHIEVEABLE** is displayed if the FMC determines that the planned descent profile cannot be accomplished. VNAV disengages if a limit speed will be exceeded.

A path descent may be initiated while the aircraft remains within 2 x RNP cross-track error regardless of whether or not LNAV is engaged.

VNAV Cruise and Path Descent Profile (Nonprecision Approach)



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① Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

② Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed or manually entered speed, and descends in VNAV PTH.

③ Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV PTH.

④ Altitude Restrictions

The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF. If required, VNAV uses a level path until intercepting the idle thrust descent path to the next altitude constrained waypoint.

⑤ Approach

VNAV descends and starts approach in VNAV PTH at the commanded speed.

⑥ Missed Approach

When TOGA is pushed during approach, or when crossing the missed approach point, VNAV disengages.

When selected during missed approach, VNAV engages in VNAV SPD.

⑦ Missed Approach Level Off

At missed approach altitude VNAV changes to VNAV PTH.

VNAV Speed Descent

A speed descent may be selected manually by selecting the **SPEED** prompt on the PATH DES page. With no E/D specified, the speed descent is the only descent mode available.

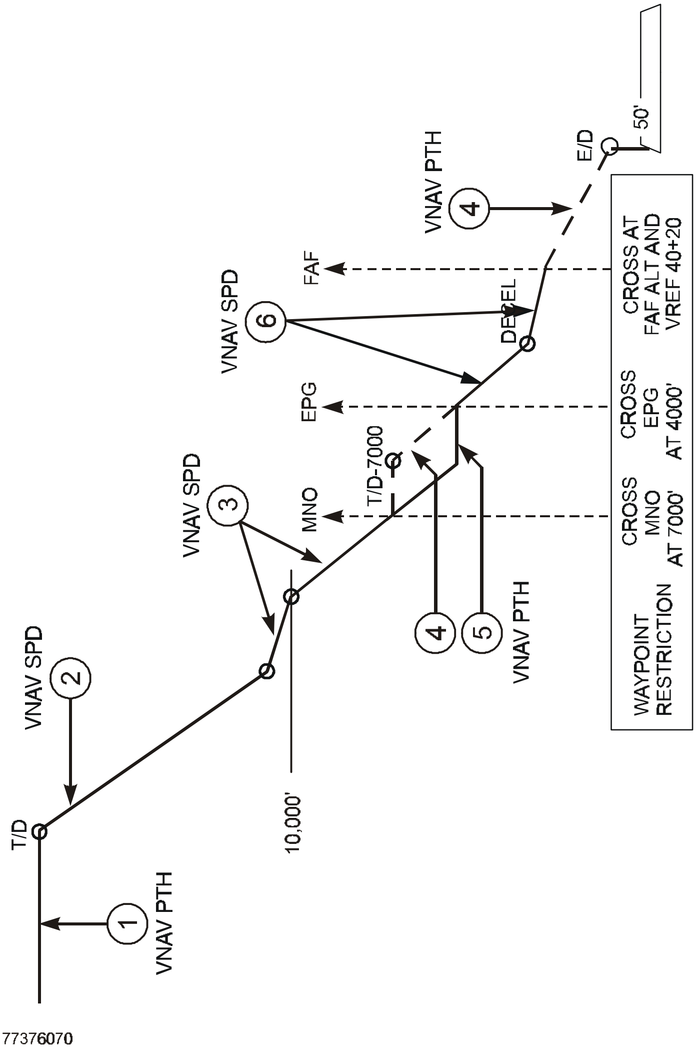
Speed descent maintains the FMC target speed. Normally, the target speed is economy until the airspeed restriction altitude and 240 knots below that altitude, until deceleration is necessary for the approach. VNAV does not permit descent below the altitude restriction until the airspeed is at or below the restricted value.

Speed descent normally begins automatically at the calculated T/D, provided the MCP altitude is reset for the descent. At the T/D, the FMC commands pitch to maintain target descent speed. LNAV does not have to be engaged in order to fly a VNAV speed descent.

Speed descent attempts to comply with waypoint altitude constraints, and does not violate these constraints. Speed descent does not guarantee the aircraft reaches an altitude restriction at the required point.

Speed descent cannot automatically revert to a path descent, except during STAR, approach transition, or approach leg with a vertical angle. However, if all required parameters for a path descent are available, a path descent may be manually selected at any time by selecting the **PATH** prompt on the DESCENT page.

VNAV Cruise And Speed Descent Profile (Nonprecision Approach)



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① Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

② Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV SPD.

③ Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV SPD.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV SPD.

④ VNAV Path

VNAV SPD will automatically revert to VNAV PTH on an approach leg with a vertical angle.

⑤ Altitude Restrictions

VNAV conforms to altitude restrictions at MNO and EPG. After MNO VNAV continues an idle thrust descent using VNAV SPD.

Upon reaching the next altitude restriction, VNAV commands level flight using VNAV PTH. The thrust mode changes to FMC SPD.

⑥ Descent and Approach

After EPG, VNAV continues the idle thrust descent using VNAV SPD.

Prior to the approach, VNAV decelerates to approach speed. The FMC prompts manual flap extension.

Vertical Angle

A vertical angle (gradient path) can be assigned to a waypoint from the navigation database. This vertical angle defines a VNAV path between the waypoint and the waypoint preceeding it. This feature can be available in approaches, approach transitions, and STARs. For example, the vertical angle for the glidepath of an ILS approach would typically be 3 degrees. This angle is displayed on the ACT RTE LEGS page above the speed / altitude line for the associated waypoint. Vertical angles may be expected in any approach ending at RWXXX or MAXXX. The E/D will be RWXXX or MAXXX, and the E/D altitude will be either threshold crossing height (TCH - typically 50 feet above the touchdown zone elevation) or the altitude specified at MAXXX.

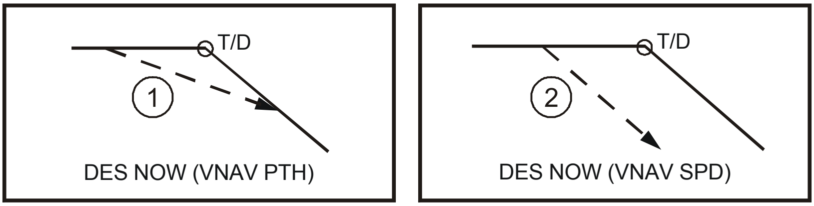
When a vertical angle leg becomes active VNAV follows the vertical angle rather than the idle thrust descent path.

If the vertical angle leg becomes active during a SPEED descent, the VNAV mode changes to PATH automatically, and there will be no **SPEED** prompt on the descent page.

Early Descent

A descent in VNAV started before the top of descent point is an early descent. If a path descent is planned, VNAV commands a descent 1000 fpm until the idle descent path is intercepted. If a speed descent is planned, VNAV commands an idle thrust descent

To start an early descent, use **DES NOW** prompt on the DES page.



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① DES NOW (VNAV PTH)

With a VNAV path descent planned, VNAV starts an early descent at 1000 fpm and captures the idle descent path. VNAV uses FMC SPD for the autothrottle mode and VNAV PTH for the pitch mode.

② DES NOW (VNAV SPD)

With a VNAV speed descent planned, VNAV starts an idle thrust early descent. VNAV does not attempt to capture the VNAV descent path. VNAV uses VNAV SPD for the pitch mode and the autothrottle commands IDLE, followed by ARM.

VNAV Use During Approaches

VNAV remains engaged at all flap settings, allowing approaches to be flown using the vertical angle guidance. Speed for final approach can be set on the APPROACH REF page.

If on a cruise segment in VNAV and configuring the aircraft below flaps 15, the minimum speed VNAV will command is flaps 15 maneuveing speed. Speed will reduce automatically after passing the T/D point.

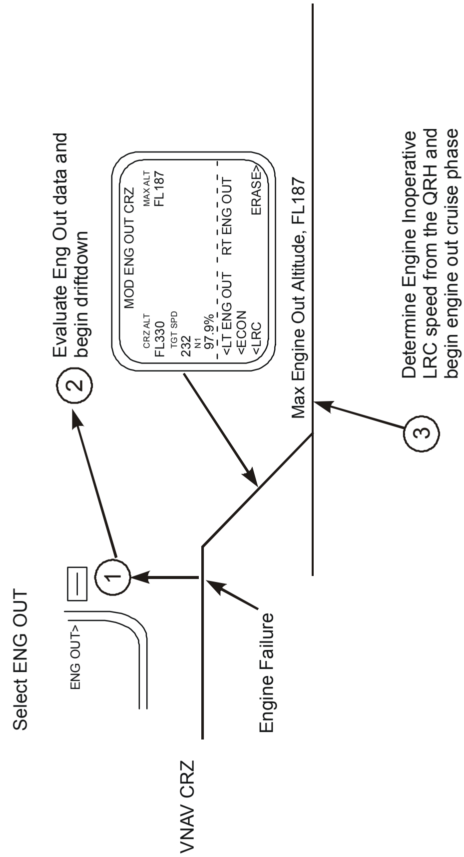
It is the flight crew’s responsibility not to descend below the DA/DDA until adequate visual contact is achieved.

Go-Around

Below 2000 feet RA, go-around is engaged when a TO/GA switch is pushed. The thrust limit is set to go-around. If VNAV is subsequently engaged, the thrust limit changes to climb and VNAV commands pitch to follow the missed approach procedure.

Upon initiation of TO/GA, a new cruise altitude is automatically assigned and appears on the FMC pages. The new cruise altitude is the highest of:

- The highest restriction in the missed approach routing,
- Default value of 1500 feet above airport elevation, or
- MCP altitude.



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① Engine Out Modification

Select the **ENG OUT** prompt on the CRZ page. The ENG OUT page displays engine out driftdown performance data to enable the aircraft to descend to the engine out maximum altitude.

② Drift Down Execution

After selecting the left or right ENG OUT mode, perform the driftdown as follows:

- Disconnect A/T
- Set maximum continuous thrust on operating engine (N1 line)
- Set MCP speed to ENG OUT SPD

- Set MCP altitude to MAX ALT or lower altitude as required
- Select LVL CHG.

The aircraft then descends at CON thrust and the driftdown airspeed to the MAX ALT. As the driftdown proceeds and aircraft gross weight decreases, the maximum altitude may increase.

The engine out cruise page provides advisory performance data for operating with one engine.

③ Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds. If range is a factor, determine Engine Inoperative LRC speed from the QRH. Thrust limit remains in CON.

Required Time of Arrival (RTA)

VNAV controls cruise speed to achieve a flight crew specified arrival time at a specified waypoint. After the appropriate waypoint and RTA are input to the FMC, the FMC computes a recommended takeoff time, speeds required to comply with the RTA, and progress information for the flight. If the RTA is not achievable, the **RTA UNACHIEVABLE** scratchpad message is displayed.

Data Entry Rules

Altitude Entry

Altitudes can be entered into the FMC as three digit (xxx), four digit (xxxx), five digit (xxxxx), or flight level (FLxxx) numbers. The FMC automatically displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (xxx, FLxxx) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008 and displayed as 800
- 1,500 feet is entered as 015 or FL015 and displayed as 1500
- 11,500 feet is entered as 115 or FL115 and displayed as FL115
- 25,000 feet is entered as 250 or FL250 and displayed as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (xxxx) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050 and displayed as 50
- 835 feet is entered as 0835 and displayed as 840
- 1,500 feet is entered as 1500 and displayed as 1500
- 8,500 feet is entered as 8500 and displayed as 8500
- 9,994 feet is entered as 9994 and displayed as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet.

Examples of five (xxxxx) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050 and displayed as 50
- 835 feet is entered as 00835 and displayed as 840
- 1,500 feet is entered as 01500 and displayed as 1500
- 8,500 feet is entered as 08500 and displayed as FL085
- 9,995 feet is entered as 09995 and displayed as FL100
- 11,500 feet is entered as 11500 and displayed as FL115
- 25,000 feet is entered as 25000 and displayed as FL250.

Negative altitude entries are allowed to -1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed or Mach number. Calibrated airspeeds are entered as three digits (xxx) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages display data in pairs separated by a slash "/." Examples of these pairs include wind direction / speed and waypoint airspeed / altitude restrictions. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an **INVALID ENTRY** message.

Bearing Entry

Entry of a bearing value requires three digits. For example, key 090, not 90. A bearing entry of 360 is displayed as 000.

Plus / Minus Signs

When entering temperature or an along-track displacement distance, positive values are assumed by the FMC and + signs are not required. For negative values, key in the – sign.

FMC Databases

The FMC contains two databases:

- Performance database
- Navigation database.

The performance database minimizes the need to refer to a performance manual during flight, and provides the FMC with information required to calculate pitch and thrust commands. All information normally required can be displayed on the CDU. The database includes:

- Aircraft drag and engine characteristics
- Maximum and optimum altitudes
- Maximum and minimum speeds.

Maintenance personnel can refine the database by entering correction factors for drag and fuel flow.

The navigation database includes most information normally determined by referring to navigation charts. This information can be displayed on the CDU or navigation display. The database contains:

- The location of VHF navigation aids
- Waypoints
- Airports
- Runways
- Other airline selected information, such as SIDs, STARs, approaches, and company routes.

If the permanent database does not contain all of the required flight plan data, additional airports, navaids, and waypoints can be defined by the crew and stored in either a supplemental or a temporary navigation database. Use of these additional databases provides world wide navigational capability, with the crew manually entering desired data into the FMC via various CDU pages. Information in the supplemental navigation database is stored indefinitely, requiring specific crew action for erasure; the temporary navigation database is automatically erased at flight completion.

The supplemental and temporary databases share storage capacity for forty navaids and six airports, the entries being stored in either database on a first come, first served basis. For the waypoint category, exclusive storage is reserved in the temporary database for twenty entries (including those created on the RTE or RTE LEGS pages). An additional twenty waypoints (up to a maximum of forty) can be stored in either the temporary or supplemental database on a first come, first served basis.

When any storage capacity is full, entries which are no longer required, should be deleted by the crew to make space for additional new entries. Created waypoints cannot be stored in the database runway category.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the normal navigation chart revision cycle. The FMC uses the active set for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the current data.

Thrust Management

The autothrottle operates in response to flight crew MCP inputs, TO/GA switches or to automatic FMC commands. Reference thrust can be selected on the N1 LIMIT page. Automatic FMC autothrottle commands are made while VNAV is engaged. The autothrottle system:

- Uses reference thrust limits calculated by the FMC
- Commands the thrust levers
- Commands thrust equalization through the electronic engine controls.

Thrust limits are expressed as N1 limits. Thrust equalization references N1.

The FMC calculates a reference thrust for the following modes:

- Takeoff
- Derated takeoff (not used)
- Assumed temperature takeoff
- Climb
- Reduced climb
- Cruise
- Continuous
- Go-around.

The thrust reference mode automatically transitions for the respective phase of flight. These modes can be selected on the N1 LIMIT page. The selected thrust reference mode is displayed on the thrust mode display.

7 8 9 The flight crew can specify the thrust reduction height where the transition from takeoff to climb thrust takes place by making an entry on TAKEOFF REF page 2. Allowable entries are 800 feet to 9999 feet.

The default value is determined by CAL operations and stored in the model / engine database.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Assumed Temperature Thrust Reduction Takeoff

A takeoff thrust less than the full rated thrust may be achieved by using an assumed temperature that is higher than the actual temperature. The desired thrust level is obtained through entry of a SEL TEMP value on the N1 LIMIT page or TAKEOFF REF page 2. Use approved sources for selecting the assumed temperature.

The maximum thrust reduction authorized is 25 percent below any certified rating.

The assumed temperature thrust setting is not considered a limitation. The assumed temperature reduction can be removed. If conditions are encountered where additional thrust is desired, the crew can manually apply full thrust.

Reduced Thrust Climb

Two climb thrust reductions can be selected on the N1 LIMIT page. CLB-1 provides a climb limit reduced by 3% N1 (approximately 10% thrust). CLB-2 provides a climb limit reduced by 6% N1 (approximately 20% thrust). The reduced climb setting gradually increases to full rated climb thrust by 15000 feet. In cruise, the thrust reference automatically changes to CRZ. The reference can be manually selected on the N1 LIMIT page.

Use of an assumed temperature reduced thrust takeoff affects automatic selection of reduced climb. If a reduced thrust takeoff has been specified on the TAKEOFF REF page, then either CLB 1 or CLB 2 is automatically specified when required to avoid a climb N1 value greater than the reduced thrust takeoff N1 value.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity indicating system. Fuel quantity values show on the PERF INIT page and on PROGRESS page 1/3.

The scratchpad message **VERIFY GW AND FUEL** shows if total fuel quantity data is invalid. The PERF INIT page FUEL line changes to dashes. The FMC uses the last valid fuel quantity for performance predictions and VNAV operation. The flight crew should manually enter estimated fuel weight. Periodic fuel weight update is required for the remainder of the flight to keep gross weight current. The FMC does not update the manual fuel weight entry. The scratchpad message **VERIFY GW AND FUEL** shows again each 30 minutes if subsequent entries are not performed. The scratchpad message does not show during descent with Vref selected.

The scratchpad message **CHECK FMC FUEL QUANTITY** shows if the FMC has detected an unexpected drop in fuel quantity.

The FMC continually estimates the amount of fuel that will remain when the destination airport is reached if the active route is flown. The CDU message **USING RSV FUEL** is displayed if the estimate is less than the fuel reserve value entered on the PERF INIT page. The CDU message **INSUFFICIENT FUEL** is displayed if predicted fuel at destination will be 2000 lb (900 kg) or less.

Loss of FMC Electrical Power

The FMC requires continuous electrical power to operate. When the electrical power is interrupted for less than ten seconds:

- LNAV and VNAV disengage
- All entered data is retained by the FMC
- The FMC resumes normal operation when power is restored.

If power is lost for ten seconds or more on the ground, all preflight procedures and entries must be done again when power is restored.

If power is lost for more than ten seconds in flight:

- LNAV and VNAV disengage
- All entered data is retained by the FMC, and when power is restored the MOD RTE LEGS page is displayed with the scratchpad message **SELECT ACTIVE WPT/LEG**.

Before LNAV can engage, the FMC must be instructed how to return to the route. Select the desired active waypoint and proceed direct or intercept a course to the waypoint.

FMC Failure

Dual FMCs Installed - Single FMC Failure

The FMC/CDU is designed to automatically preserve the most capable modes of navigation and guidance that can be maintained with the equipment and navigation aids available. If an error or system failure results in reduced capability, then the FMC may generate a message for display in the CDU scratchpad. If other system inputs to the FMC should fail, affected CDU displays are blanked to prevent the display of misleading or erroneous data. For example, loss of the total fuel input causes some performance related data to be blank. The messages and FMC internal responses provide an orderly transition from full FMC guided flight to less automated capability.

If the right FMC fails, the FMC alert light and the FMC message light illuminates. The message **SINGLE FMC OPERATION** is displayed in both scratchpads. **VTK** displays on the right navigation display. LNAV and VNAV disengage if autopilot B is in use (can be reengaged if autopilot A is selected). After 25 to 30 seconds, the right navigation display displays failure information. The right navigation display may be restored by placing the FMC source select switch to BOTH ON L.

If the above indications are observed with no VTK on the right navigation display, there is a disagreement between left and right FMC data. Moving the FMC source select switch to BOTH ON L should allow the two FMCs to resynchronize. The switch may then be returned to NORMAL when the message **DUAL FMC OP RESTORED** is displayed on both scratchpads.

If the left FMC fails, the FMC alert light illuminates. The MENU page appears on both CDUs. **VTK** appears on the left navigation display. LNAV and VNAV disengage, but can be reengaged if autopilot B is in use or is selected. After 25 to 30 seconds, the left navigation display displays failure information. To restore full operation, the FMC source select switch must be moved to BOTH ON R.

During an FMC software restart, the navigation display map track may rapidly slew to 0 degrees then to the correct value.

Dual FMC Failure / Single FMC Failure With One FMC Installed

③ If the FMC fails, the **FMC ALERT** light will illuminate. The **FMC/CDU FAIL** light will appear on the CDU's and the CDU's will display failuire modes. LNAV and VNAV will disengage.

3 5 If the FMC fails, the **FMC ALERT** light will illuminate. The **FMC/CDU FAIL** light will appear on both CDU's and both CDU's will display failure modes. **VTK** will appear on both EHSI's. LNAV and VNAV will disengage. After 25 to 30 seconds, both EHSI maps will display failure information.

7 8 9 When no FMC is operative, the FMC alert light illuminates. The MENU page appears on both CDUs. **VTK** appears on both navigation displays. LNAV and VNAV disengage. After 25 to 30 seconds, both navigation displays display failure information.

FMC PREFLIGHT

Introduction

Completion of the FMC preflight requires data entry in all minimum required data locations. Completing all required and optional preflight data entries ensures the most accurate performance possible.

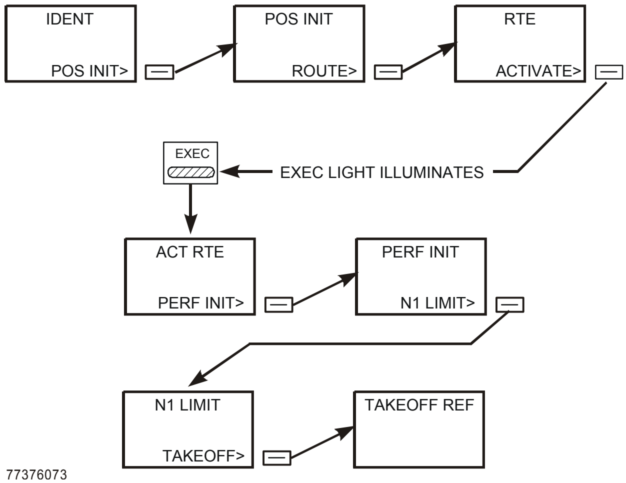
Data link can be used to load preflight data from airline ground stations. Using data link reduces the required crew actions. Manual crew entries replace existing data. Data link (as installed) can also be used to load takeoff data onto the TAKEOFF REF pages.

Preflight Page Sequence

The normal preflight sequence follows paging prompts on each CDU page.

The normal FMC power-up page is the identification page. Preflight flow continues in this sequence:

- Identification (IDENT) page
- Position initialization (POS INIT) page
- RTE page
- DEPARTURES page (no automatic prompt)
- Performance initialization (PERF INIT) page
- N1LIMIT page
- Takeoff reference (TAKEOFF REF) page.



During preflight, a prompt in the lower right of the CDU page automatically directs the crew through the minimum requirements for preflight completion. Pushing the PROMPT key for the next page in the flow presents new entry requirements. Additional entries are made on pages to refine performance and route calculations. If a required entry is missed, a prompt on the TAKEOFF page leads to the preflight page that is missing data.

The aircraft inertial position is required for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route information is origin and destination airports and a route leg.

Performance information requires the aircraft weight and cruising altitude.

Supplementary Pages

Supplementary pages are sometimes required. These pages must be manually selected. Manual selection interrupts the normal automatic sequence. Discussions of each normal page include methods to display the page when the automatic sequence is interrupted.

When the route includes SIDs and STARs, they can be entered into the preflight using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed, the route is modified, and speed / altitude restrictions are entered on the RTE or RTE LEGS pages.

Waypoint, navigation, airport, and runway data is referenced on the REF NAV DATA page or the SUPP NAV DATA page.

VNAV performance is improved if the forecast winds and temperatures are entered during the preflight.

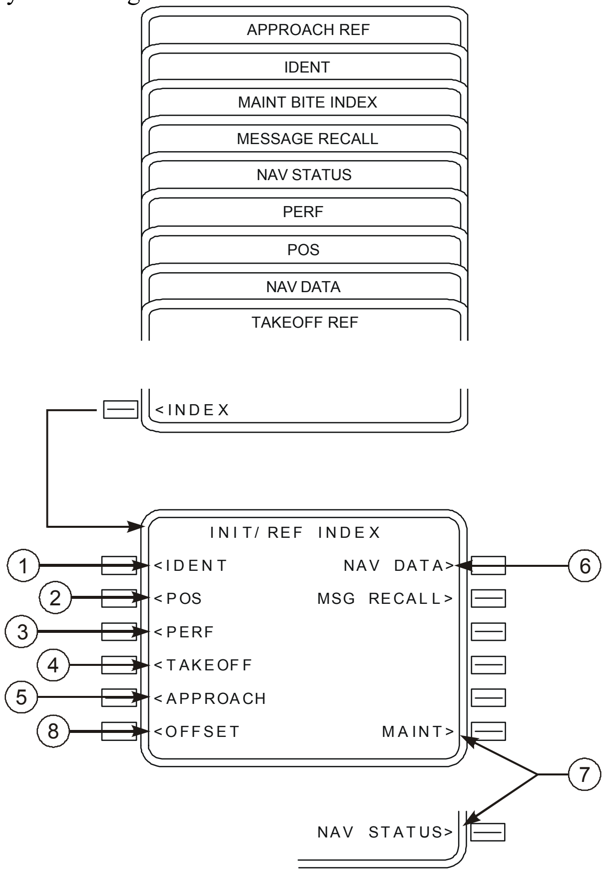
A single wind and temperature for cruise may be entered on the PERF INIT page. Wind and temperature data for specific cruise waypoints are entered on the RTE DATA page. Wind and temperature for descent is entered on the DES FORECASTS page.

Preflight Pages 1

The preflight pages are presented in the sequence used during a typical preflight.

Initialization / Reference Index Page

The INITIALIZATION / REFERENCE INDEX page provides manual selection of FMC pages. It provides access to pages used during preflight and not normally used in flight.



① IDENT

Displays the IDENT page, the first page in the automatic preflight sequence.

② Position Initialization (POS)

- Displays the POS INIT page used for IRS initialization
- POS INIT page is also used to enter / update magnetic heading for an IRS which is in the ATT mode.

③ Performance Initialization (PERF)

Displays the PERF INIT page for initialization of data required for VNAV operations and performance predictions.

④ Takeoff Reference (TAKEOFF)

Displays the TAKEOFF REF page to enter takeoff reference information and V speeds.

⑤ Approach

Displays the APPROACH REF page for entry of the approach V_{REF} speed.

⑥ Navigation Data (NAV DATA)

Displays the REF NAV DATA page to display information about waypoints, navaids, airports, and runways. On the ground, displays the SUPP NAV DATA page if SUPP is entered in the scratchpad prior to selection.

⑦ Maintenance (MAINT) or Navigation Status (NAV STATUS)

- MAINT - On ground only. Displays maintenance pages for maintenance use.
- NAV STATUS - Displays NAV STATUS page which shows status of navigation aids being tuned by the FMC. Replaces **MAINT** prompt when in air.

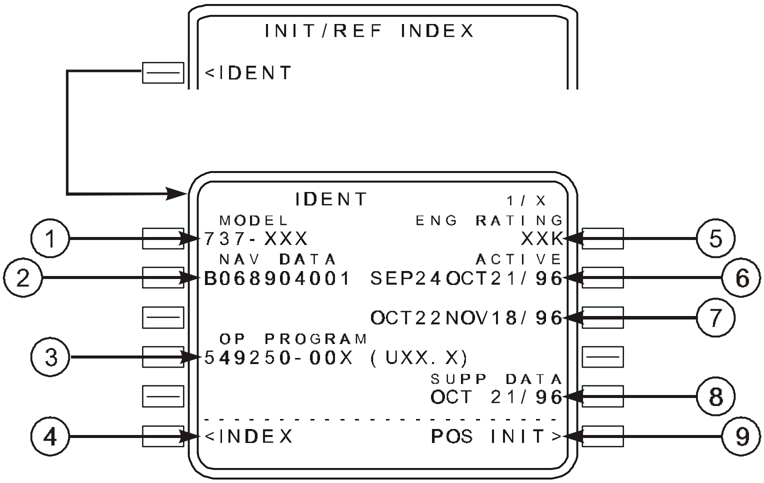
⑧ OFFSET

Displays the LATERAL OFFSET page for initiating a lateral offset.

Identification Page

Most of the data on this page is for crew verification. Active date accepts manual entries.

The crew verifies FMC data and selects a navigation database on the identification page.



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① MODEL

Displays the aircraft model from the FMC performance database (e.g., 737-600, 737-700, or 737-800).

② Navigation Data (NAV DATA)

Displays the navigation database identifier.

③ Operational Program (OP PROGRAM)

Displays the Boeing software part number and update version. Update version installed at delivery:

- Update 10.3 (U10.3)

④ INDEX

Push – Displays the INIT/REF INDEX page.

⑤ Engine Rating (ENG RATING)

Displays the engine thrust stored in the FMC performance database.

⑥ ACTIVE Date Range

Displays the effectivity date range for the active navigation database.

Database activation is accomplished by pushing the proper date range prompt to copy that date into the scratchpad. The scratchpad date may then be transferred to the ACTIVE database line. The previous active date moves down to the inactive date line.

The **ACTIVE** label appears above the active navigation database date. No label appears above the inactive navigation database date. The navigation database date can be changed only on the ground. Changing the navigation database removes all previously entered route data.

When an active database expires in flight, the expired database continues to be used until the active date is changed after landing.

⑦ Inactive Date Range

Displays the effectivity date range for the inactive navigation database.

⑧ Supplemental Data (SUPP DATA)

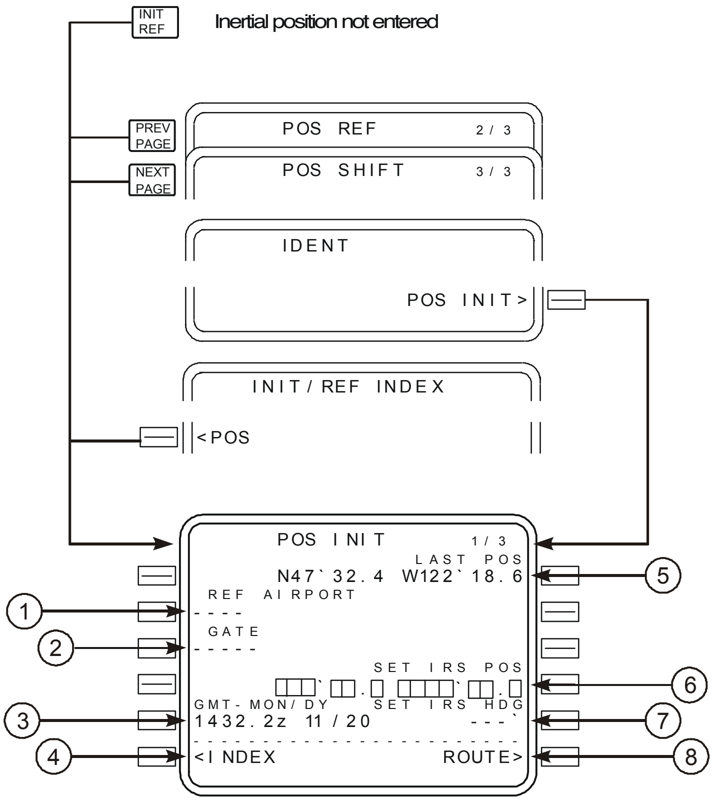
Displays the effective date of supplemental data. Blank if supplemental database is empty.

⑨ Position Initialization (POS INIT)

Push – Displays the POS INIT page.

Position Initialization Page 1/3

The position initialization page 1/3 allows aircraft present position entry for IRS alignment and FMC initialization. The same page is used to enter / update the magnetic heading for an IRS which is in the ATT mode. There are three POS pages.



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① Reference Airport (REF AIRPORT)

- The reference airport entry allows entry of the current airport for display of the airport latitude / longitude.
- Optional entry.
- Valid entries are ICAO four letter airport identifiers.
- Displays the latitude and longitude of the reference airport.

- Removes previous GATE entry.
- Entry blanks at lift-off.

② GATE

- The gate entry allows further refinement of the latitude / longitude position.
- Optional entry after the reference airport is entered.
- Valid entry is a gate number at the reference airport.
- Displays the latitude and longitude of the reference airport gate from the navigation database.
- Changes to dashes when a new reference airport is entered.
- Entry blanks at lift-off.

③ GMT – Month / Day (GMT – MON/DY)

- Displays GPS time and date.
- If the GPS time is not valid, GMT starts at 0000.0Z when the FMC is first powered. MON/DY is blank. Manually enter the correct GMT.

④ Index

- Push – Displays the INIT/REF INDEX page.

⑤ Last Position (LAST POS)

- Displays the last FMC computed position.

⑥ Set IRS Position (SET IRS POS)

- The set inertial position entry is required to initialize the IRS. Select the most accurate latitude / longitude for the initialization. A displayed latitude / longitude can be selected or a manual entry can be used.
- The following priority should be used for position update:

  1. GPS (from POS REF 2/3)
  2. Gate Coordinates (Database)
  3. Airport Reference Coordinates (Database)
  4. Manual Gate Entry

- If an entry is not made before the IRS finishes the initial alignment, the scratchpad message **ENTER IRS POS** is displayed.
- Failure of the manually entered position to pass the IRS internal check displays the scratchpad message **ENTER IRS POS**.
- Enter aircraft position latitude and longitude.
- Box prompts are displayed when either IRS is in the ALIGN mode and IRS present position has not been entered.
- Blanks when the IRS transitions from the alignment to the navigation mode.

⑦ Set IRS Heading (SET IRS HDG)

- Enter / update magnetic heading for any IRS which is in ATT mode. Line blanks when IRS not in ATT mode.

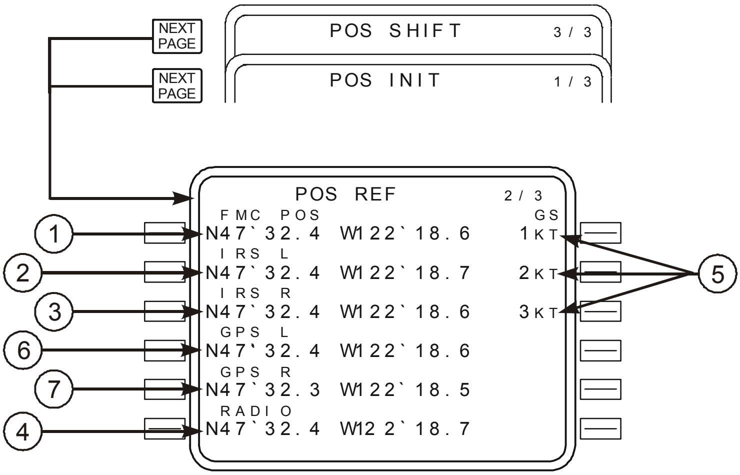
⑧ ROUTE

- Push – Displays the ROUTE page.

Position Reference Page 2/3

Position reference page 2 displays the aircraft positions as calculated by the FMC, IRS, GPS, and radio navigation receivers.

This page displays latitude / longitude. All position displays are in actual latitude and longitude, as calculated by the respective system. Ground speed is displayed for the FMC and each IRS.



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① FMC Position (FMC POS)

- Displays the FMC calculated latitude / longitude.
- Blank if FMC position is invalid.

② IRS L

- Displays the latitude / longitude position as determined by the left IRS.
- Blank if IRS position is invalid.

③ IRS R

- Displays the latitude / longitude position as determined by the right IRS.
- Blank if IRS position is invalid.

④ RADIO

- Displays the latitude / longitude position as determined by the navigation radios.
- Blank if on the ground or if radio position is invalid in flight.

⑤ Groundspeed (GS)

- Displays the ground speed for FMC and IRS.
- Blank if ground speed of related system is invalid.

⑥ GPS L (As Installed)

- Displays the latitude / longitude position as determined by the left GPS.
- Blank if GPS position is invalid.

⑦ GPS R (As Installed)

- Displays the latitude / longitude position as determined by the right GPS.
- Blank if GPS position is invalid.

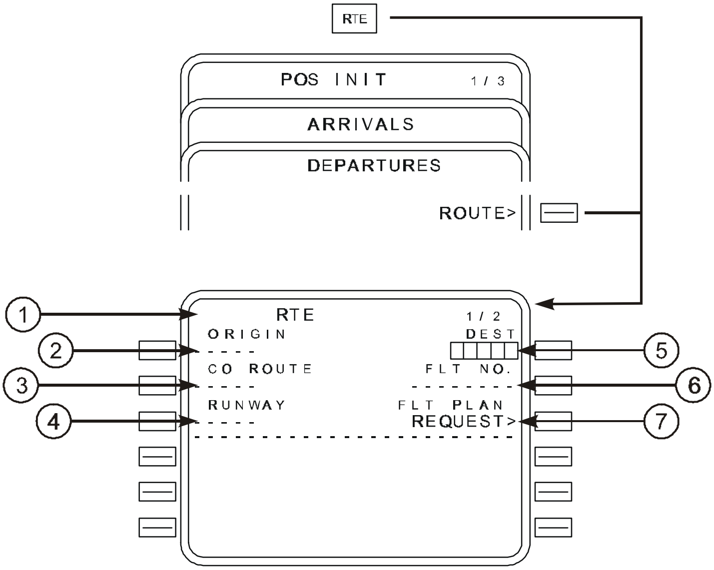
PREFLIGHT PAGES 2

Route Page 1/X

The route is entered and displayed in air traffic control format. The first route page displays origin and destination data. Route segments are displayed on subsequent route pages.

Individual portions of the route may be manually entered by the flight crew. A pre-defined route may be loaded using the CO ROUTE line. CO ROUTE entries must correspond to a company defined route in the navigation database.

7 8 9 The route may also be uplinked.



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① Page Title

- The word **ACT** appears to the left of the title when the route has been activated and executed.
- The word **MOD** appears to the left of the normal title when the route is modified and the change is not executed.
- Multiple route pages are indicated by the page sequence number to the right of the title.

② Origin

- Enter the ICAO airport identifier for the origin.
- An entry is required for route activation.
- Valid entries must be in the navigation database.
- Entry is allowed for all phases of flight. Entry of a new origin erases the previous route.
- New entries on an active route display **MOD** in the route title.
- Enables direct selection of departure and arrival procedures for the origin airport.
- Automatically entered as part of a company route.

③ Company Route (CO ROUTE)

- A company route can be called from the navigation database by entering the route identifier. The data provided with a company route can include origin and destination airports, departure runway, SID, and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.
- An entry is optional for activation of the route.
- Enter a company route identifier.
- Valid entry is any crew entered company route name. If the name is not contained in the NAV database, the scratchpad message **NOT IN DATABASE** is displayed.
- Entry of a new company route replaces the previous route.
- Inflight entry is inhibited for the active route

④ RUNWAY

- Line title does not display until after entry of origin airport.
- Enter the desired runway for the origin airport.
- An entry is optional for activation of the route.
- Entries must be in the navigation database.
- New entries on an active route display **MOD** in the route title.
- Can be entered from the DEPARTURES page.
- Deleted upon reaching the first waypoint.

⑤ Destination (DEST)

- Enter the ICAO airport identifier for the destination of the route.
- An entry is required for route activation.
- Entries must be in the navigation database.
- New entries on an active route display **MOD** in the route title.
- Enables direct selection of arrival procedures for the destination airport.
- Automatically entered as part of a company route.
- Entry and execution of a new destination clears any runway and runway dependent approach procedure of the previous destination. If the active leg is part of the affected procedure, then all subsequent (inactive) legs are cleared.

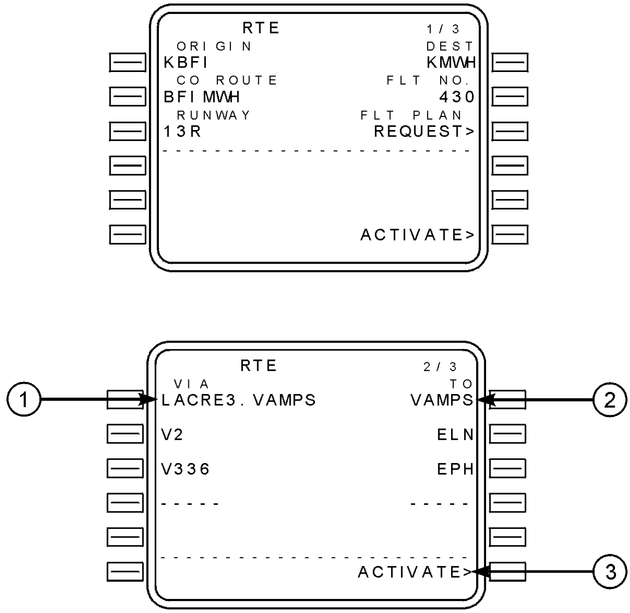
⑥ Flight Number (FLT NO)

- Enter the company flight number.
- Entry is optional for activation of the route.
- Limited to 8 characters.
- Crew entered.
- Flight number is included in the PROGRESS page title.

⑦ FLT PLAN REQUEST
789

- Push – Transmits a data link request for a flight plan route uplink.

Route Pages 1/X And 2/X With Data Entries



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① VIA

The VIA column displays the route segment to the waypoint or termination displayed in the TO column. Enter the path, which describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and box prompts are displayed in the TO column if the previous TO line contains a waypoint on the airway.

Valid entries can also include procedures or DIRECT. Procedures are normally entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is normally entered as a result of entering a TO waypoint first.

Valid airways must:

- Contain the fix entered in the TO waypoint, and
- Contain the previous TO waypoint, or

Dashed prompts change to **DIRECT** if the TO waypoint is entered first.

Dash prompts appear for the first VIA beyond the end of the route.

Invalid VIA entries display the scratchpad entry **INVALID ENTRY**.

Invalid VIA entries are:

- Airways and company routes which do not contain the TO waypoint of the previous line
- Airways or company routes that are not in the navigation database.

When entering airways, the beginning and ending waypoints determine if the entry is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the beginning point of the current route segment, or a route discontinuity is created between the segments.

Entry of a SID or transition automatically enters the VIA and TO data for the route segments of the SID. A SID automatically links to the next route segment when the final SID waypoint is part of the route segment.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 is an example of airway entry.

② TO

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway displays DIRECT in the VIA column.

Box prompts indicate that an entry is required.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

Valid waypoint entries for airways are waypoints or fixes on the airway.

Dash prompts appear on the first TO waypoint following the end of the route.

③ ACTIVATE

Pushing the ACTIVATE key arms the route for execution as the active route. When the EXEC key is pushed, the route becomes the active route and the **ACTIVATE** prompt is replaced with the next required preflight page prompt.

Push – Prepares the selected route for execution as the active route.

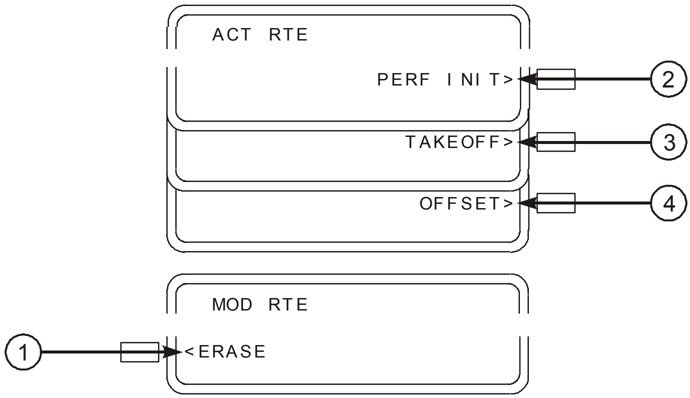
Activation of a route is required for completion of the preflight.

Displayed on inactive route pages.

After route activation, the **ACTIVATE** prompt is replaced by:

- **PERF INIT** when the required performance data is incomplete, or
- **TAKEOFF** when the required performance data is complete.

Additional Route Page Prompts For An Activated Route



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① ERASE

Push – Removes all pending modifications.

Displayed only during modifications.

② Performance Initialization (PERF INIT)

Push – Displays PERF INIT page.

Displayed only on the ground when required entries on the PERF INIT page are incomplete.

③ TAKEOFF

Push – Displays TAKEOFF REF page 1/2.

Displayed only on the ground when all required entries on the PERF INIT page are complete.

④ OFFSET

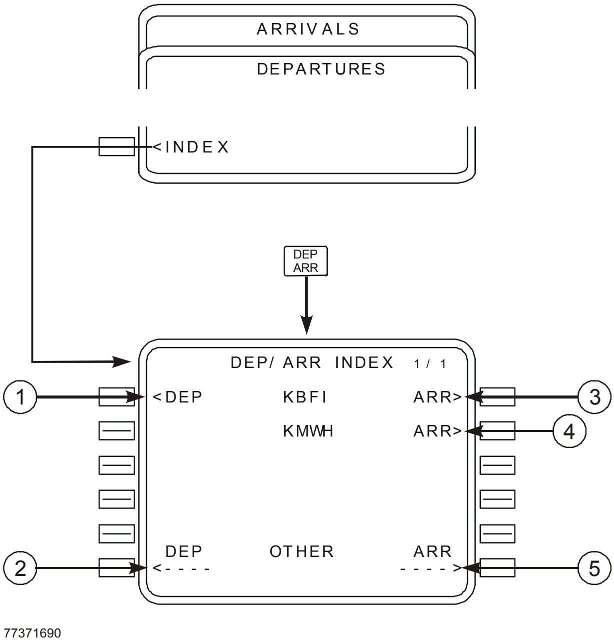
Push – Displays LATERAL OFFSET page.

Displayed only in flight.

Departure / Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival information for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



① Departure (DEP) – Origin

Push – Displays the DEPARTURE page for origin airport.

② Departure (DEP) – OTHER

Displays the DEPARTURE page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allows display of departure information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

③ Arrival (ARR) – Origin

Push – Displays the ARRIVAL page for origin airport. Origin airport arrivals selection is used during a turn-back situation.

④ Arrival (ARR) – Destination

Push – Displays the ARRIVAL page for destination airport.

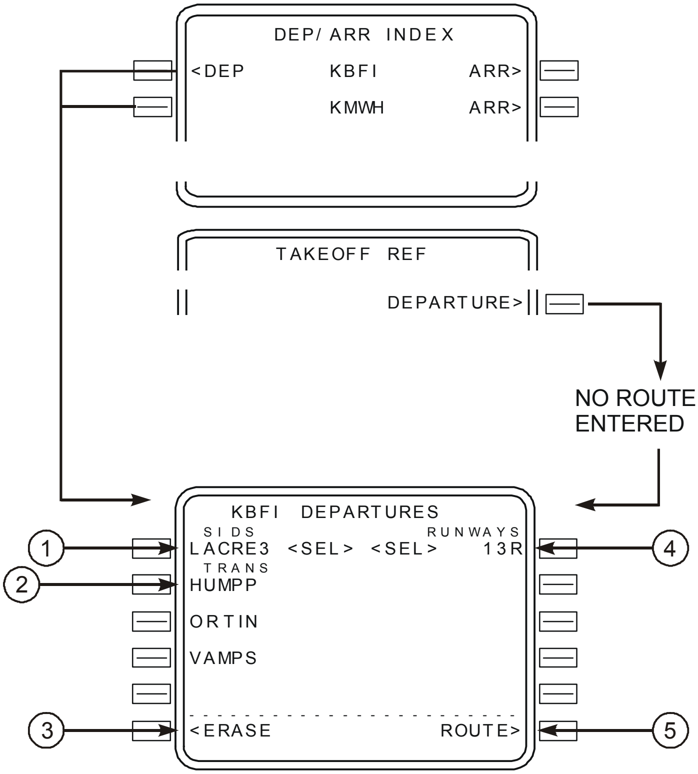
⑤ Arrival (ARR) – OTHER

Displays the ARRIVAL page for the airport entered into this line through the scratchpad.

ARR prompt for OTHER allows display of arrival information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

DEPARTURES Page

The DEPARTURES page is used to select the departure runway, SID, and transition for the route origin airport.



77371691

① Standard Instrument Departures (SIDS)

Displays SIDS for the airport and runway selections.

Without the selection of a runway on the RTE page, the initial display contains all of the information for the airport runways and SIDS. As selections are made, incompatible options are removed. SID transitions are displayed after a SID is selected.

② Transitions (TRANS)

Displays transitions compatible with the selected SID.

③ ERASE / INDEX

ERASE is displayed when a route modification is pending. **INDEX** is displayed when no route modification is pending.

ERASE Push – Removes route modifications that are not executed and restores the original route.

INDEX Push – Displays the DEP/ARR INDEX page.

④ RUNWAYS

Displays a list of runways for the selected airport.

The runway selected on the RTE page is displayed as <SEL> or <ACT> when this page is displayed.

⑤ ROUTE

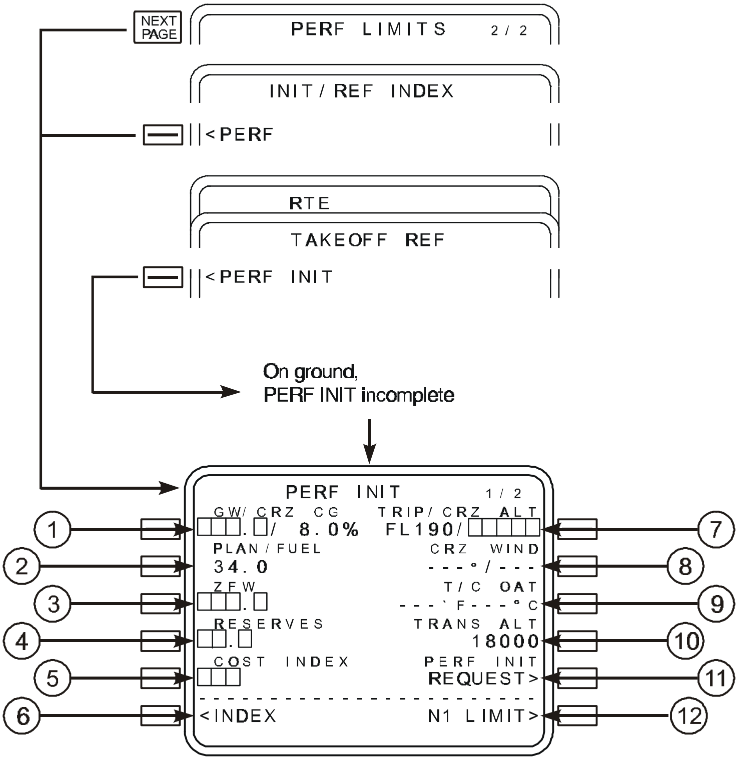
Push – Displays the RTE page.

Selecting Options

Selecting an option displays **<SEL>** inboard of the option, and a route modification is created. When the modification is executed, the **<SEL>** becomes **<ACT>**. Leaving the page and returning displays all options and the **<SEL>** or **<ACT>** prompts.

Performance Initialization Page

The PERFORMANCE INITIALIZATION page allows the entry of aircraft and route data to initialize performance calculations. This information is required for VNAV calculations.



7737611-01

① Gross Weight / Cruise Center of Gravity (GW/ CRZ CG)

Aircraft gross weight is required. The entry can be made by the flight crew or automatically calculated by the FMC, following entry of zero fuel weight.

Enter aircraft gross weight.

Valid entries are xxx or xxx.x.

Automatically displays calculated weight when zero fuel weight is entered first.

Displays default entered cruise CG. Manual entry of cruise CG is not authorized.

② FUEL

Fuel on board is automatically displayed as received from the aircraft fuel quantity indication system.

789 PLAN entry allows fuel predictions before actual fuel is known. Entry is blanked with flaps extended, both air conditioning packs on, or in flight.

In flight, when the FMC is not receiving the required fuel data, displays dashes and manual fuel weight entry is possible. After manual entry, **MAN** (manual) shows by the fuel weight. After manual entry, periodic update of the fuel weight is required for the remainder of the flight to keep gross weight current.

③ Zero Fuel Weight (ZFW)

Aircraft zero fuel weight is required. Normally the ZFW is entered from the aircraft dispatch papers and the FMC calculates the aircraft gross weight.

Enter the aircraft zero fuel weight.

Valid entry is xxx or xxx.x.

Calculated zero fuel weight is automatically displayed if aircraft gross weight is entered first and fuel on board is valid.

④ RESERVES

Enter fuel reserves for the route.

Entry is required to complete the preflight.

Valid entry is xx or xx.x.

⑤ COST INDEX

The cost index is used to calculate ECON climb and cruise speeds. The value reflects the relative impacts on overall trip cost of fuel cost as compared to other direct hourly operating costs.

Enter the cost index for ECON calculations.

Entry is required to enable use of VNAV mode.

Valid entries are 0 to 200. 0 causes the ECON speed to be MAX RANGE; 200 results in a minimum time flight.

Entry of a company route on RTE page causes any company stored value of cost index to be automatically displayed. A manual entry has priority.

⑥ INDEX

Push – Displays the INIT/REF INDEX page.

⑦ Trip / Cruise Altitude (TRIP/CRZ ALT)

Trip altitude is automatically computed and displayed whenever entries have been made for the ORIGIN, DEST, GROSS WT, and COST INDEX. Otherwise, the field is blank.

Trip altitude is the predicted minimum cost altitude determined by operator constraints. Provides crew a reference for selecting a planned cruise altitude.

Cruise altitude is required.

Enter the cruise altitude for the route.

Automatically displays this cruise altitude on the CLB, CRZ, and RTE legs pages.

⑧ Cruise Wind (CRZ WIND)

Cruise wind entry provides input to optimize FMC calculations.

Enter the forecast cruise wind.

Entry is propagated onto the RTE DATA page.

If no entry made, the FMC assumes zero wind for preflight predictions.

⑨ Top of Climb Outside Air Temperature (T/C OAT)

T/C OAT entry provides input to optimize FMC calculations.

Entry causes ISA DEV to be computed and displayed.

Enter top of climb OAT.

If no entry made, FMC assumes ISA value.

⑩ Transition Altitude (TRANS ALT)

Displays 18,000 feet at FMC power up.

Changes automatically after selecting a departure procedure with a different transition altitude.

Manual entry has priority.

11 PERF INIT REQUEST

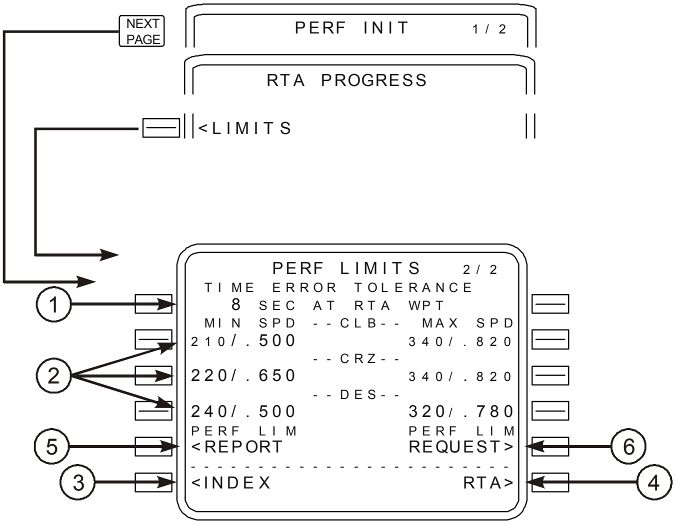
Push – Transmits a data link request for a PERF INIT uplink.

12 N1 LIMIT

Push – Displays the N1 LIMIT page.

Performance Limits Page

The PERFORMANCE LIMITS page allows the entry of performance limits affecting RTA and ECON calculations.



77371693

① TIME ERROR TOLERANCE

Used during RTA calculations to establish a boundary on computed speeds.

Valid entry range is from 5 to 30 seconds.

Default value is 30 seconds and is displayed in small font.

② Minimum Speed / Maximum Speed (MIN SPD/MAX SPD)

Establishes lower and upper speed limits for each phase of flight.

Default is 210/.40 for lower limit and 340/.820 for upper limit. Displayed in small font.

Either CAS or Mach can be entered.

Limits both RTA and ECON modes in flight.

③ INDEX

Push – Selects INIT /REF INDEX page.

④ Required Time of Arrival (RTA)

Push – Selects RTA PROGRESS page.

7 8 9

⑤ PERF LIM REPORT

Push – Transmits displayed performance limits to ground station.

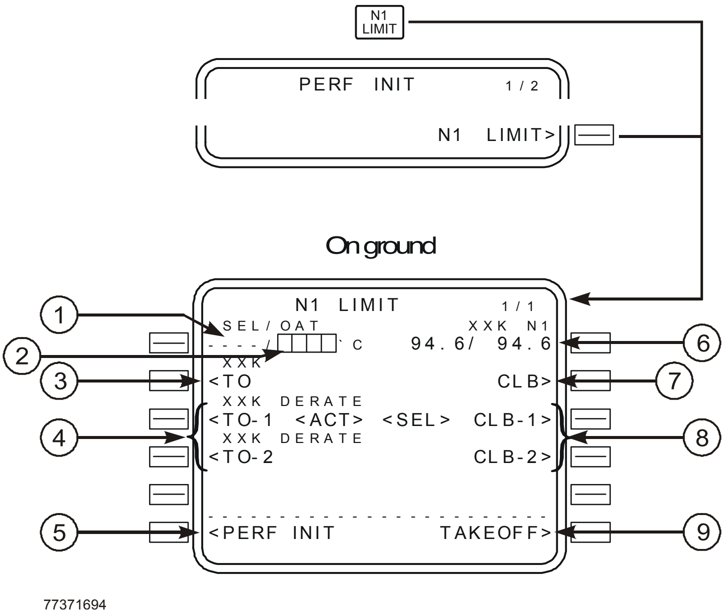
7 8 9

⑥ PERF LIM REQUEST

Push – Transmits a data link request for a performance limits uplink.

N1 LIMIT Page (Preflight)

The N1 LIMIT page is used during preflight to manage takeoff and climb thrust. Temperature data is entered, allowing the FMC to make N1 computations for normal or reduced thrust takeoff. Fixed takeoff and climb thrust derates are not used in CAL operations.



① Selected Temperature (SEL)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F). The FMC, however, limits the N1 to 25% takeoff reduction.

② Outside Air Temperature (OAT)

Manual entry of actual takeoff OAT is displayed in large-sized characters and is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

③ Takeoff Thrust Limit (TO XXK)

Push – Selects full rated takeoff thrust limit.

Data line title displays full rated thrust.

④ Takeoff Derates

Not authorized.

⑤ PERF INIT

Push – Displays the PERF INIT page.

⑥ Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff

Data line title displays full rated thrust or selected takeoff derate thrust.

Data line title changes to RED XXK N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. The reference N1 bugs still display full rated takeoff thrust N1 values.

⑦ Climb (CLB)

Push – Selects full rated climb thrust limit.

Climb thrust is automatically selected at the thrust reduction point on the TAKEOFF REF page 2.

⑧ Reduced Climb (CLB-1 and CLB-2)

Push – Selects the associated reduced thrust climb mode.

CLB-1 provides a climb limit reduced by 3% N1 (approximately 10% thrust). CLB-2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

Manual selection of a climb thrust rating overrides the automatic selection.

Takeoff data uplink may automatically select a thrust derate.

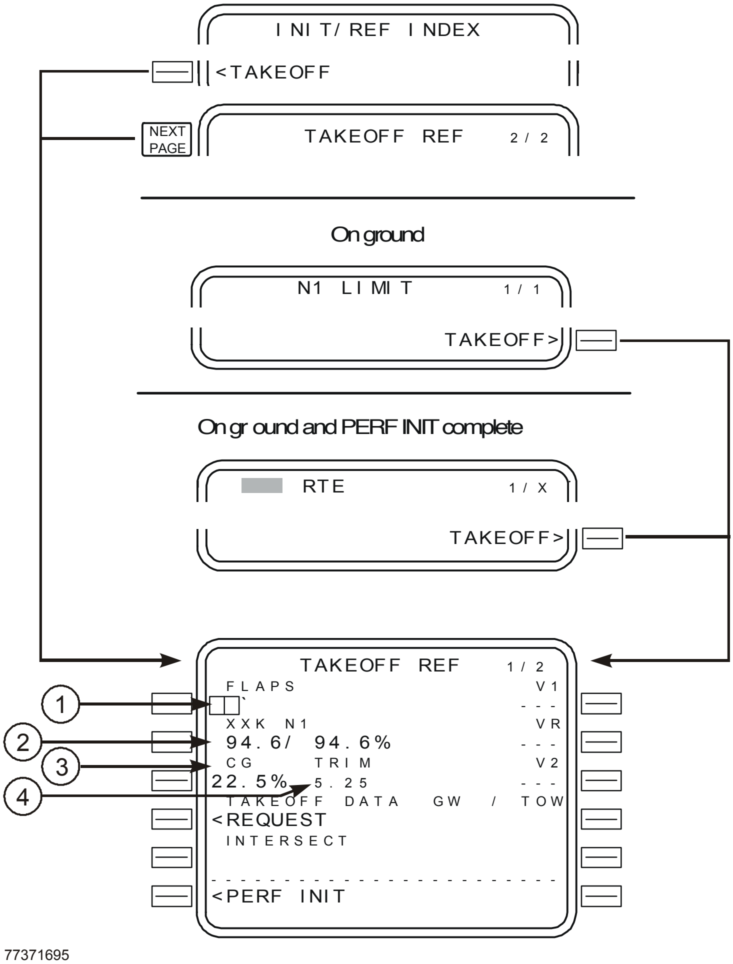
⑨ TAKEOFF

Push – Displays the TAKEOFF REF page.

Preflight Pages 3 - Takeoff Reference Page

The TAKEOFF REFERENCE page allows management of takeoff performance. Takeoff flap setting and V speeds are entered and verified. Thrust limits, takeoff position, CG, and trim can be verified or changed. Preflight pages are selectively displayed to indicate preflight status whenever required entries on those pages are incomplete.

TAKEOFF REFERENCE page entries finish the normal preflight. V speeds should be set before completion. FMC position can be updated for takeoff.



① FLAPS

Enter takeoff flap setting.

② Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff.

Data line title displays full rated thrust.

Data line title changes to RED XXK N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. The Reference N1 bugs display full rated thrust N1 values.

③ Center of Gravity (CG)

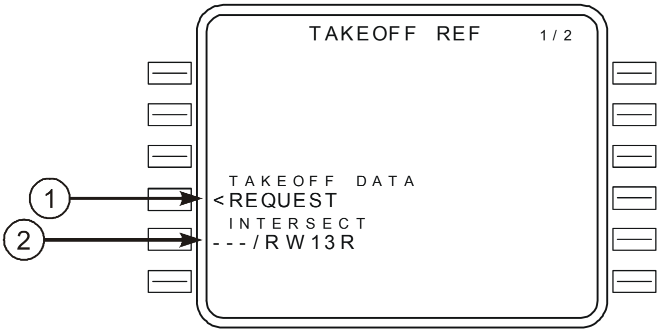
Initial display is dashes.

④ TRIM

Displays stabilizer takeoff trim setting.

Display is blank unless FLAPS and CG are entered.

TAKEOFF REF Page FMC Data Link



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7 8 9

① TAKEOFF DATA REQUEST

Push – Transmits a data link request for a takeoff data uplink. Resulting TAKEOFF REF uplink may contain takeoff data for up to 6 runways, which are stored in FMC uplink memory.

② Intersection (INTERSECT)

Displays active runway.

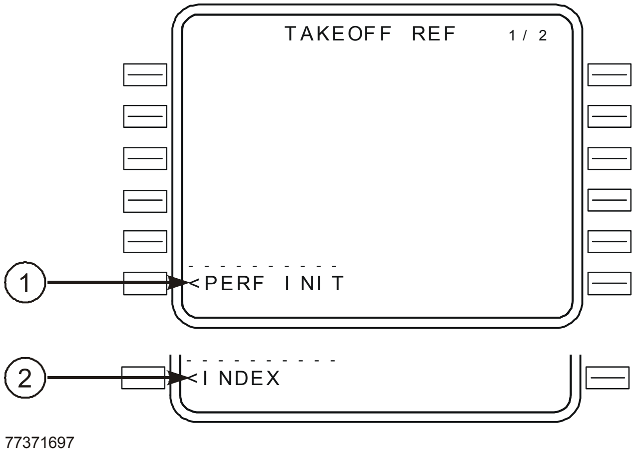
An intersection may be entered. Valid entries are 1 to 3 alphanumerics.

If an intersection is entered and TAKEOFF DATA REQUEST is made, the runway / intersection pair is included in the request downlink.

If the displayed runway or runway / intersection pair matches a runway or runway / intersection pair in FMC uplink memory, the associated **TAKEOFF REF UPLINK** is annunciated for flight crew **ACCEPT/REJECT**.

Preflight Status

When the required preflight entries are complete, the **INDEX** prompt is displayed below the TAKEOFF REFERENCE page data. When required preflight entries are not complete, the related page title replaces the **INDEX** prompt.



① Preflight Incomplete

When required preflight entries are not complete, the related page title displays:

- POS INIT – IRS position not entered or invalid.
- PERF INIT – Required performance data not entered or executed.
- ROUTE – Required RTE page data not entered or executed.
- DEPARTURE – Runway or route data not entered on the RTE page.
- N1 LIMIT – OAT not entered.

Push – Displays associated page.

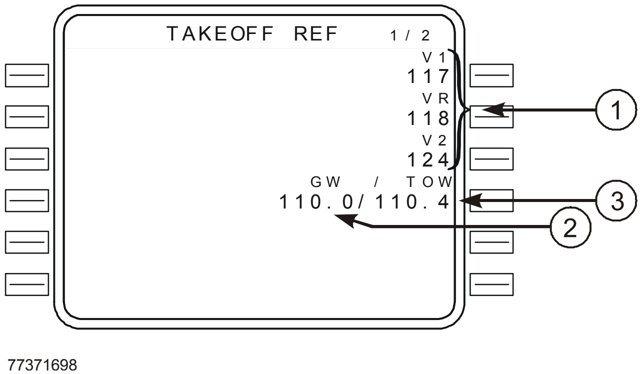
③ 3 5

② Preflight Complete (PRE–FLT COMPLETE)

Displayed following completion of required entries on the POS INIT, RTE, and PERF INIT pages.

Push – Displays INIT REF INDEX page.

V Speed Data



① V Speeds (V1, VR, and V2)

Crew calculated V speeds may be entered and displayed for reference.

V speeds may be uplinked, as installed.

Large font V speeds are displayed on the airspeed tape indication or MASI.

② Gross Weight (GW)

Displays current gross weight.

③ Takeoff Weight (TOW)

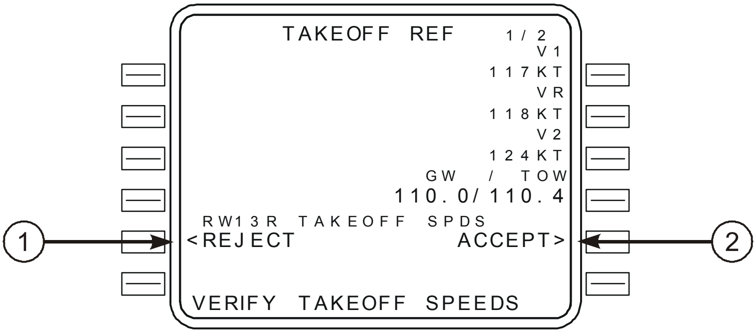
Displays gross weight the uplink V speeds are based on.

Blank if there are no uplinked V speeds in the column above.

Change of Performance Data After V Speed Entry

V speeds should be entered on the TAKEOFF REF page as a final step of FMC preflight. If V speeds are entered and then performance data (for example, OAT or takeoff thrust) is subsequently changed, the FMC automatically removes the previously entered V speeds.

In addition, the scratchpad message **VERIFY TAKEOFF SPEEDS** displays if gross weight or zero fuel weight are changed after V speeds have been entered. The previously entered V speeds are displayed in small font on the TAKEOFF REF page.



77371699

① REJECT

Displayed if V speeds have been entered and aircraft gross weight or ZFW has been changed.

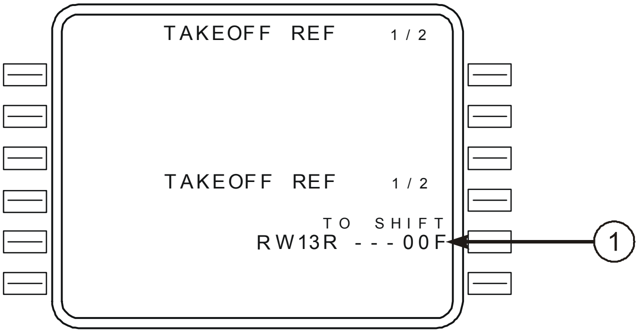
Selection causes the now small font V speeds to disappear.

② ACCEPT

Displayed if V speeds have been entered and aircraft gross weight or ZFW has been changed.

Selection changes the small font V speeds to large font.

Preflight Pages 4 – FMC Takeoff Position Update



773716100

① Takeoff Shift (TO SHIFT)

Automatically displays the departure runway from the ROUTE page.

③ The FMC updates to the runway threshold when the FMC POS UPD is line-selected and executed.

3 5 The FMC updates to the runway threshold when TO/GA is pushed. If a takeoff shift distance is entered, the FMC updates to the threshold of the departure runway plus the entered distance when the TO/GA switch is pushed.

7 8 9 If a takeoff shift distance is not entered and GPS UPDATE is OFF, the FMC updates to the runway threshold when TO/GA is pushed.

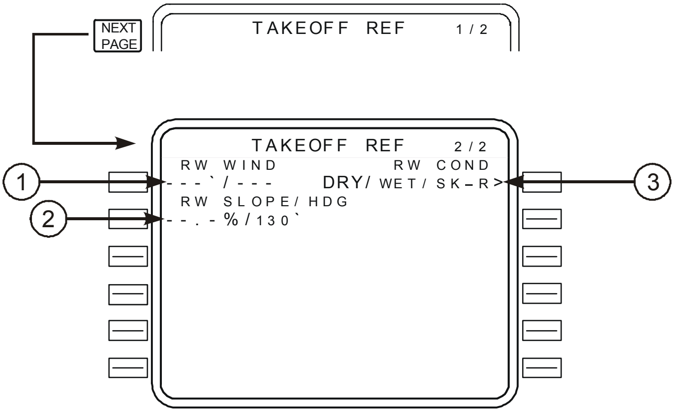
If a takeoff shift distance is entered and GPS UPDATE is OFF, the FMC updates to the threshold of the departure runway plus the entered distance when the TO/GA switch is pushed.

TO/GA position update inhibited if GPS UPDATE is ON.

Following TO/GA update, the runway identifier and any entered shift value are highlighted in reverse video characters.

To remove a TO SHIFT entry, reselect RWY on the RTE page.

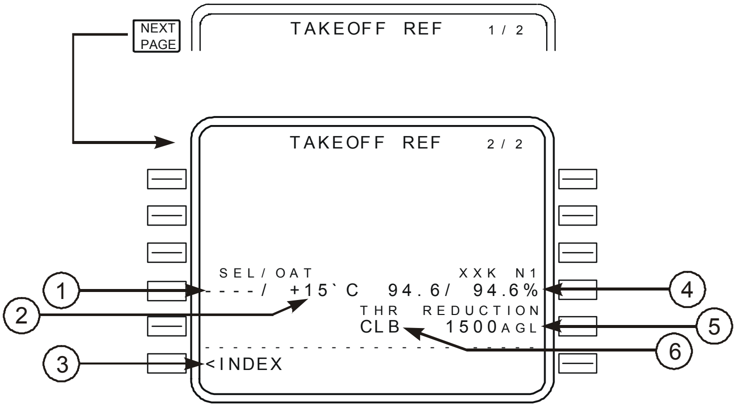
Takeoff Reference Page 2/2



773716101

7 8 9 The above three fields are not input for Continental B737 operations.

Takeoff Reference Page 2/2 – Takeoff Thrust



773716102

① Selected Temperature (SEL)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F). The FMC, however, will limit the N1 to 25% takeoff reduction.

Repeats data shown on the preflight version of the N1 LIMIT page.

② Outside Air Temperature (OAT)

Manual entry of actual takeoff OAT is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

③ INDEX

Push – Displays the INIT/REF INDEX page.

④ Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff.

Data line title should display full rated thrust. A derate selection is not authorized.

Data line title changes to RED XXK N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. The reference N1 bugs display full rated or selected takeoff derate thrust N1 values.

Repeats the same information shown on TAKEOFF REF page 1 and the preflight version of the N1 LIMIT page.

7 8 9

⑤ Thrust Reduction (THR REDUCTION)

Altitude above origin airport elevation at which the autothrottle reduces from takeoff N1 to climb N1.

The default is displayed in small font.

Manual entries allowed on the ground. Entries must be between 800 feet and 9999 feet and are displayed in large font.

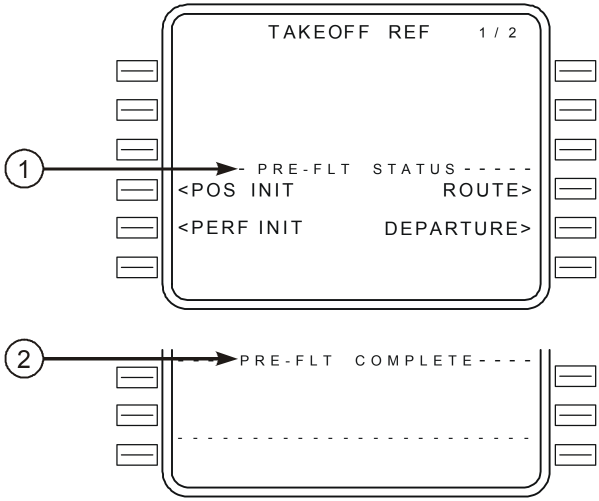
Deletion of a manual entry returns the display to the default value.

7 8 9

⑥ Selected Climb Rating

Displays the climb rating that will be set at the THR REDUCTION altitude, as selected on the preflight version of the N1 LIMIT page.

Preflight Status



773716103

③ 3 5

① Preflight Status (PRE-FLT STATUS)

Displays when required preflight data is not complete. Lines below are selectively displayed to allow line selection of incomplete pages:

- **POS INIT** shows if a valid IRS position entry disagrees with the position determined by any IRS in the ALIGN mode; otherwise blank.
- **PERF INIT** shows if any required PERF INIT entries not completed; otherwise blank.
- **ROUTE** shows if a route is not active; otherwise blank.
- DEPARTURE shows if RTE page 1 displays prompts for RUNWAY and VIA lines; otherwise blank.
- **N1 LIMIT** shows if valid OAT has not been entered.

③ 3 5

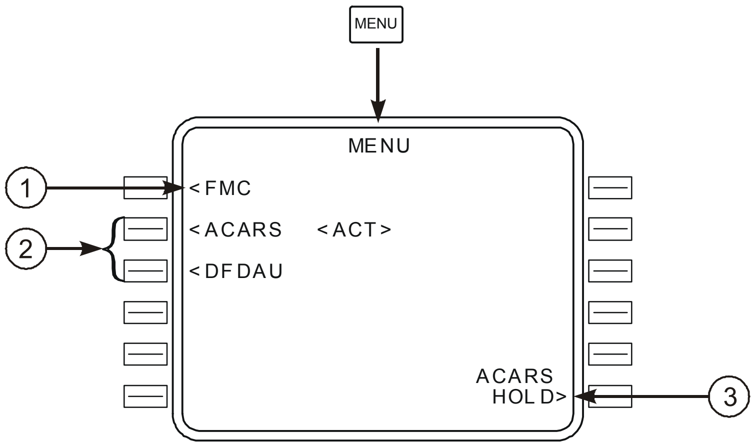
② Preflight Complete (PRE-FLT COMPLETE)

Displayed following completion of required entries on the POS INIT, RTE, and PERF INIT pages.

7 8 9 MENU Page

The MENU page is selected with the MENU key or is automatically displayed when the currently active subsystem fails or on initial power up if the FMC system is not detected.

The MENU page displays subsystems (ACARS, DFDAU, etc.) that require control / display functions through the MCDU and provides a means to temporarily access to these subsystems. The active system is indicated by **<ACT>** displayed next to the system title. A subsystem that requires use of the CDU displays a request message **<REQ>** next to the subsystem title. The FMC system or a requesting subsystem is accessed by using the line select key next to the title. The FMC can be reselected by selecting the FMC prompt on the MENU page or selecting any mode key (INIT/REF, RTE, etc.). A subsystem can be temporarily placed on hold **<HLD>** by selecting the subsystem XXXXXX HOLD> line select key returning the CDU display to the currently active FMC page (XXXXXX represents the system name). While the subsystem is on hold the **MCDU CALL** light is illuminated. To reselect the subsystem on hold, push the subsystem line select key again. When a subsystem is placed on hold a **XXXXXX LOGOFF** prompt appears to allow for release of the subsystem being held. No more than one subsystem can be selected at a time. If an attempt is made to select more than one subsystem, a **FIRST LOGOFF XXXXXX** prompt is displayed as a reminder to logoff the currently active subsystem.



773716104

① FMC

Push – Selects FMC as the system for which the MCDU will be active in providing control / display function.

② Other Aircraft Subsystems (typical)

Push – Selects the subsystem for which the MCDU will be active in providing control / display function.

③ XXXXXX HOLD/LOGOFF

Push - Places active subsystem on hold or logs off subsystem and returns control to the FMC.

FMC TAKEOFF AND CLIMB

Introduction

The FMC takeoff phase begins with the selection of takeoff / go-around (TO/GA). Preparation for this phase begins in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when climb thrust is selected. The climb phase continues to the top of climb point, where the cruise phase begins.

During these phases, the following pages are normally used:

- TAKEOFF REF page – To make last minute changes to the departure runway.
- DEPARTURES page – To make last minute changes to the SID.
- CLIMB page – To modify climb parameters and monitor aircraft climb performance.
- RTE LEGS page – To modify the route and monitor route progress.
- PROGRESS page – To monitor the overall progress of the flight.
- N1 LIMIT page – To select alternate climb thrust limits.
- DEP/ARR INDEX page – To select an approach during a turn-back.

Takeoff Phase

When last minute changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modifications are performed the same as during preflight.

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to V2+20 knots.

LNAV can engaged at 400 feet and provide roll commands to fly the route leg. With proper CLB page programming, VNAV can be engaged during the takeoff profile.

Climb Phase

VNAV commands acceleration to:

- 250 knots
- Waypoint speed constraints, or
- The speed restriction associated with the origin airport, or
- Speed constraints input to the CLIMB page, whichever is the most restrictive.

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority if slower than target speed.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level-off for a crossing altitude constraint is accomplished at the current commanded speed.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the CDU scratchpad message **UNABLE NEXT ALTITUDE**. A different speed profile that provides a steeper climb angle must be manually selected.

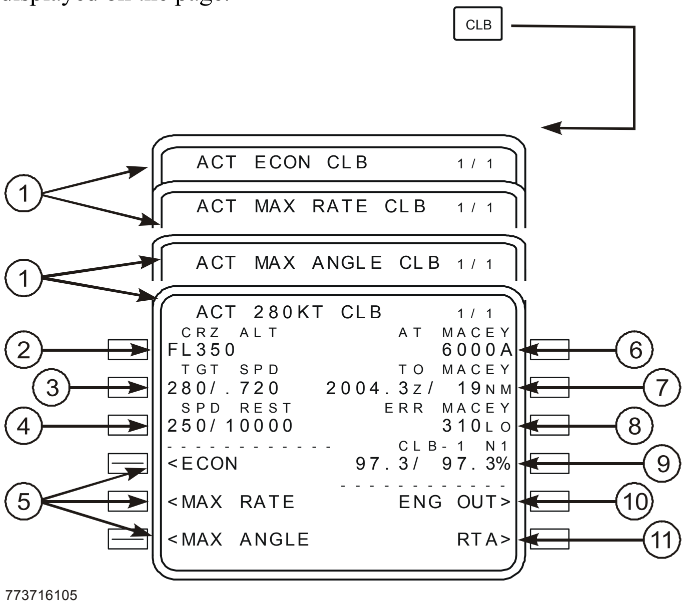
If CLB 1 or CLB 2 is selected, the selected thrust is maintained for the initial part of the climb. Thrust eventually increases to maximum climb thrust by 15,000 feet.

Climb Page

The CLIMB page is used to evaluate, monitor, and modify the climb path. The data on the CLIMB page comes from preflight entries made on the route and performance pages.

The CLIMB page is automatically selected by pushing the CLB function key on the ground and during takeoff and climb. The TAKEOFF REF page automatically transitions to the CLIMB page after takeoff.

The FMC climb mode can be economy or fixed speed. In either mode, similar data is displayed on the page.



① Page Title

The page title displays the type of climb. Normally, the title displays **ECON** for the economy climb mode. Fixed speed climbs modify the title.

ECON indicates the speed is based on a cost index.

MAX RATE indicates the speed is based on the maximum altitude over the shortest period of time.

MAX ANGLE indicates the speed is based on the maximum altitude over the shortest horizontal distance.

Fixed climb speeds display **XXXKT** for a fixed CAS climb speed or **M.XXX** for a fixed Mach climb speed profile. Reasons for fixed speeds are:

- Takeoff / climb acceleration segment constraints
- Waypoint speed constraints
- An altitude constraint associated with a speed constraint
- A speed restriction
- A crew entered speed.

Displays **ACT** when the climb phase is active.

② Cruise Altitude (CRZ ALT)

The cruise altitude from the PERF INIT page is displayed. A new altitude can be manually entered.

③ Target Speed (TGT SPD)

Displays computed values or manually entered values for the selected mode. Computed speed is limited to a maximum of 335 knots/M.809.

Airspeed and/or Mach may be entered using the keyboard. Title displays manually entered value.

The active controlling speed is highlighted in reverse video.

④ Speed Restriction (SPD REST)

The speed restriction line displays the speed restriction / altitude from one of the following sources:

- The navigation database value for the origin airport.
- Waypoint related restriction from the RTE LEGS page if restriction limits climb speed.
- A default speed of 250 knots and 10,000 feet (example 250/10000).
- Displays **XXX/FLAPS** if the active speed restriction is lower than the minimum speed for the selected flap setting.
- Displays **XXX/HOLD** when decelerating to hold speed prior to hold entry fix.

Dashes displayed if no active speed restriction exists.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

If the FMC default speed restriction is overwritten, it will be deleted and not return after the overwrite condition passes (e.g. the default of 250/10000 is overwritten to 230/3000, after 3000 feet is passed there will be no speed restriction and VNAV will accelerate to the unrestricted climb speed.

The active controlling speed is highlighted in reverse video.

⑤ Climb Page Prompts

PUSH – Selects various CLB pages.

Following line selection, the prompt for that page blanks.

⑥ AT XXXXX

The waypoint constraint line displays the next waypoint having an altitude constraint. Constraints are entered on the RTE LEGS page or by departure procedure selection. The constraints can be deleted on this page or the RTE LEGS page. The waypoint may be a HOLD AT point.

Display is blank if no restriction exists.

⑦ TO XXXXXX

Displays ETA and distance to go to waypoint on AT XXXXXX line.

If no waypoint constraint exists, values are for CRZ ALT.

⑧ Error (ERR XXXXX)

Displays predicted altitude undershoot for the waypoint on AT XXXXXX line.

During VNAV operation, the FMC commands a level off if an overshoot is predicted.

Display is blank, including the label, if no error exists.

⑨ Reduced Climb N1 (CLB – X N1)

Displays reduced climb N1 value.

Blank when reduced climb not selected.

Displays the computed climb N1 value.

⑩ Engine Out (ENG OUT)

Selection displays **RT ENG OUT** and **LT ENG OUT** prompts.

⑪ Required Time of Arrival (RTA)

Displays the RTA PROGRESS page.

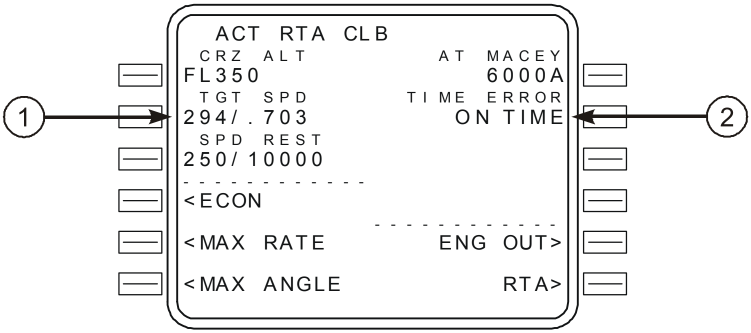
ERASE prompt replaces RTA during a page modification.

RTA Climb Page

The RTA CLIMB page is displayed when a required time of arrival is active.

The RTA CLIMB page is automatically selected by pushing the CLB function key when RTA is active.

Displays on this page are the same as other climb pages except as noted.



773716106

① Target Speed (TGT SPD)

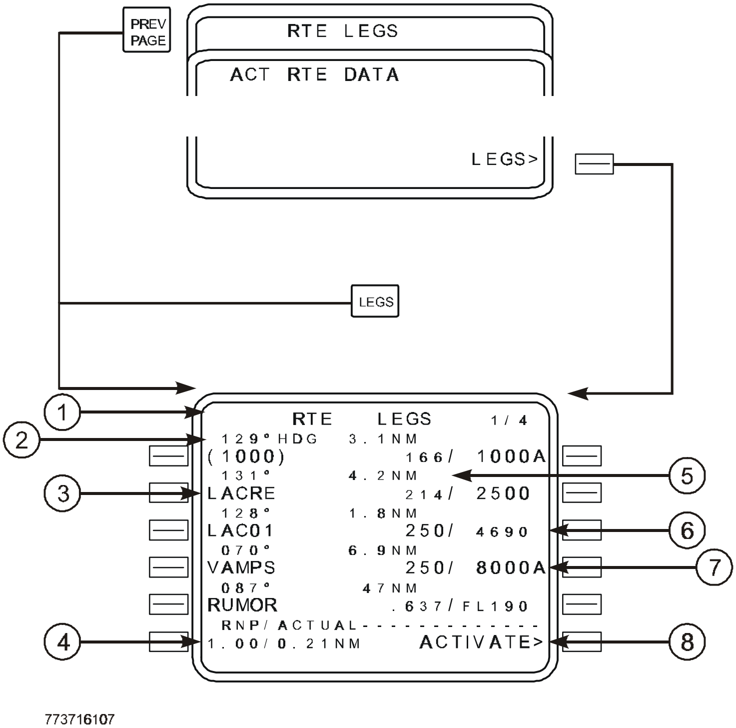
Displays computed speed required to meet entered RTA.

When RTA is exited by waypoint sequence or deletion this speed changes to FMC target speed.

② TIME ERROR

Displays computed time error at RTA waypoint. Same as RTA PROGRESS page.

RTE LEGS Page



① Page Title

An active ROUTE LEGS page title is displayed with **ACT** as part of the title. A modified page title displays a reverse video MOD.

② Leg Direction

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (**xxx°**) or true (**xxx° T**). Directions to maintain an arc display the arc distance, the word **ARC** followed by the direction, and left or right (**24 ARC L**). The computed great circle route leg directions may be different than chart values. Heading leg segments to conditional waypoints are displayed as (**xxx° HDG**) and track leg segments are displayed as (**xxx° TRK**). Directions may be displayed as special procedural instructions, such as **HOLD AT** or **PROC TURN**.

Display is blank for an undefined course.

③ Waypoint Identifier

The current active leg is always displayed at the top of the first active RTE LEGS page.

All route waypoints are displayed. Waypoints on an airway are included on the ROUTE LEGS page. Waypoints appear in flight sequence.

Waypoints can be entered and moved. This includes:

- Adding new waypoints
- Resequencing existing waypoints
- Removing existing waypoints
- Linking route discontinuities.

Displays the waypoint by name or condition.

Box prompts are displayed for route discontinuities.

Dashes are displayed for the next line beyond the end of the route.

④ Required Navigational Position / Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigaion accuracy (ANP).

Manual entry is allowed for RNP.

⑤ Distance to Waypoint

Displays the distance from the aircraft or the waypoint to the next waypoint.

⑥ Calculated Waypoint Speed / Altitude

Displays the calculated speed or altitude at the waypoint in small font.

⑦ Specified Waypoint Speed / Altitude

Displays any waypoint speed or altitude constraint in large font.

Manual entry is allowed.

⑧ ACTIVATE, RTE DATA

The **ACTIVATE** prompt is displayed on the LEGS page when the route is not active. When the ACTIVATE prompt key is pushed, the route must be executed by pushing the execute function key.

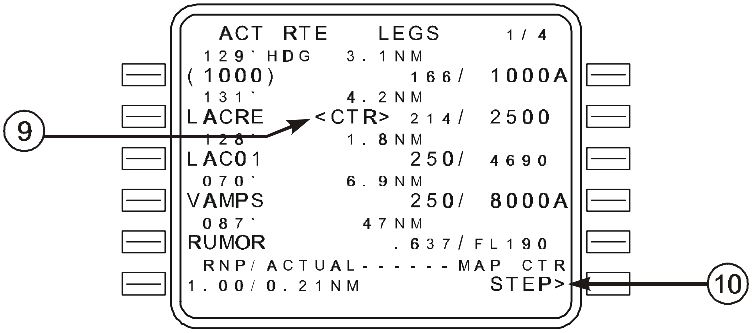
The route data prompt replaces the **ACTIVATE** prompt when the route is executed. The **RTE DATA** prompt displays the route data page.

Push –

- **ACTIVATE** is displayed when an inactive route is displayed.
- **RTE DATA** replaces **ACTIVATE** for active routes and displays the route data page.

Map Center Step Display

The map center step prompt replaces **ACTIVATE** or **RTE DATA** when the EFIS control panel mode selector is placed in the PLAN position. Pushing the prompt key advances the waypoint that is displayed in the center of the navigation display. The label **<CTR>** is displayed to the right of the corresponding waypoint on the RTE LEGS page.



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⑨ Map Center Label (<CTR>)

Identifies the waypoint around which the map display is centered.

Whenever the EFIS mode selector is positioned to PLAN, the label is automatically displayed for the first geographically fixed waypoint on the displayed page.

⑩ STEP

Displayed on a CDU when PLAN is selected on the associated EFIS control panel. Replaces the **RTE DATA** or **ACTIVATE** prompt.

Push – Moves the map center label to the next geographically fixed waypoint in the route.

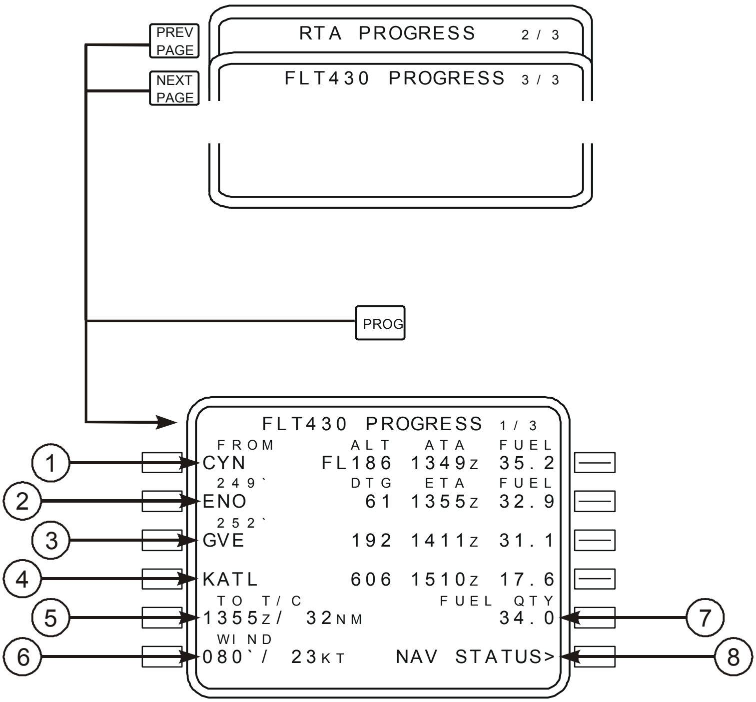
PROGRESS Page 1/3

The progress page provides general flight progress information along the route of flight.

The page title displays the company flight number from the RTE page in the title.

Page one of the progress pages displays general information (distance-to-go, ATA, ETA, fuel remaining estimates) about the following:

- Waypoints (last, active and next)
- Destination information
- Altitude change points
- Current wind
- Fuel quantity.



773716109

① FROM

Displays the identifier of the last (FROM) waypoint, the altitude (ALT), the actual time of arrival (ATA), and the fuel at that waypoint.

② Active Waypoint

Displays the identifier of the active waypoint, the flight plan course to the active waypoint, and distance-to-go (DTG) from present position to the active waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the active waypoint. The active waypoint is highlighted by reverse video.

③ Next Waypoint

Displays the identifier of the next waypoint which follows the active waypoint, the flight plan course for that leg, and flight plan distance-to-go (DTG) from present position to the next waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the next waypoint.

④ Destination

Displays the identifier of the destination airport (DEST) and flight plan distance-to-go (DTG) from present position to the destination. Also displays estimated time of arrival (ETA) and predicted fuel remaining at the destination.

When a route modification is in progress, the destination line label displays **MOD**. Performance predictions include the modification.

⑤ Altitude Change Point (TO XXXXX)

Displays **ETA** and distance to go to the following altitude change points as appropriate to phase of flight:

- TO T/C: to top of climb for the active climb
- TO STEP POINT: to the step point if a STEP TO entry is made on CRZ page
- TO T/D: to top of descent, if no STEP TO entry is made on CRZ page
- TO E/D: to the end of descent waypoint for an active path descent; blank if a path descent is not available.

⑥ WIND

Displays current true wind direction and speed.

⑦ Fuel Quantity (FUEL QTY)

Displays the present total fuel quantity remaining as obtained from the aircraft fuel quantity indication system.

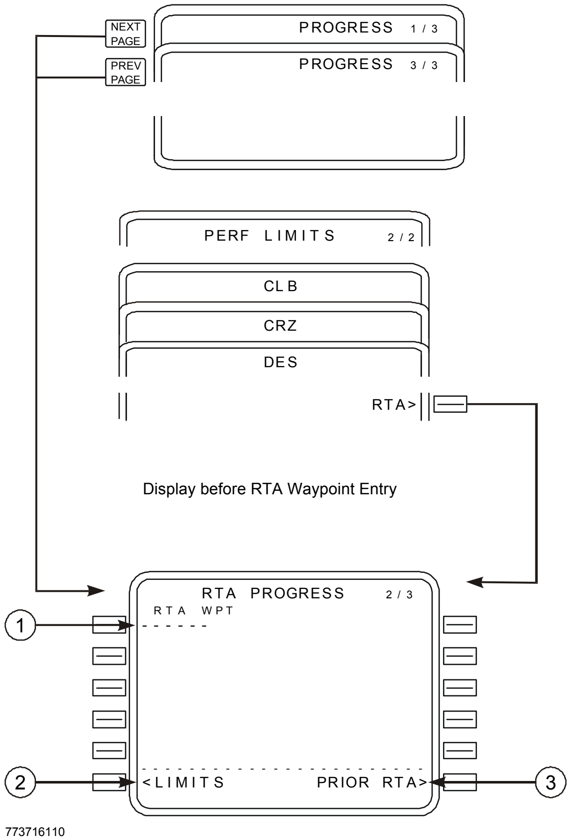
⑧ NAV STATUS

Push – Displays the navigation status page.

RTA PROGRESS Page 2/3

RTA PROGRESS page is used to initiate the required time of arrival (RTA) mode.

The RTA page provides advisory data on flight progress in the RTA mode and advises of control times such as recommended takeoff time to meet RTA.

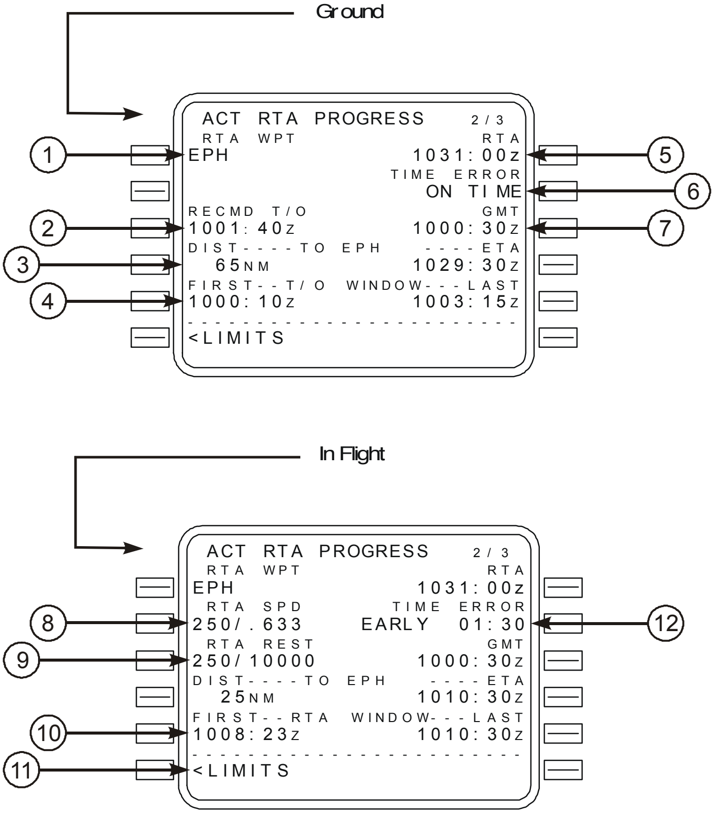


① Required Time of Arrival Waypoint (RTA WPT)
Displays dashes when entry allowed.

② LIMITS
Displays the PERF LIMITS page.

③ Prior RTA Waypoint (PRIOR RTA)
Prompt displayed when the RTA waypoint field contains dashes and a previous RTA waypoint is still in the flight plan; otherwise blank.
Push – Displays last active RTA waypoint data.

RTA PROGRESS On Ground And In Flight



773716111

① Required Time of Arrival Waypoint (RTA WPT)

Waypoint entry must be in flight plan or the CDU message **NOT IN FLIGHT PLAN** is displayed.

Entering a valid waypoint generates a MOD RTA PROGRESS page and illuminate the **EXEC** light.

Deletion of the RTA waypoint creates a MOD RTA PROGRESS page with all data blanked and **EXEC** light illuminated. Execution will exit the RTA mode.

Deletion of the RTA waypoint does not remove the waypoint from the flight plan.

Automatically clears the RTA waypoint and exits the RTA waypoint after sequencing the RTA waypoint out of the flight plan.

② Recommended Takeoff Time (RECMD T/O)

Displays the recommended takeoff time to meet the planned RTA.

Time is based on entered cost index.

③ Distance To RTA Waypoint (DIST – – – – TO XXX)

Displays the distance to the RTA waypoint.

Displays ETA to the RTA waypoint based on:

- Immediate takeoff
- MIN/MAX speeds on PERF LIMITS page
- Entered forecast winds.

④ Takeoff Window (FIRST – – T/O WINDOW – – – LAST)

Displays earliest and latest takeoff times to meet the planned RTA.

Times are based on minimum and maximum speeds on the PERF LIMITS page.

⑤ Required Time of Arrival (RTA)

After RTA waypoint entry, initially displays current ETA based on the active flight plan and performance parameters at time of waypoint entry.

Desired RTA may be entered by overwriting displayed data.

Entry must be in one of the following forms:

- XXXXXX (hr/min/sec)
- XXXX (hr/min)
- XXXX.X (hr/min/tenths of min).

Entry of "A" after RTA specifies arrival time of at or after.

Entry of "B" after RTA specifies arrival time of at or before.

⑥ TIME ERROR

Displays the most recent time error in minutes and seconds up to a maximum of 59:59 minutes.

Displays **ON TIME** if GMT is within current T/O WINDOW.

Displays **EARLY** or **LATE** as appropriate if GMT is not within current T/O WINDOW.

⑦ GMT

Displays the actual GMT.

⑧ Required Time of Arrival Speed (RTA SPD)

Displays the target speed required to meet the planned RTA.

Same as speed displayed on RTA CLB, CRZ, or DES page.

Limited by MIN/MAX speeds on the PERF LIMITS page and the SPD REST line.

⑨ Required Time of Arrival Speed Restriction (RTA REST)

Displays the current speed restriction affecting RTA progress.

⑩ Arrival Time Window (FIRST – – RTA WINDOW – – – LAST)

Displays earliest and latest achievable arrival times at the RTA waypoint.

Times based on MIN/MAX speeds on PERF LIMITS page, existing winds, and entered forecast winds.

⑪ LIMITS

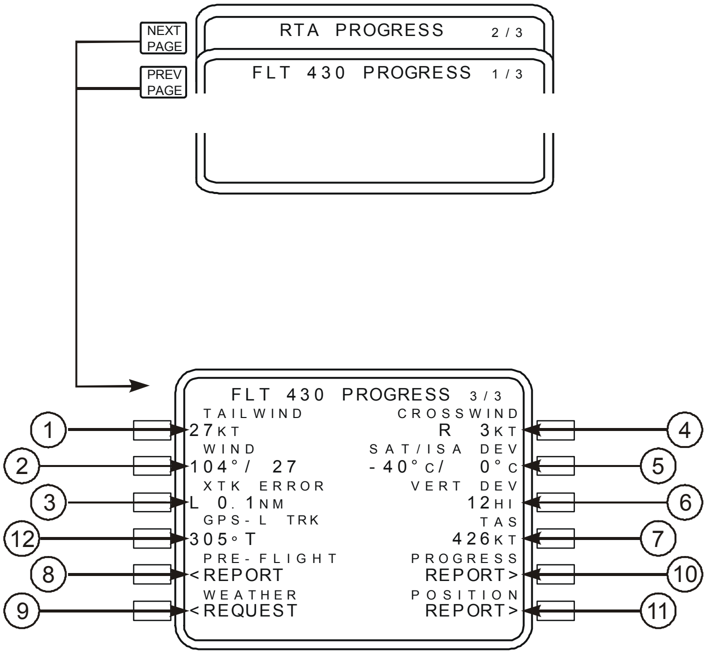
Push – Displays PERF LIMITS page.

⑫ TIME ERROR

In flight, displays difference between the ETA and the RTA plus the TIME ERROR TOLERANCE on the PERF LIMITS page.

PROGRESS Page 3/3

The PROGRESS page 3/3 displays wind, track, path, temperature, and speed data.



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① HEADWIND or TAILWIND

Displays the present headwind or tailwind component.

② WIND

Displays the present true wind direction / speed.

③ Crosstrack Error (XTK ERROR)

Displays present cross-track error from the desired LNAV course.

Blank if error is greater than 99.9 nm.

④ CROSSWIND

Displays present crosswind component (left or right).

⑤ Static Air Temperature / ISA Deviation (SAT/ISA DEV)

Displays present SAT and the equivalent ISA deviation.

⑥ Vertical Descent Path Deviation (VERT DEV)

Displays present computed deviation (HI or LO) from the FMC vertical path.

Blank if descent not active or path not available.

⑦ TAS

Displays present TAS.

7 8 9

⑧ PRE-FLIGHT REPORT

Push – Transmits downlink report of preflight data.

⑨ WEATHER REQUEST

Push – Transmits a data link request for a weather uplink.

⑩ PROGRESS REPORT

Push – Transmits a downlink report of progress data.

⑪ POSITION REPORT

Push – Transmits a downlink report of position data.

⑫ GPS-L TRK

Displays GPS track.

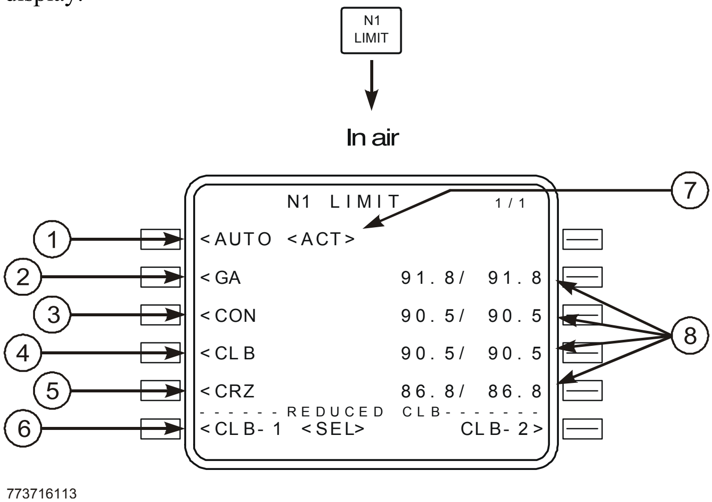
N1 LIMIT Page

Normally, N1 limits are automatically specified. Pilot selection of other limits is allowed.

Pilot selection of a reduced climb mode does not change the automatic selection for other phases of flight.

Pilot selected mode is automatically replaced by AUTO selection when the autopilot next changes vertical mode.

The active thrust limit is used by the autopilot and is displayed on the thrust mode display.



① AUTO

Push – Selects automatic computation of N1 limits for all phases of flight.

② Go Around (GA)

Push – Selects the go-around thrust limit.

③ Continuous (CON)

Push – Selects the maximum continuous thrust limit.

④ Climb (CLB)

Push – Changes the thrust mode from AUTO to the active climb thrust, i.e. CLB, CLB-1, or CLB-2.

⑤ Cruise (CRZ)

Push – Selects the cruise thrust limit.

⑥ Reduced Climb (REDUCED-CLB)

Push – Selects either of two reduced climb thrust modes.

CLB-1 provides a climb limit reduced by 3% N1 (approximately 10% thrust).

CLB-2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

The reduced climb N1 value is displayed on the CLB pages.

If either mode is <SEL>, deletion allows return to full rated climb thrust.

Any reduced climb selection is automatically deleted above 15,000 feet.

If a reduced thrust takeoff has been specified on the TAKEOFF REF page, then either CLB-1 or CLB-2 may be automatically specified if required to avoid a climb N1 value greater than the RED-TO N1.

⑦ ACT> STATUS LABEL

Identifies the active N1 thrust limit.

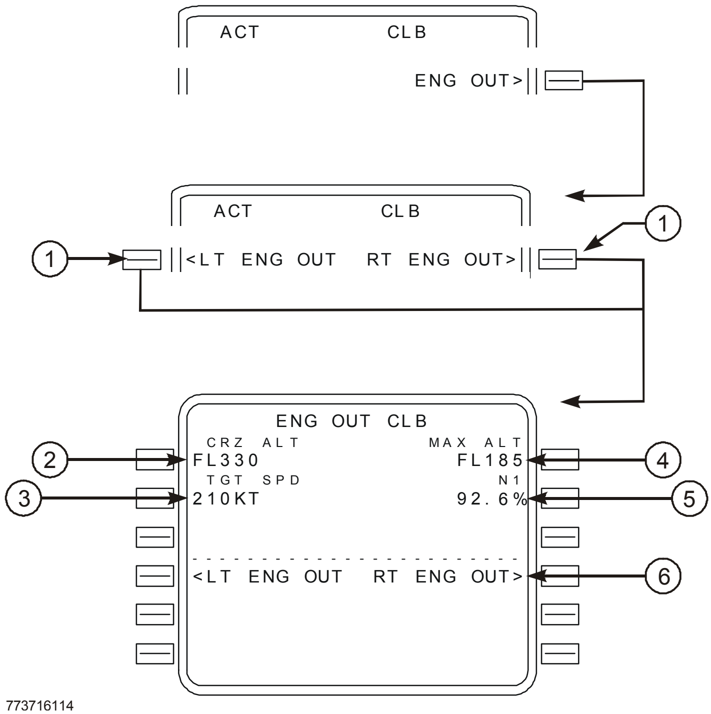
⑧ N1

Displays the N1 for individual thrust limits based on present conditions and bleed air configuration.

If CLB-1 or CLB-2 is selected, the N1% for CLB and the N1 cursors still display values for full rated climb.

Engine Out Climb

Engine out climb advisory data is available on the CLB page. Engine out data is also available with both engines operating. The engine out climb phase automatically transitions to the engine out cruise phase when reaching the cruise altitude.



① Engine Out Selection (LT ENG OUT RT ENG OUT)

Displayed after selection of **ENG OUT** prompt.

Selection of left or right engine changes display to MOD ENG OUT CLB page. The execute light does not illuminate. After viewing engine out data, select ERASE to return to the active climb mode.

② Cruise Altitude (CRZ ALT)

Displays the current cruise altitude. Manual entry is allowed.

③ Engine Out Speed (ENG OUT SPD)

Displays the engine out climb speed.

④ Maximum Altitude (MAX ALT)

Displays the maximum altitude at which company specified rate of climb can be achieved using one engine at maximum continuous thrust (default climb rate is 100 fpm).

After page selection, the FMC accounts for wing and engine anti-ice, air conditioning, and engine bleed of the operating engine.

⑤ Continuous N1

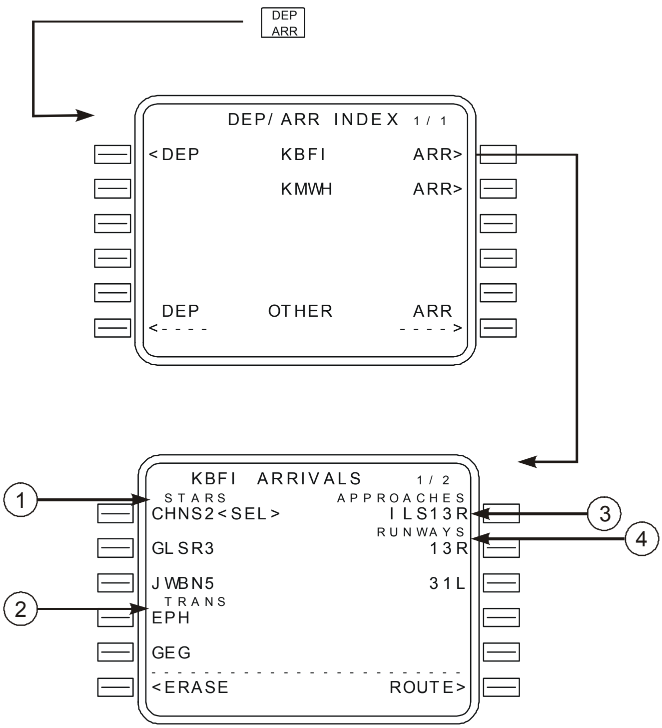
Displays the N1 for maximum continuous thrust.

⑥ ENG OUT

Reverse highlights the selected engine out.

Air Turnback – ARRIVALS Page

During a turn-back situation, the crew requires quick access to the arrival information for the origin airport. The departure / arrivals index and ARRIVALS page provide access without changing the destination on the route page.



773716115

① Standard Terminal Arrival Routes (STARS)

Displays **STARS** for the origin airport.

② Transitions (TRANS)

Displays transitions for the origin airport.

③ APPROACHES

Displays approaches for the origin airport.

④ RUNWAYS

Displays runways for the origin airport.

FMC CRUISE

Introduction

The cruise phase automatically begins when the top of climb is reached.

During cruise, the primary FMC pages are:

- RTE LEGS
- PROGRESS
- CRZ.

The RTE LEGS pages are used to manage route restrictions and modify the route. The PROGRESS pages display flight progress information. RTA requirements are also specified on the PROGRESS pages. The CRZ pages display VNAV related information. Other pages include:

- POS REF page – Verifies the FMC position.
- POS SHIFT page – Permits selection of preferred position from list of references.
- RTE DATA page – Displays progress data for each waypoint on the RTE LEGS page. Displays wind data for cruise waypoints.
- REF NAV DATA page – Displays information about waypoints, navaids, airports, or runways.
- LATERAL OFFSET page – Permits selection of a route offset.
- FIX INFO page – Displays information about waypoints, and can be used to create new waypoints and fixes.
- SELECT DESIRED WAYPOINT page – Permits selection of the desired waypoint from a list of duplicate named waypoints.
- NAV STATUS page – Displays information about available navigation aids.

The only cruise mode automatic page changes are the transition from climb to cruise at the top of climb point and from cruise to descent at the top of descent point.

LNAV Modifications

This section presents the normal techniques for modifying the route. The modifications include:

- Adding and deleting waypoints
- Resequencing waypoints
- Linking discontinuities
- Intercepting a course.

RTE LEGS Page Modifications

When modifications are made to the RTE LEGS page, several automatic prompt or identifying features assist in managing and executing the modifications, such as:

- **ERASE**
- **INTC CRS.**

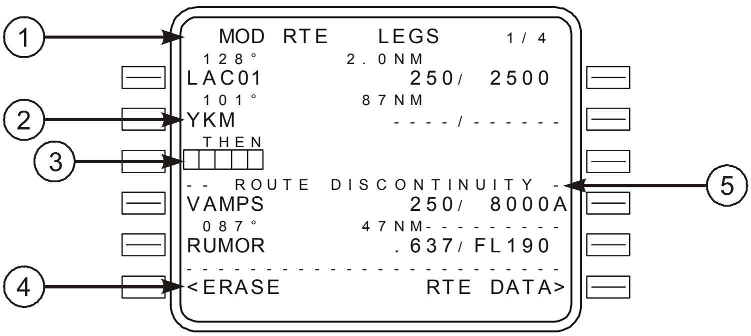
A waypoint can be added to the route whenever necessary.

The new waypoint must first be placed into the CDU scratchpad. Existing waypoints can be copied from a RTE LEGS page into the scratchpad by pushing the line select key adjacent to the desired waypoint.

The new waypoint is then inserted into the route at the desired sequence point by pushing the line select key adjacent to the desired location for the new waypoint. Using the NEXT PAGE/PREV PAGE function keys to select the desired location does not alter the CDU scratchpad. The new entry automatically links to the preceding waypoint via a direct route. Placing the new waypoint into the active waypoint line is a special case and is discussed under Intercept Course in this section.

All new waypoints, except along track waypoints, cause a route discontinuity between the new waypoint and the following waypoint.

If the FMC NAV database contains a HOLD pattern at the FAF, executing a database approach with a procedure turn and then executing a HOLD at the same FAF, using any inbound course, may cause a discontinuity between the FAF and the procedure turn. If the discontinuity is removed, LNAV guidance is available to fly the approach from the published holding pattern. LNAV guidance is not available to fly the published procedure turn.



773716116

① Page Title

When the page is modified, **MOD** appears in front of the title in reverse highlighting. This means the route is now altered. The **MOD** title also shows that the modifications are not yet executed and can be removed using the **ERASE** prompt.

② Modified Waypoint

YKM waypoint is entered into the route between LAC01 and VAMPS. This modification creates a route discontinuity.

③ Discontinuity Waypoint

Box prompts indicate the requirement to link the route by entering a route waypoint into the discontinuity waypoint position.

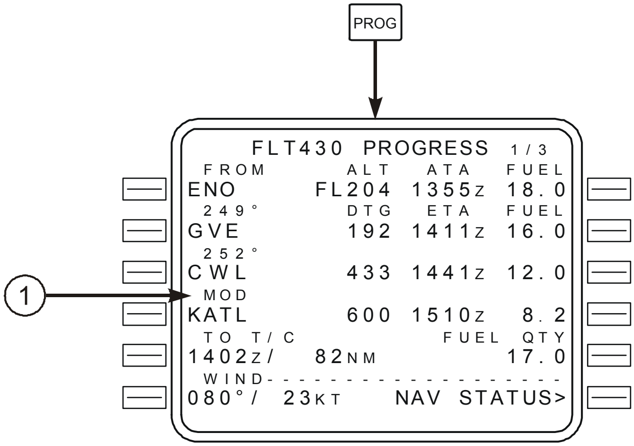
④ ERASE

The **ERASE** prompt is displayed when the first modification is entered. The prompt remains on the page until the modifications are erased or executed. Selecting **ERASE** removes all modifications and restores all active data.

⑤ Discontinuity Header

Indicates that the route is not continuous. Distance to destination on the PROGRESS page is not correct.

PROGRESS Page



773716117

① Modified (MOD)

Displays **MOD** when the route is being modified.

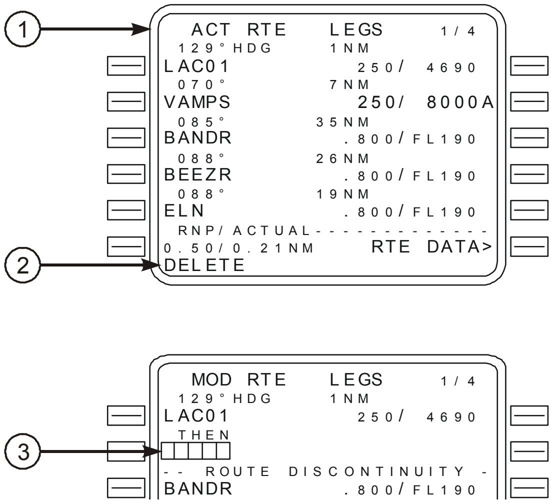
Line data is valid for the modified route.

Deleting Waypoints

Waypoints can be removed from the RTE LEGS page. There are two normal methods to remove a waypoint:

- Delete the waypoint using the DEL function key (not possible for the active waypoint and some conditional waypoints).
- Resequence the route by moving a down-route waypoint up in the sequence and automatically removing all waypoints that are between.

During the deletion process all of the route prior to the deletion point remains unchanged. Removing a waypoint using the DEL function key causes a route discontinuity to replace the deleted waypoint.



773716118

① Active Route

The existing route shows VAMPS followed by BANDR, BEEZR, and ELN.

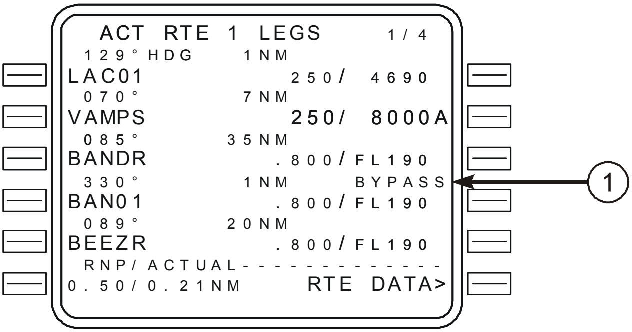
② DELETE Entry

Push the DEL key to arm the delete function. **DELETE** is displayed in the scratchpad.

③ Delete VAMPS

With **DELETE** displayed in the scratchpad, push the line select key left of VAMPS to delete the waypoint. Box prompts replace VAMPS and a route discontinuity follows the box prompts.

Leg Bypass



773716120

① Bypass Notification

A waypoint (BAN01) has been entered into the route, which is very close to another route waypoint (BANDR). It is impossible for the aircraft to turn and capture the leg between BANDR and BAN01, so a bypass is noted.

Turn construction is based upon FMC criteria, which assume that LNAV is engaged. Normal turn construction may not be possible under certain combinations of airspeed, short leg length, and a significant change in leg direction. If normal turn construction cannot provide a continuous path, the FMC bypasses the affected leg and uses alternative turn construction to intercept the leg to the subsequent waypoint. When the bypass is for the active waypoint, the waypoint remains active until the aircraft passes abeam.

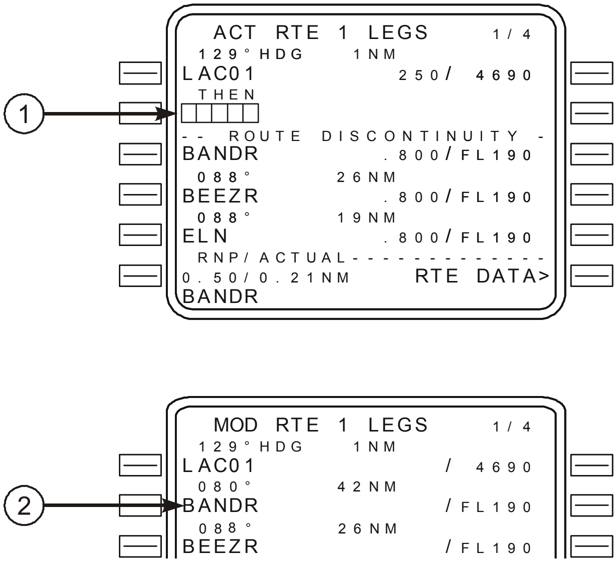
Any mandatory altitude-crossing restriction for the bypass waypoint is still observed if VNAV is engaged, based on passing abeam the waypoint.

If a double bypass condition occurs (bypass of two consecutive legs), a route discontinuity will be inserted.

Removing Discontinuities

A discontinuity exists when the FMC is unable to determine the route leg following a waypoint. Discontinuities are removed by linking the route segment following the discontinuity to the route segment preceding the discontinuity.

The next desired waypoint from the subsequent route is copied into the CDU scratchpad and entered into the discontinuity, just as when adding a waypoint.



773716121

① ROUTE DISCONTINUITY

The active route shows a discontinuity. The aircraft must fly direct from LAC01 to BANDR. The BANDR waypoint is copied into the scratchpad in preparation to remove the discontinuity. Any waypoint from the route can be copied into the scratchpad to remove the discontinuity.

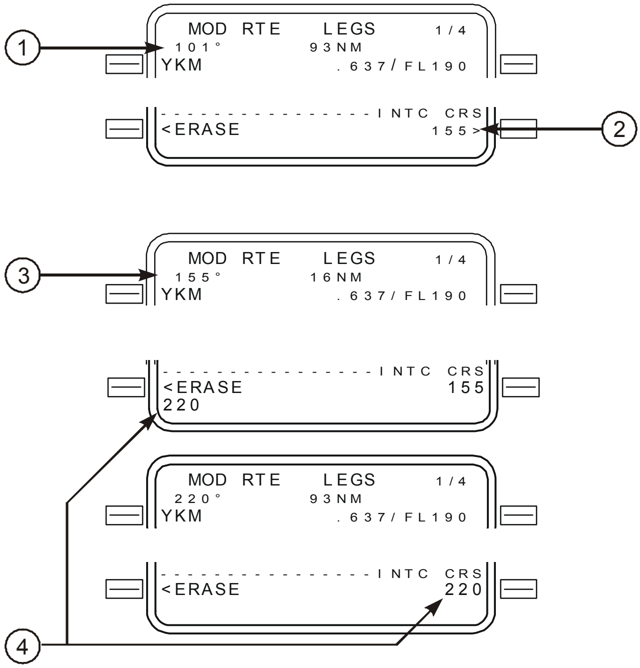
② Continuous Route

BANDR is copied into the box prompts to remove the discontinuity.

Entering a waypoin,t which does not already exist, on the route moves the discontinuity one waypoint farther down the route.

Direct To And Intercept Course

To fly direct to a waypoint or intercept a course to a waypoint, enter the waypoint name on RTE LEGS page, 1 active waypoint line. The **INTC CRS** prompt displays in line 6R. The example shows the result with YKM entered into the active waypoint line.



773716122

① Direct Course

Direct course from aircraft present position to entered waypoint.

Execute to proceed direct to active waypoint.

② Intercept Course (INTC CRS)

Push – Puts displayed course (155) into active waypoint leg direction. Enables intercept course function.

Displayed whenever the active waypoint name is modified.

Displays flight plan leg direction to entered waypoint in small font. Displays dashes if entered waypoint was not in the flight plan.

Valid input is any course from 000 through 360. May be changed until executed. Entered or selected value displays in large font.

③ Leg Direction

Displays the course inbound to the active waypoint after selecting the course displayed in the INTC CRS line.

④ Intercept Course (INTC CRS) – Change

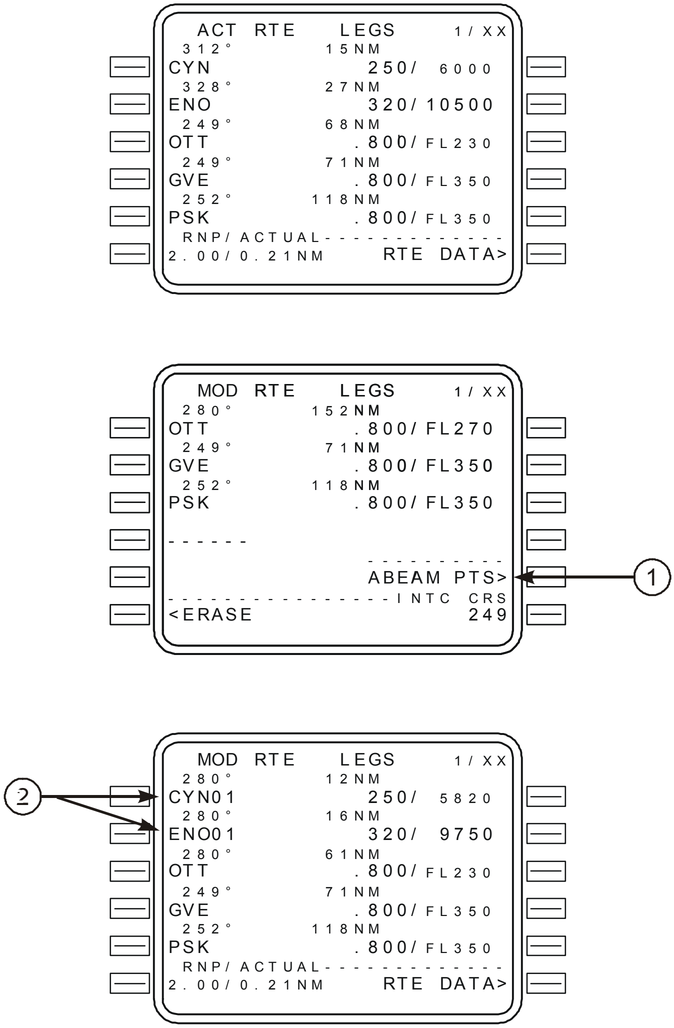
Enter the inbound intercept course to the modified waypoint in the scratchpad.

Select the INTC CRS line to change the leg direction.

The example shows 220° intercept course to YKM entered in the INTC CRS line.

Abeam Points

When a direct-to modification bypasses existing route waypoints, these bypassed points can be projected onto the new route as abeam points. Abeam points are perpendicular to the bypassed waypoints.



773716123

① Abeam Points (ABEAM PTS)

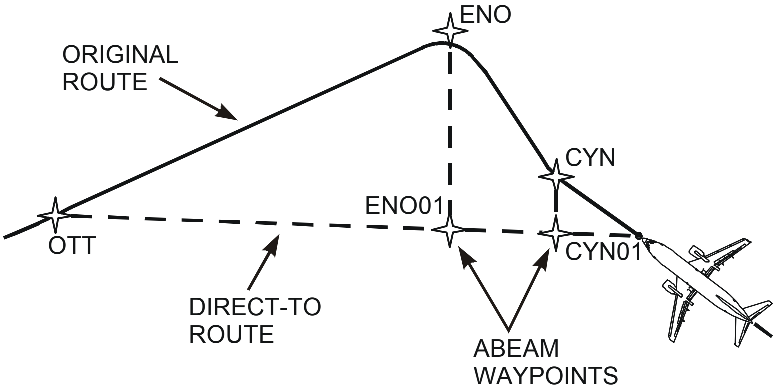
Selecting the prompt permits the retention of waypoints following a direct-to modification. The FMC creates and displays points on the new route which are abeam the waypoints bypassed by the route modification.

In the example, the route has been modified to proceed direct to OTT. This modification bypasses CYN and ENO.

② Abeam Waypoints

CYN01 and ENO01 have been created. Data and status corresponding to the parent waypoints is passed to the abeam waypoints. If abeam distance is less than 100 NM, only the wind data is passed to the abeam waypoint.

The following diagram depicts the situation.



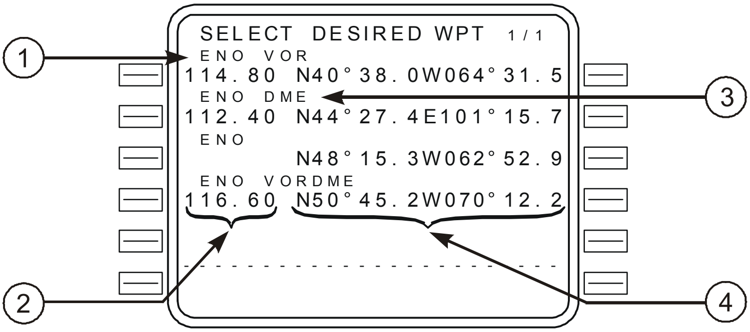
The **ABEAM PTS** prompt do not appear if no abeam waypoints are possible or if selection would increase the total number of waypoints to more than 150.

Abeam waypoints are not generated for floating (non-fixed) waypoints; if the abeam distance exceeds 700 NM; or if the abeam waypoint would fall within 10 NM of either the present position or the direct-to waypoint.

If two or more identical (within 1 NM of each other) abeam waypoints are generated only one is designated.

Select Desired Waypoint Page

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which geographical location to use must be made before the waypoint can be used in the route. The SELECT DESIRED WPT page is automatically displayed when the FMC encounters more than one location for the same waypoint name after a waypoint entry.



773716125

① Identifier

Displays the identifiers for the duplicate named waypoints. Select the proper waypoint by pushing the appropriate left or right line select key. This page is automatically removed after a waypoint is selected.

② Frequency

Displays the frequency of the navaid.

Blank if the waypoint is not a navaid.

③ Type

Shows type of navaid.

Blank if the waypoint is not a navaid.

④ Latitude / Longitude

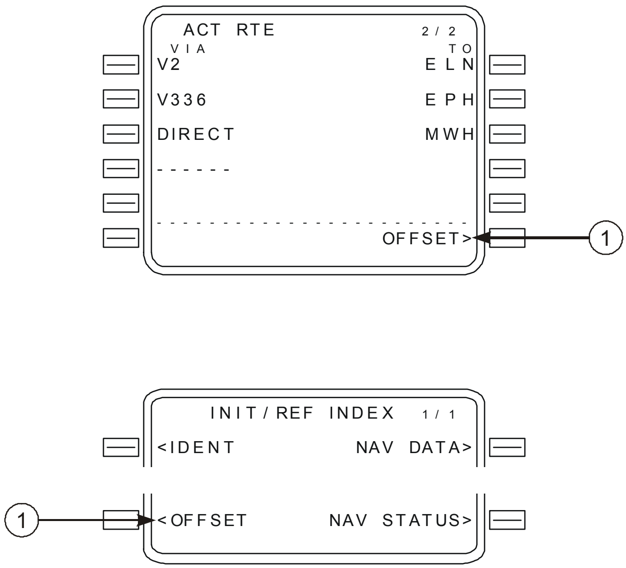
The latitude / longitude is displayed for each duplicate name.

Lateral Offset

A lateral offset may be specified up to 99.9 nautical miles left or right of course. The **OFFSET** prompt is displayed on the INIT/REF INDEX page and in flight on the RTE page. Selection displays the **LATERAL OFFSET** (or ACT LATERAL OFFSET page if an offset already exists).

Some legs are invalid for offset. These include:

- End of flight plan waypoint
- Discontinuity
- Beginning of approach transition
- Approach procedure
- DME arc
- Heading leg
- Holding pattern (except PPOS)
- Certain legs containing flyover waypoints
- Course change greater than 135 degrees
- Preplanned termination waypoint.

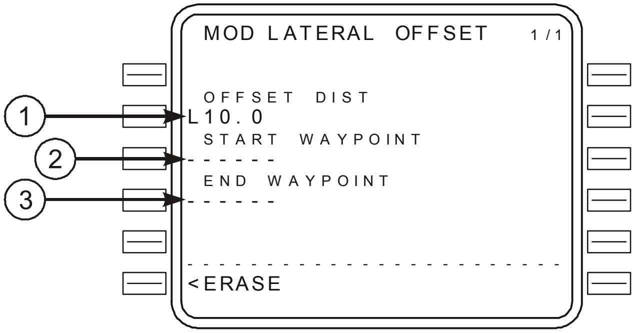


773716126

① OFFSET

Selection displays the lateral offset page.

LATERAL OFFSET Page



773716127

① Offset Distance (OFFSET DIST)

The desired lateral offset distance is entered on line 2L. In the example, the 10.0 NM offset left of course could be entered L10.0, L10, 10.0L, or 10L.

Entry results in display of start and end waypoint fields.

② START WAYPOINT

The waypoint at which the offset is to begin may be entered (up to 6 characters).

Dashes are displayed if current leg is valid for offset. Box prompts are displayed if current leg is invalid for offset.

Offset begins at the first valid offset leg after the start waypoint.

Deletion of start waypoint (or no entry) results in offset beginning at first valid offset leg in the flight plan.

③ END WAYPOINT

The waypoint at which the offset is to end may be entered (up to 6 characters).

Offset propagates through flight plan until end waypoint is encountered.

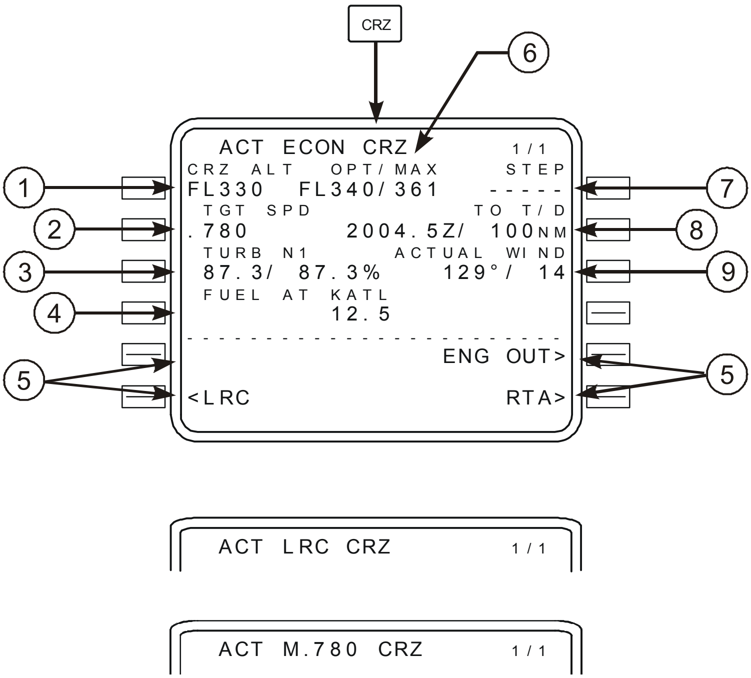
Deletion of end waypoint (or no entry) results in offset propagating until an invalid offset leg is encountered.

VNAV Modifications

Three primary cruise modes are available - economy (ECON) cruise, long range cruise (LRC), and cruise with a manually selected speed.

Access to the various cruise pages is obtained by pushing the CRZ mode select key.

Cruise Page



773716128

① Cruise Altitude (CRZ ALT)

Displays present cruise altitude in flight level or feet x 100. Value may be entered via the keyboard or propagated from the PERF INIT, CLB, CRZ CLB, or CRZ DES pages.

During active cruise, entry of a new value propagates to all other pages, which display cruise altitude and causes the MOD CRZ CLB or MOD CRZ DES page to appear.

② Target Speed (TGT SPD)

Displays the computed or manually selected value for target airspeed or Mach. Computed speed is limited to a maximum of 335 knots or M.809.

The value is reverse highlighted on an active cruise page.

③ Turbulence N1 (TURB N1)

Displays proper N1 for turbulence penetration.

Value is for reference only. It is not commanded to the autothrottle.

④ Fuel at Destination (FUEL AT XXXX)

Displays the predicted fuel remaining at destination.

The value assumes continued flight per the displayed cruise and planned descent modes along the active route.

If a step to altitude is entered on line 1R, the computation assumes that the step occurs at the step point. After passing the step climb point, the predicted fuel weight is based on an immediate step climb from current position.

⑤ Cruise Page Prompts

Allow line selection of the various cruise pages.

The RTA prompt is replaced with **ERASE** when a MOD page is displayed.

⑥ Optimum / Maximum Altitude (OPT/MAX)

Displays the computed optimum altitude for the displayed cruise mode. The value is not constrained by minimum cruise time criteria, as is the **TRIP ALT** on the PERF INIT page.

Also displays the maximum possible altitude based on the selected target speed and the specified maneuver margin.

Values are advisory only. They are provided for crew reference.

⑦ Step to Altitude Line (STEP)

This line may be used to enter a possible step climb or descent altitude for crew evaluation.

The line is blank when within 100 NM of top of descent or when RTA mode is active.

⑧ Top of Descent (TO T/D) Line

Displays time of arrival at and distance to top of descent point.

The data is always displayed when the distance is less than 100 NM. If the distance is more than 100 NM, the data is displayed only if a step to altitude has not been entered.

⑨ ACTUAL WIND

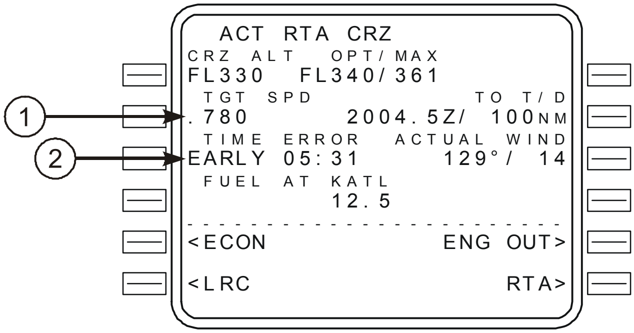
Displays computed or manually entered true wind for present altitude.

A manual entry has priority. The data line title then changes to **EST WIND** (estimated wind).

The displayed value is used as the assumed true wind at the step to altitude for making wind / altitude trade computations.

RTA Cruise

If an RTA waypoint has been specified, the cruise page will reflect the RTA data.



773716129

① Target Speed (TGT SPD)

Displays the computed speed required to meet the RTA.

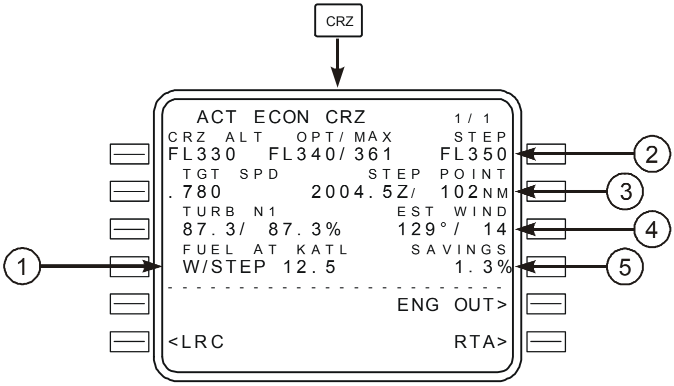
When RTA mode is exited by waypoint sequence or by deletion, this speed becomes the FMC target speed on a manual speed cruise page and the scratchpad message **SELECT MODE AFTER RTA** is displayed.

② TIME ERROR

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Cruise With Step Climb



773716130

① Fuel at Destination with Step Climb Altitude (FUEL AT XXXX)

The computation assumes the step climb occurs at the STEP point, and the value is prefixed by W/STEP.

② Step To Altitude (STEP)

Used to enter step climb or step descent altitudes for crew evaluation.

Blank when within 100 NM of top of descent or when RTA mode is active.

③ STEP POINT

Displays the computed ETA at, and distance to, the first possible step climb point based on gross weight.

Blank if no entry on STEP TO line.

④ Wind (ACTUAL WIND or EST WIND)

Used as the assumed true wind at the STEP TO altitude for making wind-altitude trade computations.

⑤ Savings / Penalty (SAVINGS or PENALTY)

Displays the predicted cost savings or penalty associated with flying the displayed speed / altitude step climb or descent profile, as compared to flying the current cruise speed schedule and maintaining present altitude to top of descent.

Blank if no step data entered.

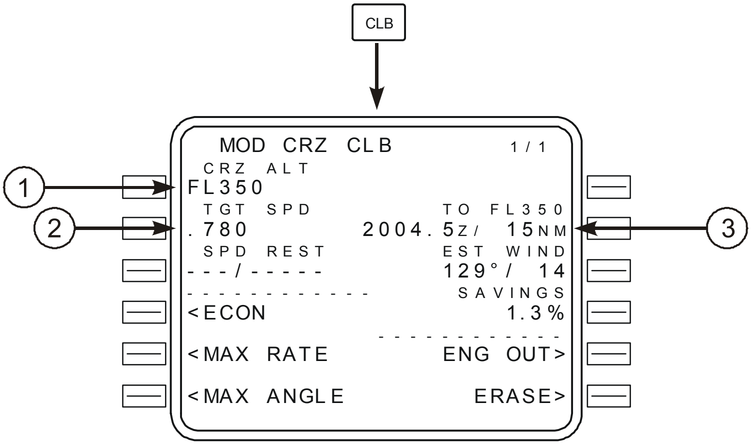
Cruise Climb

The cruise climb page displays data for a cruise climb to a new altitude.

MOD CRZ CLB is automatically displayed during cruise if a higher cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a climb at climb thrust and cruise target speed to the new altitude.

The VNAV climb mode is active until reaching the selected altitude. The mode then automatically changes back to cruise.



773716131

① Cruise Altitude (CRZ ALT)

Initially displays the **CRZ ALT** entered on the CRZ page.

Manual entry may be made.

② Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

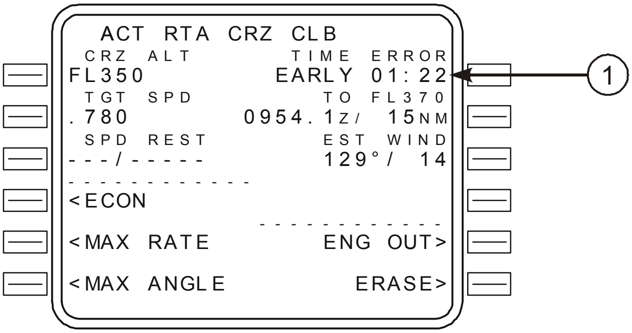
Manual entry may be made.

③ TO FLXXX

Displays ETA at, and distance to, the displayed cruise altitude.

RTA Cruise Climb

The RTA cruise climb page displays the same data as the cruise climb page except for the TIME ERROR line.



773716132

① TIME ERROR

Displays the computed time error at the RTA waypoint.

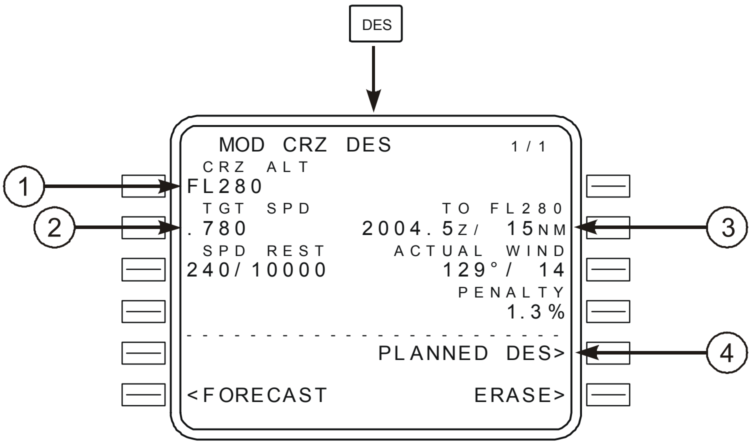
Same as time error on RTA PROGRESS page.

Cruise Descent

The cruise descent page displays data for a cruise descent to a new altitude.

MOD CRZ DES is automatically displayed during cruise if a lower cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a descent at 1,000 feet per minute and cruise target speed to the new altitude.



773716133

① Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

② Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

Manual entry may be made.

③ TO FLXXX

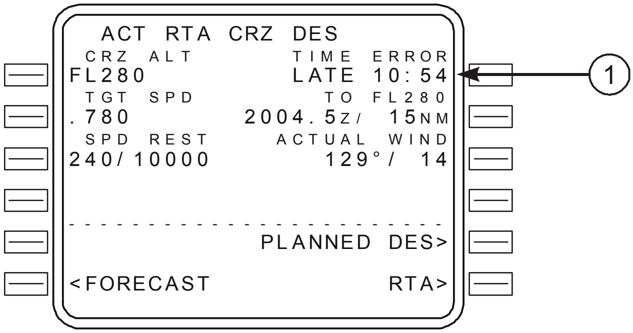
Displays ETA at, and distance to, the displayed cruise altitude.

④ Planned Descent (PLANNED DES)

Shows the PLANNED DES page and allows access to the planned standard descent mode.

RTA Cruise Descent

The RTA cruise descent page displays the same data as the cruise descent page except for the TIME ERROR line.



773716134

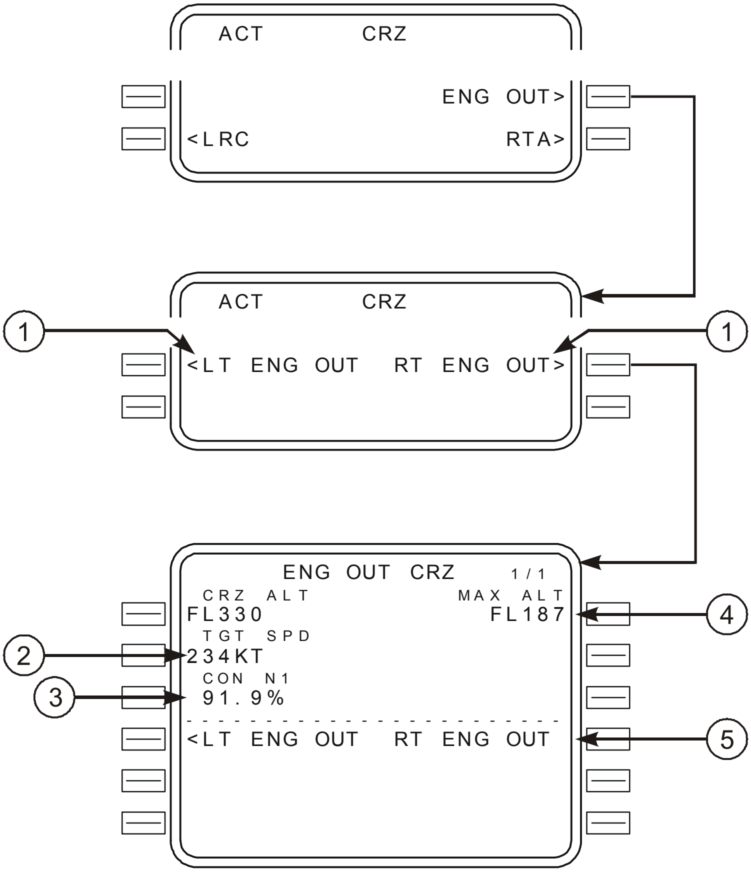
1 TIME ERROR

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Engine Out Cruise

The engine out cruise page may be accessed by selecting the **ENG OUT** prompt on the cruise page. The page displays advisory data for a one engine inoperative condition.



773716135

① Left / Right Engine Out (LT ENG OUT / RT ENG OUT)

Selection changes display to ENG OUT CRZ page. The ENG OUT CRZ page is information only.

② Target Speed (TGT SPD)

Displays the optimum speed based on minimum drag.

③ Continuous N1 (CON N1)

Displays N1 for maximum continuous thrust.

N1 is computed using actual bleed conditions.

④ Maximum Altitude (MAX ALT)

Displays the computed maximum altitude at which a specified rate of climb can be achieved, using one engine at maximum continuous thrust. Default climb rate is 100 feet per minute.

After page selection, the FMC accounts for wing and engine anti-ice, air conditioning, and the engine bleed of the operating engine.

⑤ LT ENG OUT / RT ENG OUT

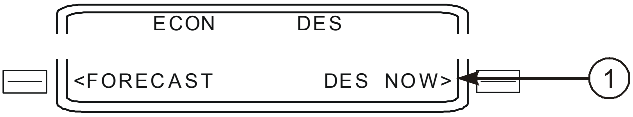
Selected engine is shown in reverse highlighting.

Early Descent

Early descents are initiated from the DES page. Once an early descent is executed, VNAV transitions to the descent mode and cruise features are no longer available.

For a path descent the **DES NOW** prompt is not displayed until a descent path is established. Once executed, the autothrottle adjusts thrust to maintain 1000 feet per minute until intercepting the descent path.

For a speed descent, the autothrottle retards to idle, and pitch maintains target speed.



773716136

① Descend Now (DES NOW)

Selecting the PATH DES page before reaching the top of descent displays the normal descent page with the prompt **DES NOW** on the bottom right of the page. Selecting and executing the **DES NOW** prompt initiates a VNAV descent of 1000 feet per minute at ECON speed. Upon reaching the planned descent path, VNAV transitions to maintain the planned descent path.

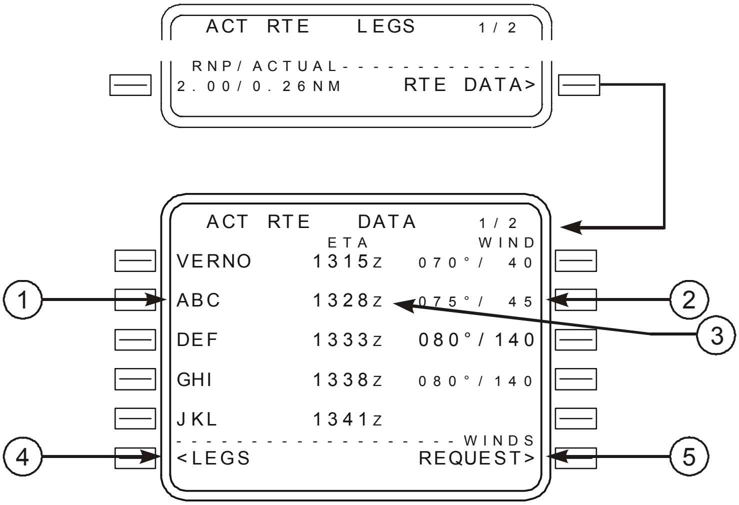
Selecting the SPD DES page and executing the **DES NOW** prompt initiates a VNAV descent at idle thrust and target speed.

Route And Waypoint Data

Route Data (RTE DATA) Page

The RTE DATA page displays ETA for each waypoint on the RTE LEGS page. This page also displays forecast wind data for cruise waypoints.

One page displays data for five waypoints.



773716137

① WAYPOINT

Displays the identifier for the waypoint from the ACT RTE LEGS page.

② WIND

Used for entry and/or display of the true winds at the cruise waypoint identified on the same line.

Entry may be via the keyboard, or propagated from the CRZ WIND entry on the PERF INIT page.

The CRZ WIND value (075°/45 is depicted) propagates to all cruise waypoints (ABC to GHI is the depicted cruise segment).

If no CRZ WIND entry was made, the FMC assumes 000°/000.

A keyboard entry has priority and propagates to all down path cruise waypoints (an entry of 080°/140 at DEF is depicted). The entry must be executed.

Any entries propagated from the CRZ WIND entry are displayed in small font. Keyboard entries are displayed in large font.

Crew entries of forecast winds (or default 000°/000) are automatically biased with the actual wind computed by the FMC when within 100 NM of a cruise waypoint and within 2000 feet of a cruise altitude. Biased values are not displayed.

Blank for non-cruise waypoints (VERNO and JKL are depicted). Entry is inhibited.

③ Estimated Time of Arrival (ETA)

Displays the FMC calculated waypoint ETA.

④ LEGS

Selection displays the RTE LEGS page.

7 8 9

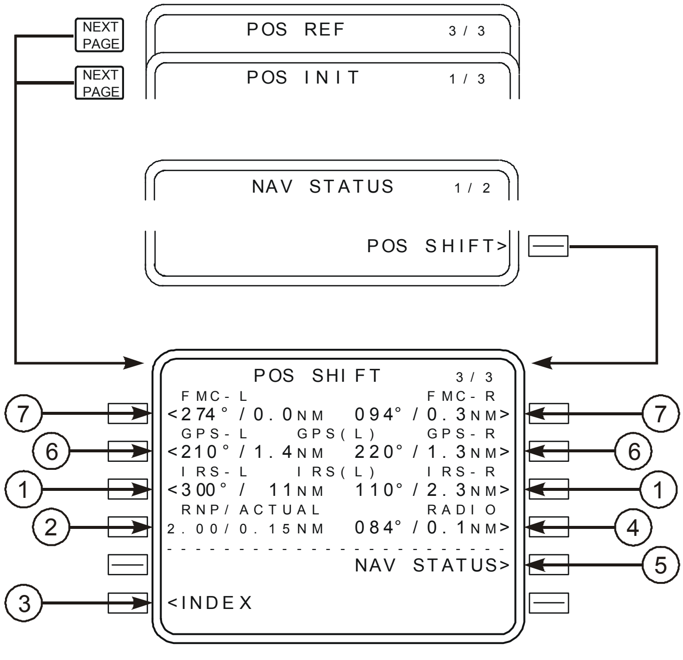
⑤ WINDS REQUEST

Push – Transmits a data link request for winds uplink.

Position Shift Page 3/3

On the POS SHIFT page, each prompt indicates the bearing and distance of the indicated system relative to the FMC position. FMC position is displayed on line 1R of POS REF page 2/3. The entries with parentheses in the center of the page show the active position references.

Data fields are blank when on the ground.



773716138

① IRS Position L/R

Displays left and right IRS position relative to FMC position using current mag / true reference. Blank if IRS position is invalid.

Push – Highlights the line, illuminates the EXEC key, and displays the **CANCEL** prompt.

② Required Navigation Position / Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

③ INDEX

Push – Displays the INIT/REF INDEX page.

④ RADIO Position

Displays radio position relative to FMC position using current mag / true reference. Blank if radio position is invalid.

Push – Highlights the line, illuminates the EXEC key, and displays the **CANCEL** prompt.

⑤ Navigation Status (NAV STATUS)

Push – Displays the NAV STATUS page.

⑥ GPS Position L/R (As Installed)

Displays left and right GPS position relative to FMC position using current mag / true reference. Blank if GPS position is invalid.

Push – Highlights the line, illuminates the EXEC key, and displays the **CANCEL** prompt.

⑦ FMC Position L/R (As Installed)

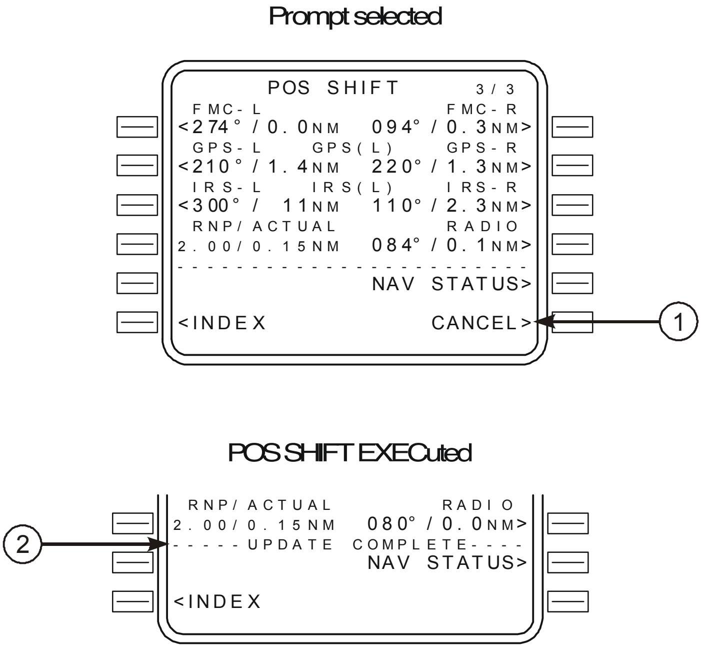
Displays left and right FMC position relative to FMC position using current mag / true reference. Blank if FMC position is invalid.

Push – Highlights the line, illuminates the EXEC key, and displays the **CANCEL** prompt.

Inflight Position Update

FMC position update is accomplished on the POS SHIFT 3/3 page in flight. Selecting a prompt stops the updating of the relative position. The bearing and distance is highlighted, the execute key is illuminated, and the **CANCEL** prompt is displayed in line 6R.

When the position shift is executed, **UPDATE COMPLETE** is displayed.



773716139

① CANCEL

Displayed when a line selection is made for position update. Selection prior to execution cancels the line selection.

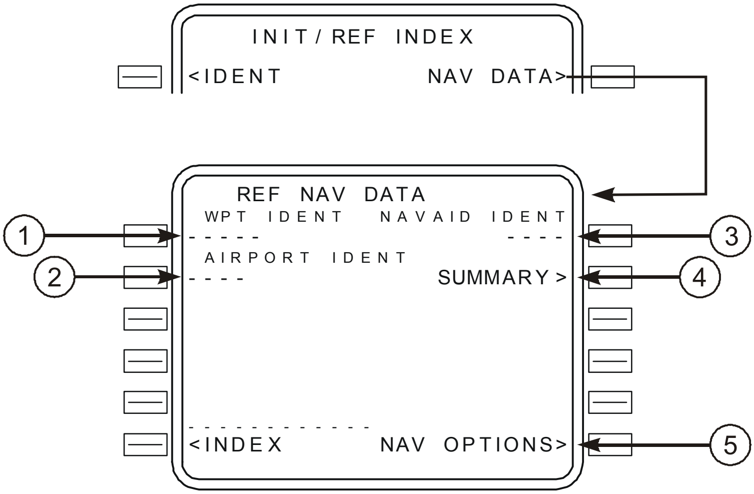
② UPDATE COMPLETE

Displayed after a position shift has been selected and executed.

Navigation Data

Reference Navigation Data (REF NAV DATA) Page

The reference navigation data page provides information about waypoints, navaids, airports, and runways. Entering the appropriate identifier initiates the display. Writing **SUPP** in the scratchpad prior to selecting NAV DATA results in display of the supplemental navigation data (SUPP NAV DATA) page.



773716140

① Waypoint Identifier (WPT IDENT)

② Airport Identifier (AIRPORT IDENT)

③ Navigation Aid Identifier (NAVAID IDENT)

④ SUMMARY

Selection displays NAV SUMMARY pages.

Blank if supplimental and temporary databases are empty.

⑤ Navigation Options (NAV OPTIONS)

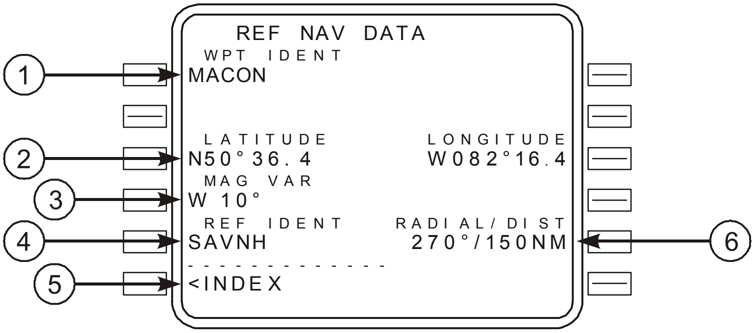
Selection displays NAV OPTIONS page.

If the entered identifier is already stored in the permanent, supplemental, or temporary database, then relevant data propagates to the subsequent **REF NAV DATA** display.

If the entered identifier is not stored in any database, the subsequent **REF NAV DATA** display contains box prompts. Following entry of the required information, the new data may be stored in the temporary database by executing (except for runway data). Data may be subsequently deleted from the temporary database by deleting the individual identifier, if the identifier is not presently being displayed on another page (e.g., RTE LEGS, PROGRESS, etc.).

All data stored in the temporary database is cleared at flight completion.

Waypoint Data Display



773716141

① Waypoint Identifier (WPT IDENT)

Displays or permits entry of the desired waypoint. When this entry is complete, the associated data lines are displayed.

② LATITUDE / LONGITUDE

Displays or permits entry of waypoint latitude and longitude. Entry on the REF IDENT and RADIAL/DIST lines cause latitude and longitude to be computed and displayed.

③ Magnetic Variation (MAG VAR)

Displays or permits entry of waypoint magnetic variation. Data is automatically computed based on latitude and longitude.

Manual entry has priority.

④ Reference Identifier (REF IDENT)

Together with RADIAL/DIST, displays or permits entry of reference point for a created waypoint.

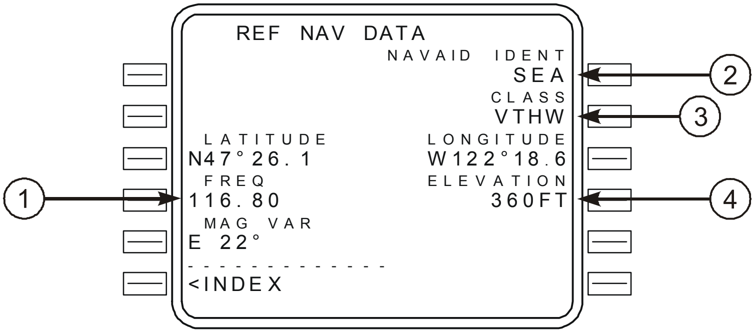
⑤ INDEX

Selection displays REF NAV DATA page.

⑥ Radial / Distance (RADIAL/DIST)

Together with REF IDENT displays or permits entry of bearing and distance for a created waypoint.

Navigation Aid Data Display



773716142

① Frequency (FREQ)

Displays or permits entry of the frequency of the entered navaid.

② Navigation Aid Identifier (NAVAID IDENT)

Displays or permits entry of navaid identifier (5 characters maximum). Following entry, the associated data lines are displayed.

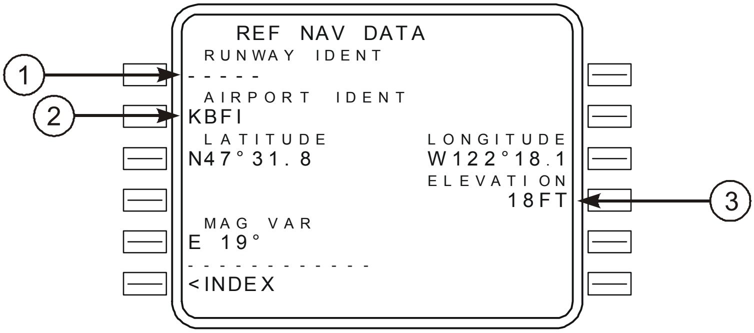
③ Classification (CLASS)

Displays or permits entry of the classification of the entered navaid.

④ ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered navaid.

Airport Data Display



773716143

① Runway Identifier (RUNWAY IDENT)

Permits entry of runway identifier.

② Airport Identifier (AIRPORT IDENT)

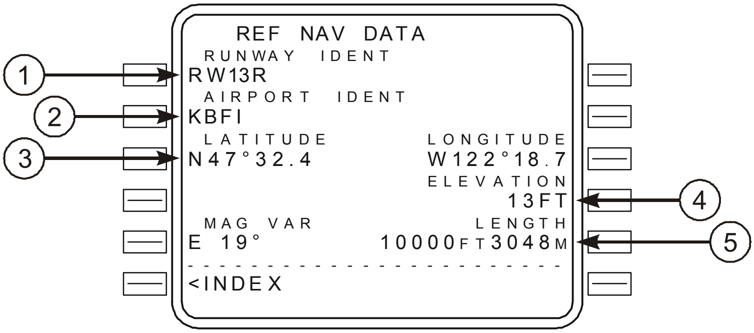
Displays airport identifier.

③ ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered airport.

Runway Data Display

A runway identifier may be entered on the airport data display page or as a waypoint on the REF NAV DATA page. On the airport data display page, entry may be in the form of 13R or RW13R. Single digit entries are possible, with or without leading zeros. If the waypoint method is used, entry must be in the form RW13R, and the proper airport identifier must be entered on the runway data display page. Runways must be stored in the permanent navigation database.



773716144

① Runway Identifier (RUNWAY IDENT)

Displays runway identifier.

② Airport Identifier (AIRPORT IDENT)

Displays airport identifier.

③ LATITUDE / LONGITUDE

Displays latitude and longitude of entered runway.

④ ELEVATION

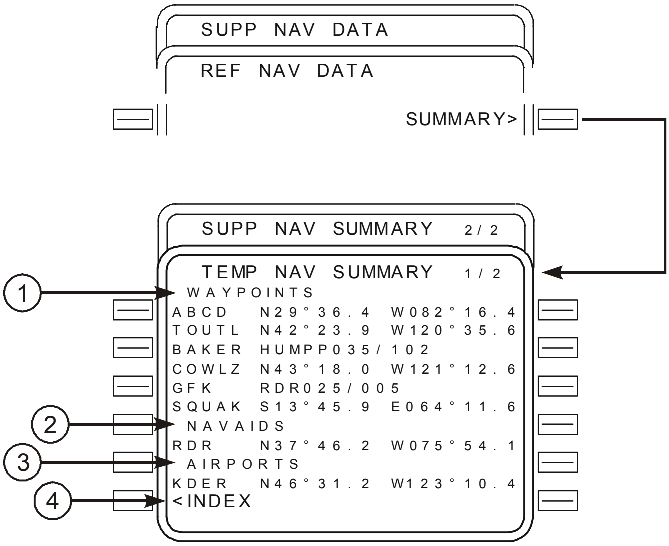
Displays elevation (feet above MSL) of the entered runway.

⑤ Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

Navigation Summary (NAV SUMMARY)

The NAV SUMMARY pages show the contents of the temporary and supplemental navigation databases. Contents of the temporary navigation database show first, followed by contents of the supplemental navigation database.



773716145

① WAYPOINTS

Shows waypoints stored in related database.

Waypoints show in defining format.

② NAVAIDS

Shows navaids stored in related database.

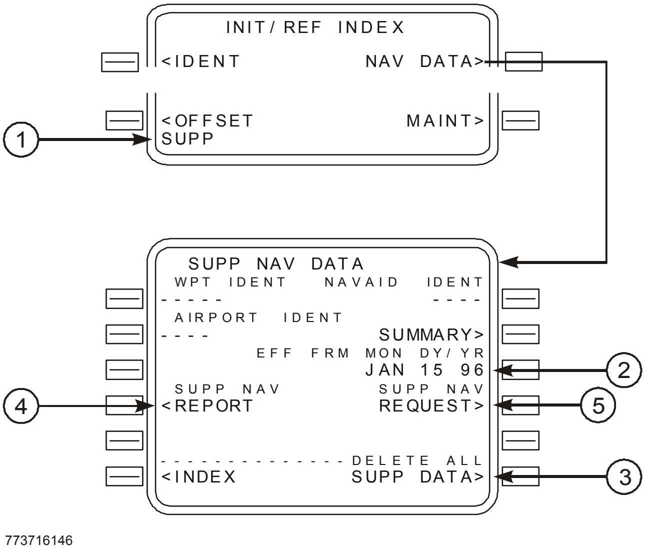
③ AIRPORTS

Shows airports stored in related database.

④ INDEX

Push – Shows page (REF NAV DATA or SUPP NAV DATA) used to access NAV SUMMARY pages.

Supplemental NAV Data



① SUPP Scratchpad Entry

The supplemental navigation database is accessed by typing **SUPP** in the scratchpad while on the INIT/REF INDEX page, then selecting the **NAV DATA** prompt. Access is only available on the ground.

② Effectivity Date (EFF FRM MON DY/YR)

Allows entry of month, day, and year that the supplemental database becomes valid. The date is displayed on IDENT page 1/2 after entry. Box prompts are displayed if an effectivity date is not entered.

③ Delete All Supplemental Data (DELETE ALL SUPP DATA)

Data may be deleted from the supplemental database by two methods. Deletion may be accomplished one item at a time on the display pages, or the entire database may be deleted by selecting this prompt. The prompt is only available before entry of an origin airport.

④ SUPP NAV REPORT (as installed)

Push – Transmits a copy of supplemental navigation database.

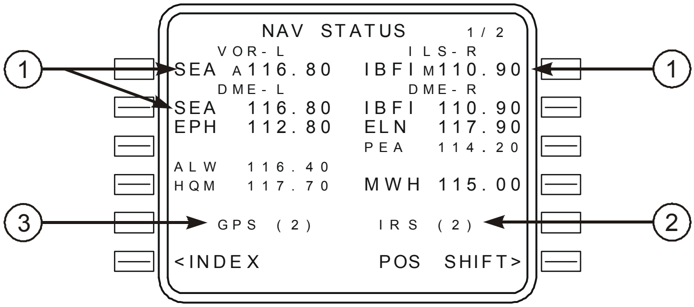
⑤ SUPP NAV REQUEST (as installed)

Push – Transmits a data link request for a supplemental navigation database uplink.

Navigation Status Display

The NAV STATUS page displays the current status of the navaids being tuned.

Access to the **NAV STATUS** display is from the **NAV STATUS** prompt on the POS SHIFT page 3/3, the PROGRESS page 1/3, and (in flight) the INIT/REF INDEX page or from the NAV OPTIONS page 2/2, NEXT or PREV PAGE.



773716147

① VOR/ILS and DME Lines

Lines 1L and 1R display VOR or ILS identifier and frequency tuned on the corresponding VHF NAV control panel.

Lines 2L – 2R through 4L – 4R display up to five DME identifiers and frequencies tuned by the corresponding scanning DME receiver.

Data is displayed in large font with the identifier highlighted if that facility is being used for navigation.

Data is displayed in large font with the identifier not highlighted if that facility is being received but not used for navigation.

Data is displayed in small font if that facility is being tuned but not received.

If the navaid has failed, **FAIL** is displayed in small font.

If there is no corresponding identifier for the displayed frequency, then the identifier field blanks and only the frequency is displayed.

On lines 1L or 1R, for VOR/ILS displays, the mode of tuning is shown:

- **M** – Manual
- **P** – Procedural
- **A** – Automatic.

On lines 2L – 2R through 4L – 4R, if no DME information is received then the identifier and frequency field is blank.

② IRS Status Display (As Installed)

Displays the IRS currently selected for use in navigation. “L” or “R” indicates left or right, and “2” indicates dual system with both IRSs used in the FMC position calculation.

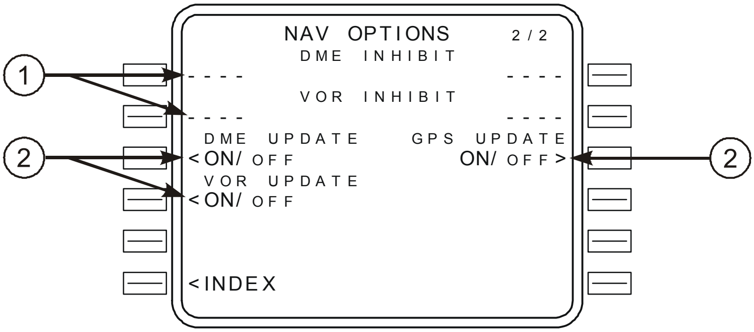
③ GPS Status Display (As Installed)

Displays the GPS currently selected for use in navigation, “L” or “R” indicates left or right, and “2” indicates dual system with both GPSs used in the FMC position calculation. The display is blank if GPS is not installed or inhibited for use in navigation.

Navigation Options (NAV OPTIONS)

When a navigation facility or internal system is invalid, the invalid data must be inhibited to prevent incorrect position calculations.

Access to the NAV OPTIONS page may be gained by selecting the **NAV OPTIONS** prompt on the REF NAV DATA page or by selecting NEXT or PREV PAGE on the NAV STATUS page.



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① DME/VOR INHIBIT

Enter the identifier of up to two VOR, VOR/DME, VORTAC, or DME stations that must not be used for FMC position updates.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

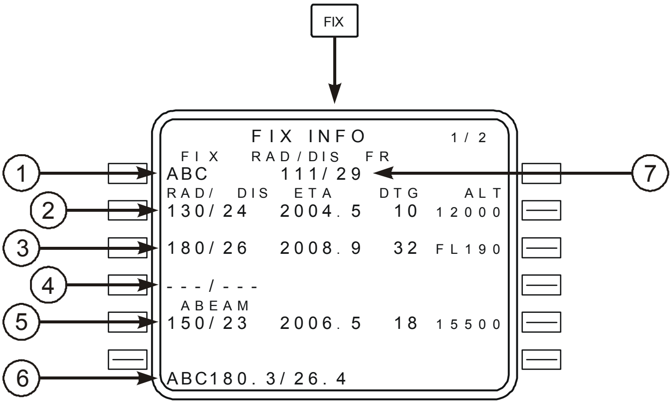
② DME/VOR/GPS UPDATE

Selection permits switching between ON and OFF modes for updating FMC position. Default mode is ON. The current mode is highlighted.

Selection is reset to ON at flight completion.

Fix Information Page

Two identical FIX INFO pages are used to identify waypoint fixes for display on the navigation display map mode. If desired, fix information can be copied into the route. Page access is via the FIX key.



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① FIX Name

Enter the desired fix. Valid entries are airports, navaids, and waypoints from the navigation database. The selected fix is displayed on the navigation display map mode and highlighted by a green circle.

② Distance Entry

Enter a distance from the fix. Distances from the fix are displayed on the navigation display map mode as a dashed green circle around the fix.

When the distance intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed for that intersection.

If there is more than one intersection, the data applies to the first occurrence and sequences as each intersection is passed.

Valid entries are xxx.x:

- Leading zeros can be omitted for distance
- Decimal values can be omitted
- Distance only entries must start with a /.

ETA – Displays the estimated time of arrival to the intersection point.
DTG – Displays the distance to go to the intersection point.
ALT – Displays the predicted altitude at the intersection point.

③ Radial Entry

Enter a radial from the fix. Radials are displayed on the navigation display map mode as green dashed lines from the fix.

When the radial intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed.

If there is more than one intersection, the data applies to the first occurrence and sequences as each intersection is passed.

Valid entries are xxx.

④ Radial / Distance Entry

Enter a radial, distance, or both radial and distance from the fix. A radial and distance from the fix is displayed on the navigation display map mode by both radial and distance, but ETA and ALT fields are blank.

⑤ ABEAM

Displays the abeam point and calculates the ETA, DTG, and ALT information.

The fix abeam point ahead of the aircraft is displayed by a radial line from the waypoint ending at the nearest perpendicular route leg intersection.

If there is more than one intersection, the data applies to the first occurrence and sequences as each intersection is passed.

⑥ Route Intersection Point Copied

Pushing the line select key for one of the RAD/DIS entries copies the fix place / bearing / distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

⑦ Radial / Distance From Fix (RAD / DIS FR)

Displays the radial and distance from the fix to the aircraft. This information is continually updated as the aircraft position changes.

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FMC DESCENT AND APPROACH

Introduction

The descent phase begins at the top of descent point and continues to the end of descent point. Planning for the descent phase begins during cruise.

The approach phase begins at the end of descent point and continues to touchdown or go-around. When a go-around is accomplished, the FMC enters the cruise phase.

The only automatic page change provided in the descent / approach modes is the transition from cruise to descent at the top of descent.

Early Descent

Early descent may be commenced prior to reaching the top of descent by using the **DES NOW** prompt.

Descent

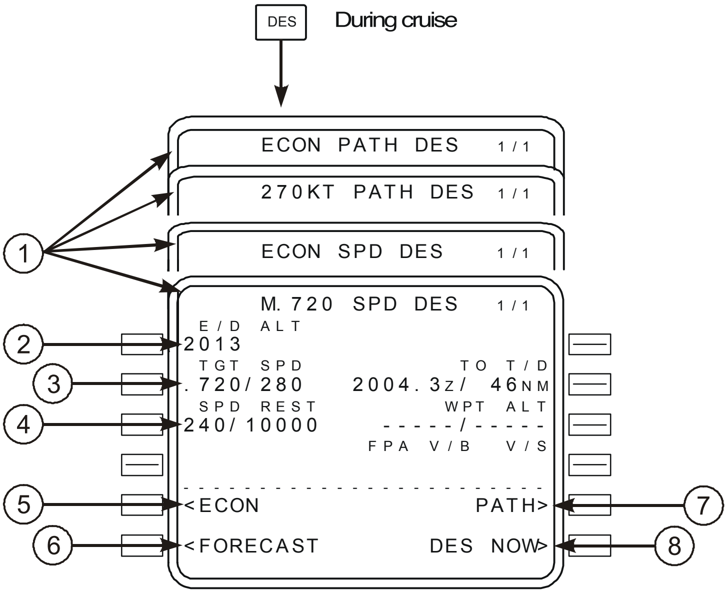
During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

The DES FORECASTS page is also available to enter forecast wind data to aid in descent planning.

Descent Page (During Cruise)

The descent page is used to monitor, revise, or select the descent path. Descent modes are economy (ECON) path or speed and manual path or speed. The default VNAV descent mode is ECON PATH. The crew must select a manual speed descent mode.

The page title reflects the VNAV descent mode. The path mode controls descent to fly a vertical path, which complies with altitude and speed restrictions in the flight plan. The speed mode controls descent at a fixed speed and complies with altitude and speed restrictions in the flight plan.



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① Page Title

The page title identifies the selected mode. When a manual speed is selected, the title includes XXXKT for fixed CAS or M.XXX for fixed Mach selections.

Displays **ACT** when the descent phase is active.

② End Of Descent Altitude (E/D ALT)

Displays the end of descent altitude.

- For a PATH DES page, displays the altitude restriction for the E/D waypoint; blank if path descent not available.
- For a SPD DES page, displays the altitude restriction for the E/D waypoint, if an E/D waypoint is present.
- If an approach is selected which ends at RWXXX, the E/D altitude is Threshold Crossing Height (TCH), 50 feet above the runway.

The end of descent altitude is the lowest altitude constraint, including threshold crossing height for the runway, if not preceeded by a lateral discontinuity.

③ Target Speed (TGT SPD)

Displays the command speed used above all waypoint constraints, or speed constraints.

On ECON PATH or ECON SPD DES pages, displays the computed values for target Mach and airspeed. Speeds are performance limited.

Manual entries may be made and cause the manual PATH or manual SPD DES page for that value to display (M.720 SPD DES is depicted).

Blank for any PATH DES page, if a path descent is not available.

④ Speed Restriction (SPD REST)

Displays the most restrictive of the following speeds:

- Destination airport speed minus 10 knots
- Waypoint speed constraint if greater than minimum flaps up maneuvering speed
- Minimum flaps up maneuvering speed
- Selected V_{ref} + wind correction for landing flap setting
- Whenever flaps are extended, the, appropriate flap speed shall be displayed as **XXX/FLAPS**. This shall supersede any other speed restriction
- Displays **XXX/HOLD** when decelerating to hold speed prior to hold entry fix.

Dash prompts displayed when there is no active speed restriction.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

⑤ Economy (ECON)

Displayed on the manual DES pages.

Push – Selects the corresponding ECON SPD or ECON PATH DES page.

⑥ Descent Forecasts (FORECAST)

Push – Selects the DES FORECASTS page.

⑦ PATH

Displayed on the SPD DES pages if a path descent is available.

Push – Selects the corresponding PATH DES page.

⑧ Descend Now (DES NOW)

Displayed on the standard DES pages whenever descent is not ACT or MOD.

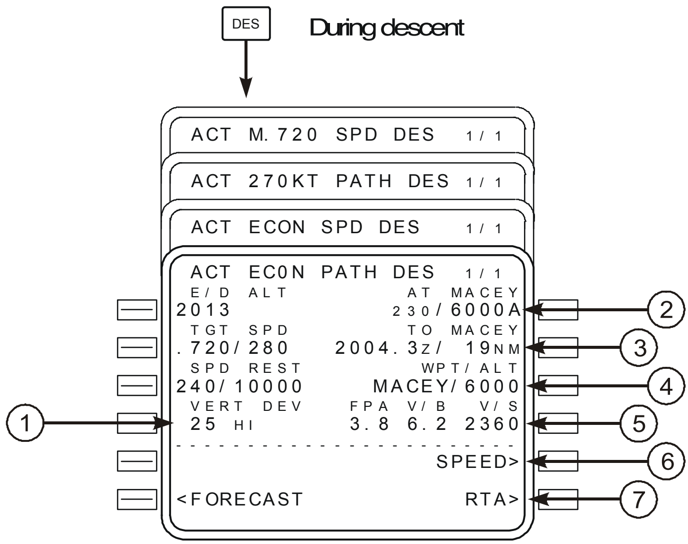
Blank for any PATH DES page if a path descent is not available.

Push – Arms the DES NOW function and illuminates the **EXEC** light.

On a PATH DES page, execution allows early initiation of PATH descent at 1000 fpm until intercepting the computed path. On a SPD DES page, execution allows early initiation of a SPD descent at the specified speed (ECON or manual).

Descent Page (During Descent)

Display when any descent mode is active after beginning of descent.



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① Vertical Deviation (VERT DEV)

Displays present deviation (feet **HI** or **LO**) from the computed vertical path.

The deviation is always in relation to the path descent profile, regardless of which page is active (PATH DES or SPD DES).

Blank if a path is not available.

② Altitude Restriction (AT XXXXX)

Displays the next waypoint constraint from the RTE LEGS page.

The constraint is speed / altitude. If an airspeed constraint exists at the waypoint, it is displayed in large font; otherwise the predicted speed will be displayed in small font.

Can be deleted on this page.

The display is blank when no constraint exists, or for any PATH DES page if a path descent is not available.

③ To Waypoint (TO XXXXX)

Displays computed ETA and distance to go to T/D when not in an active descent mode.

If an early descent is in progress (initiated using **DES NOW** prompt), ETA and distance to go to original T/D is displayed until passing the T/D.

If a descent mode is active, displays ETA and distance to go to the first of the following points:

- The waypoint in the AT XXXXX line
- An intermediate T/D (TO T/D – XXXXX, where XXXXX is the altitude).

The display is blank if a path descent is not available, or if the AT XXXXX line is blank and no T/D information is displayed.

④ Waypoint / Altitude (WPT/ALT)

Displays the waypoint and altitude that serves as the basis for the vertical bearing (**V/B**) display on line 4R.

Normally displays the same waypoint / altitude constraint that is displayed on the AT XXXXX line.

May be overwritten by pilot entry.

Dash prompts are displayed if there is no entry.

⑤ Vertical Path Parameters (FPA V/B V/S)

Displays the following parameters related to the present vertical path:

- **FPA** – Actual flight path angle based on present ground speed and vertical speed (that is, the present vertical bearing being flown).
- **V/B** – Vertical bearing direct from present position on the WPT/ALT line (that is, the flight path angle required if flying direct to the waypoint and altitude on the WPT/ALT line).
- **V/S** – The required vertical speed (in fpm, based on present ground speed) to fly the displayed **V/B**.

Blank if no entry on the WPT/ALT line.

⑥ SPEED

Displayed on PATH DES pages.

Push – Selects the related SPD DES page.

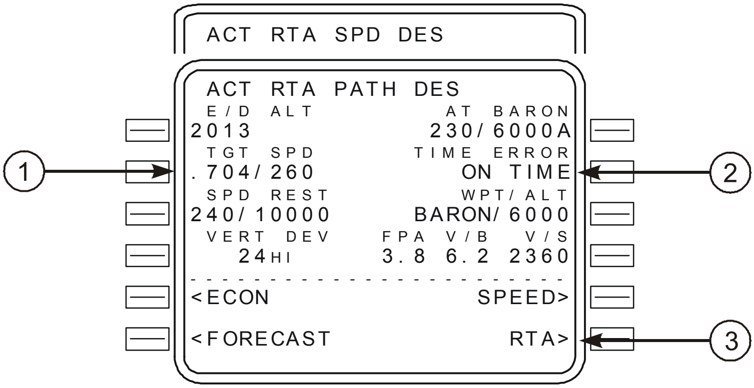
⑦ RTA

Displayed when **DES NOW** or **ERASE** prompt is not displayed.

Push – Selects the RTA PROGRESS page.

RTA Descent Page

RTA descent pages are displayed when an RTA mode is active. Displays are the same as on other descent pages except as noted.



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① Target Speed (TGT SPD)

Displays computed RTA target speed.

Changes to FMC target speed if the RTA mode is exited.

② TIME ERROR

Displays computed time error at the RTA waypoint.

Same as time error line on RTA PROGRESS page.

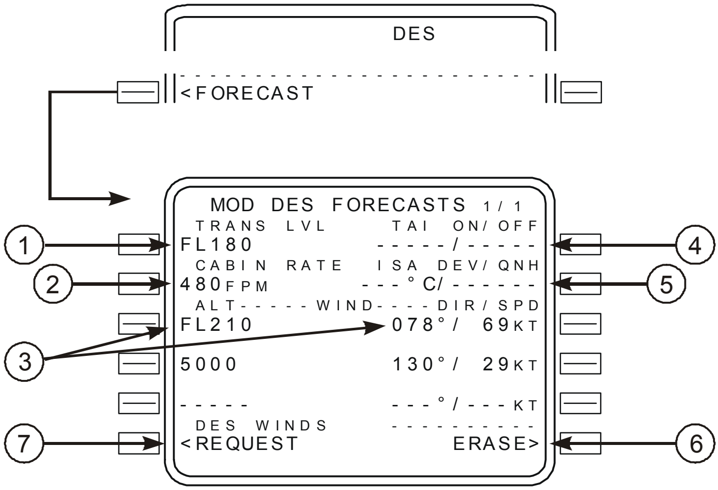
③ RTA

Push – Selects the RTA PROGRESS page.

Descent Forecast Page

The descent forecast page is used for pre-descent planning to enter forecast data for more precise descent path calculation.

The primary entries are wind direction and speed for up to three descent altitudes, and the altitude that anti-icing is turned on and off.



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① Transition Level (TRANS LVL)

Normally displays FL180 as the assumed descent transition level.

Changes automatically if an arrival procedure having a different stored value is entered.

Manual entry allowed and takes priority.

② CABIN RATE

Displays the predicted cabin rate of descent required by the flight plan descent profile.

③ Descent Wind (ALT - - - - - WIND - - - - DIR/SPD)

Allows entry of altitude and wind direction / speed for up to three forecast wind values.

Entries may be made in any altitude sequence and are automatically ordered by altitude from highest to lowest.

④ Thermal Anti-Ice On / Off (TAI ON/OFF)

Enter the altitudes in flight level or feet at which anti-ice is expected to be turned on and off.

⑤ ISA Deviation And QNH (DEV/QNH)

Enter the average ISA deviation for descent in °C (+/–XX°C) or °F (+/–XX°F).

Enter the destination QNH altimeter setting (IN, HG, or MB). Do not enter a QFE altimeter setting.

⑥ ERASE

Push – Deletes modification and returns page to previously displayed descent page.

7 8 9

⑦ DES WINDS REQUEST

Push – Transmits a data link request for descent winds.

Engine Out Descent

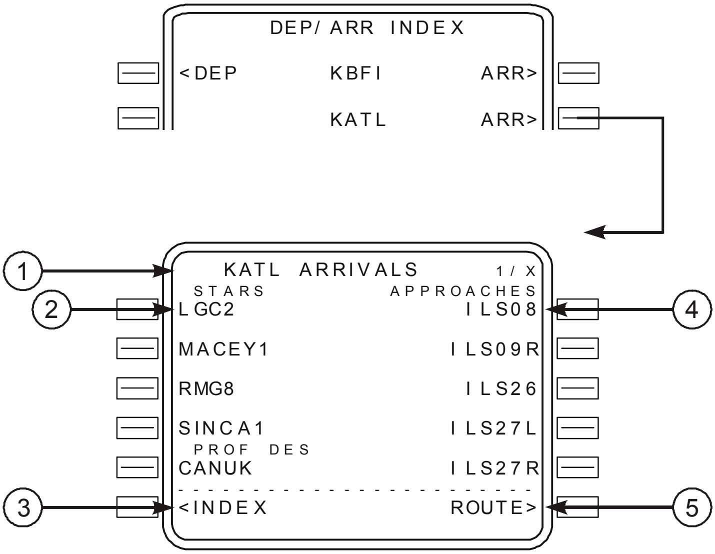
There are no specific engine out pages for descent. Use the normal descent planning features and pages.

APPROACH

Arrivals Page – IFR Approaches

The ARRIVALS page allows selection of an approach, standard terminal arrival route (STAR) and arrival transitions to the destination airport. This page can also be used to view information about a selected airport that is not the destination. Only procedures for the origin and destination airport can be selected for entry into the flight plan.

The approaches, STARS / profile descents, and transitions are displayed and selected on this page.



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① Page Title

The destination airport identifier is displayed in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

② Standard Terminal Arrival Routes (STARS)

Upon initial selection, an alphabetical listing of all STARS and profile descents is displayed.

STARS are displayed first in a list under the **STAR** label. Profile descents are listed after the STARS under the **PROF DES** label.

Selection of the desired STAR deletes all other STARs and non-applicable approaches / runways, and displays a listing of any arrival transitions applicable to that STAR.

The selection of an approach or runway deletes all STARs not related to that approach / runway.

③ INDEX

Push – Displays the DEP/ARR INDEX page.

④ Approaches And Runways (APPROACHES)

Upon initial page display, an alphabetical listing of all approaches for the airport, followed by a numerical listing of all runways, is displayed.

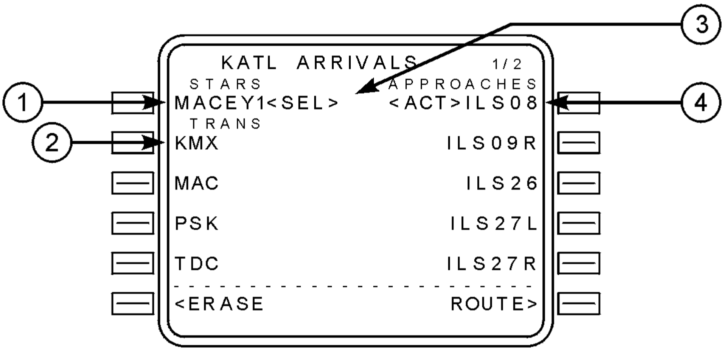
Selection of the desired approach or runway deletes all other approaches / runways.

⑤ ROUTE

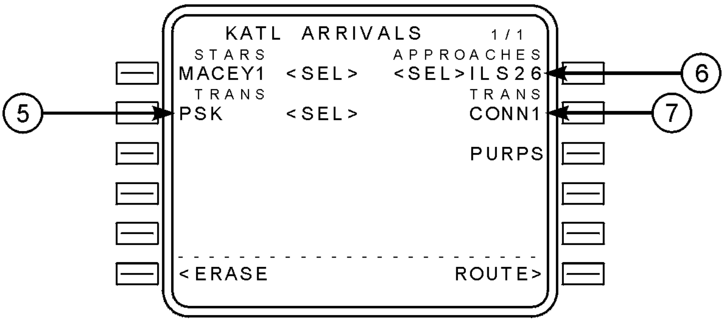
Push – Displays the RTE page.

Arrivals Page During Approach Selection

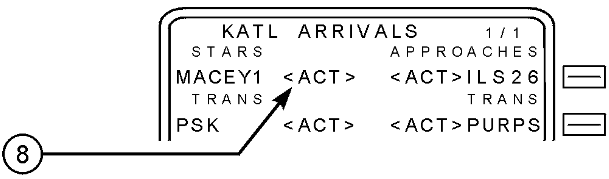
Display after STAR selected



Display after STAR Transition and Approach/Runway selected



Display after executing



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① STARS

Displays the selected STAR.

② Arrival Transitions (TRANS)

Displays all arrival transitions related to the selected STAR.

③ Selected Status Label (<SEL>)

Identifies arrival / approach procedures or a runway which has been selected for entry into the route, but not executed.

All **<SEL>** entries propagate to the MOD RTE and MOD RTE LEGS pages for subsequent execution.

④ Approach And Runway (APPROACHES, RUNWAYS)

Displays all approaches related to the selected STAR, followed by all related runways (unless the desired approach / runway was selected on the initial display).

⑤ Arrival Transition (TRANS)

Displays the selected arrival transition.

⑥ APPROACHES

Displays selected approach / runway.

⑦ Approach Transition (TRANS)

Displays all approach transitions related to the selected approach.

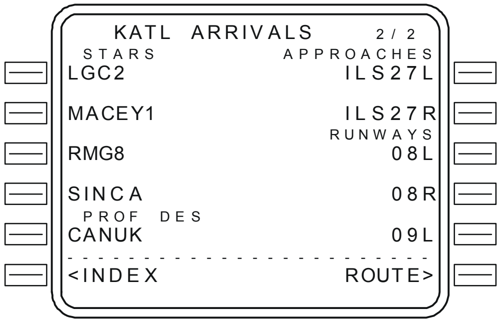
⑧ Active Status Labels (<ACT>)

Following execution of the selected entries, the arrival / approach procedures and runway are identified as active.

For an existing active route, the execute key illuminates upon STAR or approach / runway selection. Following selections, the **ERASE** prompt is available. Selections should be executed on the RTE or RTE LEGS pages after linking any route discontinuities.

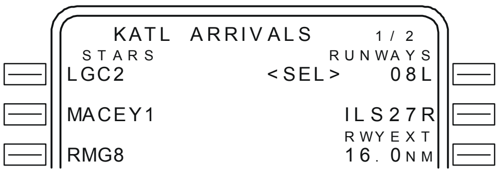
Arrivals Page – Runway Extension Fix

Initial display

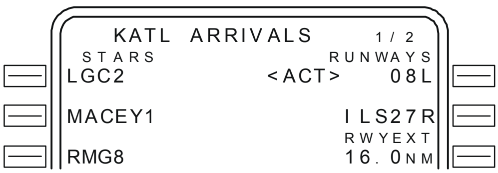


Display after runway 08L selected

Display after runway 08L extension inserted



Display after execution



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① Runway Extension (RWY EXT)

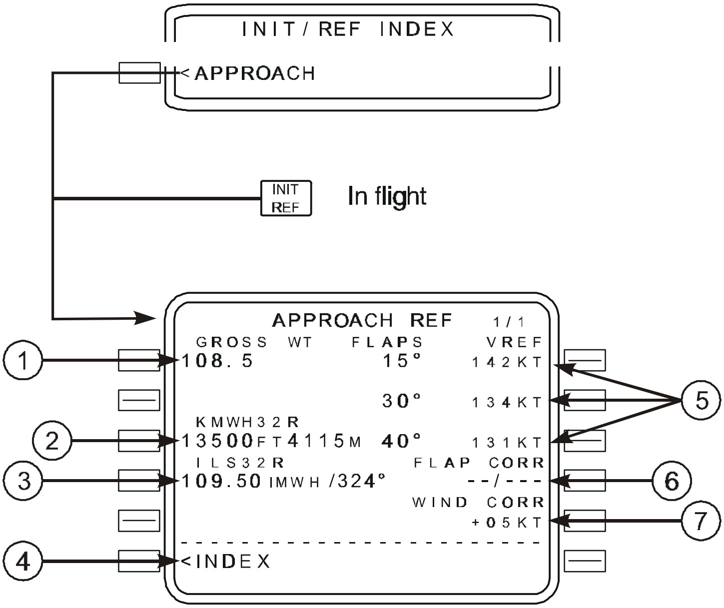
Permits entry of runway extension waypoint following selection of desired runway.

Desired extension distance is entered in scratchpad, then inserted on RWY EXT line. This creates a waypoint on the extended runway centerline at the specified distance from the threshold.

Waypoint is identified on the RTE and RTE LEGS pages as RXYYY, where YYY is the runway designation.

Approach Reference Page

The approach reference page displays approach planning information and approach reference speed (VREF) selection. The displayed data is for the DEST airport and the arrival / approach entered into the FMC flight plan.



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① Aircraft Gross Weight (GROSS WT)

Normally displays the FMC calculated aircraft gross weight.

A manual entry of gross weight is allowed.

Displays box prompts when gross weight is not available from the FMC.

Valid entry is XXX.X.

Leaving and returning to this page replaces a manually entered weight with FMC computed gross weight.

② Runway Length

Displays the length in feet and meters of the referenced runway

Blank if no runway has been entered and executed.

③ ILS Approach

Displays the runway number and associated ILS frequency / identifier for the ILS, LOC, or back course approach in the active flight plan.

Displays front course, if an ILS, localizer, or localizer backcourse is displayed on 5L. If the course is true displays is suffixed with "T."

Blank if no approach has been executed.

④ INDEX

Push – Selects the INIT/REF INDEX page.

⑤ V_{REF} (FLAPS _ _ _ VREF)

Displays landing V_{REF} for three flap settings as computed by the FMC. Displayed in small size characters.

Selection causes the flap and V_{REF} speed to be placed in 4R.

Double line selection of a displayed V_{REF}, or manual entry of another value, causes the flap and V_{REF} speed to be placed in 4R and causes V_{REF} to be displayed on the airspeed display. CDU display changes to large size characters.

Speeds are based on displayed gross weights.

Double line selection provides V_{REF} to be used by VNAV in combination with wind correction.

V_{REF}, once selected, will not be updated. To obtain an updated speed, the current speed must be deleted or a different V_{REF} selected or entered.

⑥ Flap / Speed (FLAP/SPD)

Displays selected approach reference flap and speed. If selected value is not one of the three settings a flap 40 value will be displayed.

Manual input of desired flap and/or speed settings may be made.

Entries are blanked at flight completion.

⑦ Wind Correction (WIND CORR)

Displays current wind correction for approach. Default is +05 knots.

Manual input of desired wind correction may be made up to +20 knots.

Hold Page

The HOLD page is used to enter a holding pattern into the route.

When the flight plan does not have a holding pattern, push the HOLD function key to show the LEGS page with the HOLD AT line.

Two versions of the hold page are possible:

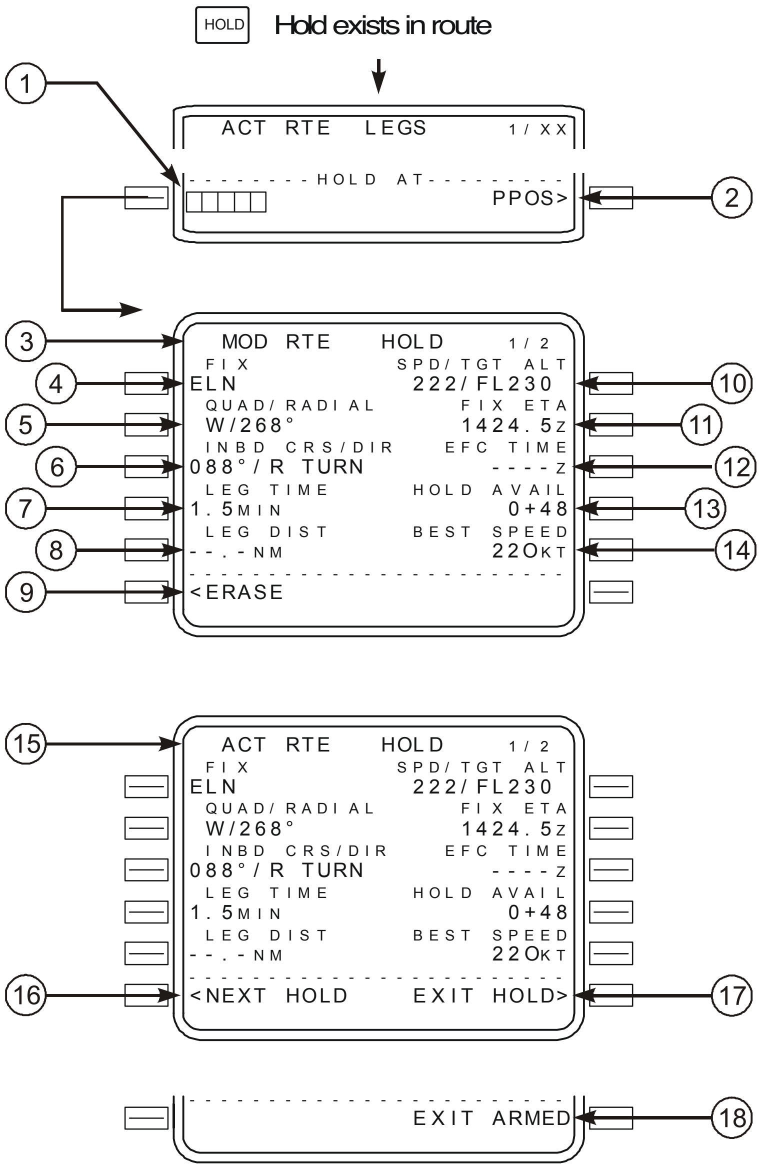
- An airway or procedure holding pattern (from the navigation database)
- A flight crew-entered holding pattern.

The holding page shows actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the navigation display.

During FMC guided entrance to a hold, portions of the LNAV magenta holding pattern on the navigation display may not show. This only occurs when the holding pattern is within 5000 feet of the FMC computed MAX ALT, and after the **UNABLE HOLD AIRSPACE** scratchpad message shows. LNAV hold entry guidance functions normally.


HOLD
Hold exists in route
ACT RTE LEGS 1/XX
--------HOLD AT---------
PPOS>
MOD RTE HOLD 1/2
FIX
ELN
SPD/TGT ALT
222/FL230
QUAD/RADIAL
W/268°
FIX ETA
1424.5Z
INBD CRS/DIR
088°/R TURN
EFC TIME
----Z
LEG TIME
1.5MIN
HOLD AVAIL
0+48
LEG DIST
--.-NM
BEST SPEED
220KT
<ERASE
ACT RTE HOLD 1/2
<NEXT HOLD
EXIT HOLD>
EXIT ARMED
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

773716158

① HOLD AT

When the HOLD function key is pushed and no holding pattern exists in the route, the LEGS page shows prompts to enter the holding fix. Enter the holding fix to show the RTE HOLD page.

Displays a prompt to enter the holding fix, a route waypoint, or present position.

A waypoint is entered as the holding fix.

② HOLD AT Present Position (PPOS)

Selects the aircraft present position as the holding fix.

③ Modified Route Hold Status

MOD indicates that the holding fix has not been executed.

Execution changes the page title to RTE HOLD (ACT RTE HOLD if holding at PPOS).

④ FIX

Displays waypoint identifier of the holding fix.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

If PPOS was selected on the HOLD AT page, then the FMC assigns PPOS as the fix identifier.

⑤ Quadrant / Radial (QUAD/RADIAL)

Displays holding pattern quadrant and radial.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

Valid entry is **XXX** (radial) or **XX/XXX** (quadrant / radial). Valid quadrant entry is **N**, **NE**, **E**, **SE**, **S**, **SW**, **W**, **NW**.

Quadrant shall be determined by the resulting inbound course.

⑥ Inbound Course / Direction (INBD CRS/DIR)

Displays holding inbound course and turn direction.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

Valid entry is **XXX** (inbound course), **XXX/X** (inbound course / turn direction), **/X** or **X** (turn direction).

Automatically changes **QUAD/RADIAL** to agree.

For a flight crew-entered holding pattern, the inbound course is initially the same as the preceding leg to the fix.

For a flight crew-entered holding pattern, if no entry is made, the FMC assumes right turns.

7 LEG TIME

Displays holding pattern leg time.

Valid entry is **XXX.X**. Manual entry has priority.

If no entry is made, the FMC assumes the standard times of 1.0 minute at or below 14,000 feet, and 1.5 minutes above 14,000 feet.

If a **LEG DIST** is manually entered, then dashes will be displayed.

8 Leg Distance (LEG DIST)

Dash prompts are normally displayed.

Entry may be propagated either automatically from the database, or made by manual entry.

Manual entry has priority.

Overrides **LEG TIME**.

9 ERASE

Displayed only while modification is in progress.

Push – Deletes modification and returns to ACT RTE HOLD page, if one exists; otherwise returns to the ACT RTE LEGS page.

10 Speed / Target Altitude (SPD/TGT ALT)

Displays current speed and altitude (small font).

Speed or altitude constraint may be entered. Manual entries are in large font and propagate to LEGS page.

11 Fix Estimated Time Of Arrival (FIX ETA)

Displays computed time for next passage over holding fix.

12 Expect Further Clearance Time (EFC TIME)

Entry of the EFC time optimizes FMC performance computations.

Computation of destination fuel assumes that departure from the holding fix occurs at this time.

(13) Hold Available (HOLD AVAIL)

Displays available holding time in hours + minutes remaining if destination is to be reached with planned fuel reserves as entered on PERF INIT page.

(14) BEST SPEED

Displays computed best holding speed based on present altitude and conditions.

May exceed maximum speed permitted by regulatory agency.

(15) Active Route Hold Status

ACT indicates that the aircraft has entered the holding pattern.

(16) NEXT HOLD

Displayed when the route contains less than five holding patterns and there is no route modification in progress.

Push – Displays next holding pattern if another holding pattern is entered in the route; displays (RTE LEGS) HOLD AT page if there is no other holding pattern in the route.

(17) EXIT HOLD

Displayed on the holding page when in the holding pattern.

Used when preparing to depart holding pattern.

Push – Changes prompt to **EXIT ARMED** and illuminates execute key.

(18) EXIT ARMED

Displayed on the holding page when in the holding pattern and after line selection of **EXIT HOLD** prompt.

Execution activates LNAV flight back to the holding fix via a shortened holding pattern, departure from holding pattern, and continued flight along the active route. ACT RTE LEGS page **1/XX** appears after holding exited.

Highlighted in reverse video after execution.

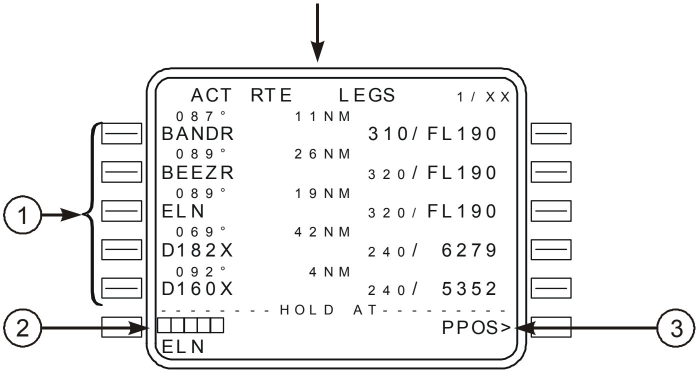
RTE Legs Hold At (Fix In Route)

Used to enter proposed fix for racetrack holding pattern at either present position or any waypoint.

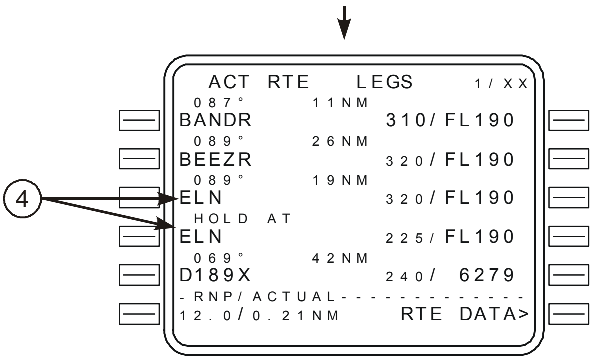
A maximum of five holding patterns may exist at one time.

Two holding patterns may exist at the same waypoint if one is in the route and the other is in the missed approach.

HOLD Proposed holding fix in current route; no holding pattern currently exists in route



HOLD After executing route hold at downtrack waypoint



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① Data Lines

Display same data as the corresponding RTE LEGS page.

② HOLD AT

Used to enter any waypoint identifier, which then defines a holding fix.

Entry may be via keyboard, or by transfer of any downpath waypoint, which is in the existing route (the example depicts ELN line selected into the scratchpad).

Following line selection of the desired waypoint into the box prompts, the MOD RTE HOLD page appears and the execute key illuminates.

③ Present Position (PPOS)

Push – Selects holding fix at present position. The MOD RTE HOLD page appears and the execute key illuminates ("present" is at the time of execution of the MOD RTE HOLD page).

Displayed only in flight.

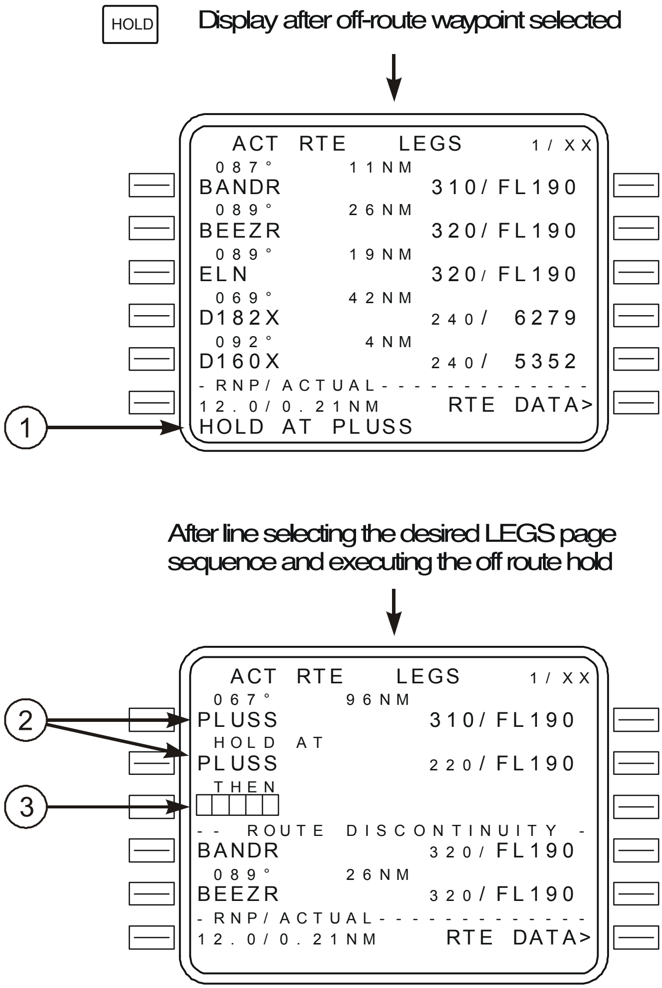
Default parameters are a standard holding pattern on the inbound leg.

④ Hold At Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

RTE Legs Hold At (Fix Not In Route)



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① Hold At Waypoint (HOLDAT XXXX)

Displayed in the scratchpad whenever the entry in the HOLD AT line is not a waypoint in the existing route (the example above depicts entry of PLUSS).

Route position of the holding fix is defined by line selecting to the desired LEGS page sequence.

Following line selection to the desired LEGS page sequence, the MOD RTE HOLD page appears and the execute key illuminates.

② Hold At Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

③ ROUTE DISCONTINUITY

The entered route must always form a continuous path of linked legs.

The example depicts a HOLD AT entry where the entry was not a downpath waypoint.

The FMC computes a direct course to the off-route holding fix.

The HOLD AT waypoint becomes a termination identifier which is not part of the existing route. The resulting route discontinuity is identified by box prompts, requiring entries to define the route after PLUSS.

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FMC MESSAGES

Introduction

FMC messages inform the flight crew when system operation is degraded, crew data input errors, or general information.

FMC messages show in the CDU scratchpad. The messages are categorized as:

- Alerting messages
- Entry error messages
- Advisory messages
- FMC data link messages (alerting and advisory)

The FMC messages are shown according to their level of importance. Alerting messages are most important, followed by entry error messages. Advisory messages are least important. If multiple messages exist, a less important message replaces another message in the scratchpad when the CLR key is pushed or the condition is corrected.

The amber FMC alert light on each pilot's instrument panel illuminates when there is an FMC alerting message. All FMC messages illuminate the CDU message (**MSG**) light. Clear the message or correct the condition to cancel the message.

The following tables are general lists (as installed).

FMC Alerting Messages (As Installed)

These messages relate to operationally significant conditions, which affect FMC operation.

FMC alerting messages:

- Are shown in the CDU scratchpad
- Cause the amber FMC alert light on each pilot's instrument panel to illuminate
- Illuminate message lights (**MSG**) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CYCLE IRS OFF-NAV	IRS is unable to complete alignment under current conditions.	Cycle IRS mode selector to "OFF" and back to "NAV."
DATA BASE INVALID	The automatic validity test of the permanent navigation database has failed.	Advise maintenance personnel to check the FMC and reload the database, as required. If desired, consider the use of the temporary nav database.
DISCO INSRTD AFTR XXXXX (waypoint identifier)	A ROUTE DISCONTINUITY has been inserted into the flight plan due to undefined termination of a downpath leg or a double waypoint BYPASS.	Select the RTE or RTE LEGS pages and modify the waypoints for a continuous route.
DISCONTINUITY	Passing the last waypoint in the route prior to a ROUTE DISCONTINUITY (LNAV disengages) or pressing LNAV while in a discontinuity.	Select the RTE LEGS page. Enter the desired active waypoint into the box prompts. Correct any ROUTE DISCONTINUITY and EXECute. Reengage LNAV.
DUAL FMC OP RESTORED	Dual FMC operation has been successfully restored. (Dual FMC as installed.)	Clear message and set FMC source select switch to NORMAL.
END OF OFFSET	Two minutes prior to passing offset leg termination.	Confirm ATC clearance.
END OF ROUTE	LNAV engaged and passing the last waypoint in the route (LNAV disengages).	Select the RTE LEGS page. Enter the desired active waypoint into the dash prompts and EXECute. Reengage LNAV.
ENTER IRS POSITION	IRS in the alignment mode needs present position to complete alignment. Previous present position entry was not received back from the IRS.	Enter IRS present position into the scratchpad and line select 4R on the POS INIT page of the CDU. If present position was previously entered, overwrite displayed data. If necessary, enter present position directly into the IRS control / display unit.

INSUFFICIENT FUEL	A change in conditions or flight plan route causes predicted fuel at destination to be 900 kilograms / 2000 lbs or less.	Modify the route plan or cruising altitude, or divert for additional fuel.
IRS MOTION	IRS has automatically restarted the alignment due to detection of excessive motion.	Clear message and attempt to reduce aircraft movement, if practicable.
LNAV BANK ANGLE LIMITED	5 minutes prior to an LNAV guided course change that may exceed airway / route boundary due to LNAV performance limited bank angle.	Review the LNAV course change. If course change exceeds airway / route boundary, consider flight plan change.
MISSED CAPTURE	Proper localizer capture maneuver was performed, but the AFDS did not capture.	Clear the message.
MODEL/ENG DATA INVALID	A valid performance database is not available.	Contact maintenance personnel.
NAV DATA OUT OF DATE	Effectivity dates of nav database do not agree with date input from clock.	Check the IDENT page and reverse the dates for ACTIVE NAV DATA if required.
NAV INVALID–TUNE XXXXX (navaid identifier)	FMC is unable to auto-tune or receive the navaid for a RNAV or VOR approach procedure.	Cross-check radios and manually tune the desired navaid.
OVERSPEED DISCONNECT	U10.2 and later: During path descent and above or below the speed restriction altitude, VNAV disengages when airspeed exceeeds FMC speed restriction by more than 15 knots.	Manually reduce speed and reengage VNAV or continue descent in LVL CHG.
7 8 9 **PARTIAL ROUTE LOADED**	A route is loaded which references data not contained in the database.	Clear the message.
PERF DEFAULTS INVALID	Validity check of performance defaults database has failed.	Contact maintenance personnel.
RESET MCP ALT	Within 5 NM of the top-of-descent point without selecting a lower altitude on the AFDS MCP.	Select lower MCP altitude values as clearances permit.
RTA UNACHIEVABLE	The RTA is not in the computed RTA window under current parameters.	Enter an achievable RTA or discontinue the RTA mode of navigation. Adjust parameters to meet the RTA.

RW/APP TUNE DISAGREE	During approach, manual tuned approach frequency or channel does not match active flight plan.	Clear the message and select correct approach frequency.
RW/APP CRS ERROR	During approach, MCP selected course does not match front course for the approach in the active flight plan.	Clear the message and select correct MCP course.
7 8 9 **SCANNING DME FAIL**	Inputs from both frequency scanning DME radios have failed.	Clear the message and check position. Radio updating of FMC position is not available.
SELECT MODE AFTER RTA	RTA mode has been discontinued due to sequencing of RTA waypoint or RTA waypoint has been removed from the flight plan.	Select desired navigation mode. (ECON, manual speed, etc.)
SINGLE FMC OPERATION	The primary FMC has determined that the secondary FMC is not available. (Dual FMC as installed.)	Move FMC source selector switch to “BOTH ON L” or “BOTH ON R.”
TAKEOFF SPEEDS DELETED	New performance data is entered after the V speeds have been entered on the TAKEOFF REF page, or a takeoff thrust selection change is entered after the V speeds have been entered.	Select new V speeds.
UNABLE HOLD AIRSPACE	LNAV guided holding pattern may exceed allowable hold airspace due to LNAV performance limited bank angle.	Review the holding pattern. If holding pattern exceeds allowable holding airspace, consider flight plan change.
UNABLE NEXT ALTITUDE	Unable to meet the next flight plan altitude constraint in a **VNAV SPD** climb or descent. The message appears only with VNAV engaged.	Clear the message and review the prediction. For undershoot condition during climb, consider selection of MAX RATE CLB or MAX ANGLE CLB, or a different N1 limit as appropriate.
UNABLE REQD NAV PERF-RNP	FMC actual navigation performance is not sufficient for the displayed RNP.	Go-around and/or rejected to ground-based nav aid reference, if necessary. Investigate status of FMC updating..

VERIFY GW AND FUEL	Fuel data becomes invalid, PERF INIT fuel value is replaced with dashes. FMC uses last valid fuel quantity for performance predictions until manual entry is made. Shows if 30 minutes have elapsed since last manual entry. Does not show in descent with Vref selected.	Enter fuel weight on PERF INIT page 1/2. Periodic update of fuel weight is required to keep gross weight value current.
VERIFY POSITION	Position information is contradictory. Inhibited during approach.	Revert to ground-based nav aid reference, if necessary. Investigate position disagreements of the POS SHIFT page.
VERIFY RNP	Underlying RNP value is less than manually entered value.	Enter appropriate RNP.
VERIFY TAKEOFF SPEEDS	A PERF INIT change has been made after takeoff speeds were specified.	On TAKEOFF REF page 1, accept previous V speeds, or reject previous V speeds and enter new V speeds.
VNAV DISCONNECT	The criteria for VNAV engagement is not satisfied (VNAV disengages).	Manually control the vertical path.

FMC Entry Error Messages

These messages relate to incorrect scratchpad entries. FMC entry error messages:

- Are shown in the CDU scratchpad
- Illuminate the message light (**MSG**) of the CDU where the entry error was made
- Temporarily overwrite data in the scratchpad.

Use the CLR key or key in new data to remove the message. If the CLR key is used to remove the message, the data previously entered is once again displayed. If new data is keyed in over the message, the message and the data previously entered are removed.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
ALT CONSTRAINT XXXXX (waypoint identifier)	A flight plan modification has caused an altitude conflict with a waypoint that has an altitude constraint.	Clear the message and revise the entry.
DATA BASE FULL	Entry attempted into a supplemental or temporary navigation database category which is full.	Go to the NAV DATA pages and delete unneeded waypoints, navaids, or airports from the appropriate database and re-attempt entry.
DUPLICATE FLIGHT PLAN ID	The entry attempted is a duplicate of an existing supplemental flight plan name. (U10.3)	Clear the message and select a unique flight plan name.
INVALID DELETE	DEL key operation was attempted for a data line to which it was not applicable.	Clear the message and select the proper line after the DEL key is pressed.
INVALID ENTRY	Attempted data entry has incorrect format, range, etc. for the selected data line. Entered RTA waypoint is not in the flight plan.	Clear the message and scratchpad entry, and repeat the entry with the correct data.
INVALID QUAD	Attempted HOLD page QUAD entry has incorrect format or range.	Clear the message and revise the QUAD entry.
NO OFFSET AT LEG XXXXX (waypoint)	Attempted entry of a lateral offset start or end waypoint XXXXXX that is not offsetable (lateral offset as installed).	Clear the message and amend the route.

NOT IN DATA BASE	FMC does not contain the required data for the entered identifier.	Clear the message and check data entry, or enter the required information into the supplemental or temporary navigation database via the NAV DATA pages.
NOT IN FLIGHT PLAN	RTA waypoint or lateral offset (as installed) start / end waypoint entry is not in active flight plan.	Clear the message and amend the entry.
ROUTE FULL	Entry of more than maximum allowed number of waypoints or holding patterns attempted.	Clear the message and review existing and desired waypoints and holding patterns for possible deletion.
SUPP RTE DATA BASE FULL	Attempted save of the 11th supplemental flight plan.	Clear the message, delete unneeded supplemental flight plans and re-attempt entry.

FMC Advisory Messages

These messages relate to FMC status. FMC advisory messages:

- Are shown in the CDU scratchpad
- Illuminate message lights (**MSG**) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	The aircraft is above its maximum certified altitude.	Descend to an altitude below the maximum certified altitude.
APPRCH VREF NOT SELECTED	Aircraft has transitioned into approach environment and Vref has not been selected on APPROACH REF page.	Select Vref on APPROACH REF page.
ARR N/A FOR RUNWAY	Runway or approach does not match the selected arrival procedure.	Go to the ARRIVALS page and modify selection.
BUFFET ALERT	Current conditions result in a maneuver margin less than specified.	Bring the aircraft back within the operating envelope.
CHECK FMC FUEL QUANTITY	The FMC has detected an unexpected drop in the fuel quantity.	Check the fuel quantity indications for correctness.
DES PATH UNACHIEVABLE	When in path descent and above the path, the FMC predictions show the profile restrictions at the next waypoint cannot be achieved (LNAV remains engaged).	Modify the restrictions.
DRAG REQUIRED	Airspeed is 10 kts or more above FMC target speed or within 5 kts of Vmo/Vmmo.	Use speedbrakes, trim or reduced thrust, as required, to bring the aircraft within 5 kts of FMC target speed.
INVALID OFFSET	Desired offset does not meet FMC offset criteria.	Clear the message and amend the entry.
LOC CAP ACTIVE	The aircraft is approaching its turn onto the localizer course and will maintain an intercept heading.	Clear the message manually, or wait for the AFDS to signal reset status to the FMC.

LOC CAP CANCELLED	Flight plan modifications or the aircraft condition did not facilitate localizer capture.	Clear the message manually, or wait for the AFDS to reset to LOC CAP ACTIVE.
MAX ALT FLXXX (flight level value)	Altitude entry on any page is above the maximum altitude for current selected performance margins.	Clear the message or amend the data entry.
MAX MACH .XXX/MIN MACH .XXX OR **MAX CAS .XXX/MIN CAS .XXX**	FMC target speed is greater than the maximum or less than the minimum buffet speed for the entered cruise or step climb altitude.	Change the target speed to within the message limits or enter a lower altitude.
NO DES PATH AFTER XXXXX (waypoint)	FMC is unable to construct a PATH DES that satisfies all altitude restrictions after XXXXX.	Modify speed or altitude restrictions on the RTE LEGS pages.
NOT ON INTERCEPT HEADING	Aircraft is not within the LNAV capture criteria for the active leg (LNAV disengages).	Manually place the aircraft on an intercept heading and reengage LNAV.
OFFSET DELETED	The entered start waypoint has been deleted from the flight plan. (lateral offset as installed)	Clear the message and amend the route.
OFST ENDS ABEAM XXXXXX	An invalid offset leg exists between the end waypoint (XXXXXX) and the start of offset or no end waypoint exists.	Clear the message and amend the route.
PERF DEFAULTS DELETED	Performance database has been automatically deleted due to conflict with performance database limits.	Contact maintenance personnel.
PROGRAM PIN ERROR	FMC connector wiring is incorrect.	System unusable; advise maintenance personnel. The CLR key will not clear the message.
PROGRAM PIN NOT IN DB	FMC connector wiring or performance database is incorrect.	Contact maintenance personnel.
RESET MCP ALT	FMC operation cannot take aircraft away from the AFDS MCP altitude.	Select a MCP altitude value in the proper direction (higher for climb, lower for descent).
RUNWAY N/A FOR SID	The selected runway is not applicable to the selected departure procedure.	Clear the message and check selections on the DEPARTURES page. Modify as required.

SELECT ACTIVE WPT/LEG	Power-up restart or insertion of a different flight plan while airborne.	EXECute a direct-to or leg intercept to tell the FMC which leg of the route is active.
STEEP DESCENT AFTER XXXXXX	An excessive vertical discontinuity exists after point XXXXXX.	Check routing.
TAI ON ABOVE 10°C	Aircraft is operating with anti-icing with TAT above +10°C.	Clear the message and check the use of anti-icing for engines and/or wings.
UNABLE CRZ ALT	FMC predicts that the aircraft cannot reach the new CRZ ALT due to performance limitations. FMC predicts that no cruise time is possible at the entered CRZ ALT.	Clear the message and review the CRZ ALT selection. Clear the message and review the CRZ ALT selection.
UNABLE MACH .XXX	The entered cruise Mach is unattainable based on present gross weight.	Select a smaller Mach number or wait until gross weight is reduced sufficiently.
UNABLE TO OFFSET	A valid offset cannot be constructed due to geometric limitations.	Clear the message and amend the route.
USING RSV FUEL	Predicted fuel remaining at DEST is less than the RESERVES entry on the PERF INIT page.	Clear the message and change routing if required.
VERIFY RNP VALUE	When entering an RNP the underlying RNP value is smaller than the manually entered value or the ANP is greater than the manually entered RNP.	Change or delete the manually entered RNP.
XXXX (airport identifier)	A REF AIRPORT is entered on the POS INIT page and no entry of ORIGIN yet appears on RTE page 1.	Enter the airport identifier on the ORIGIN data line.
XXXXX (MCP altitude value)	With the CRZ page displayed, resetting the AFDS MCP altitude to a value different from the CRZ ALT causes the value to appear in the scratchpad.	Enter the MCP altitude value on the appropriate target altitude data line.

FMC Data Link Messages (As Installed)

These messages relate to FMC data link message status. FMC data link alerting and advisory messages function the same as the alerting and advisory messages described above:

FMC Data Link Alerting Messages

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CRZ WIND UPLINK LOADING	An FMC cruise wind uplink message is loading (after LOAD selected on the RTE DATA page).	Wait for load to complete.
CRZ WIND UPLINK READY	An FMC cruise wind uplink message has been received and is available for loading on the RTE DATA page.	Select RTE DATA page, LOAD cruise wind, and execute or **ERASE**.
CRZ WIND XXXXX (cruise altitude) **UPLINK**	An FMC cruise wind uplink message has been loaded on the RTE DATA page, and is ready for flight crew review.	Review the cruise wind uplink, and execute or **ERASE**.
FORECASTS UPLINK READY	An FMC descent forecasts uplink message has been received and is available for loading on the DESCENT FORECASTS page.	Select DESCENT FORECASTS page, LOAD descent forecasts winds, and execute or **ERASE**.
DATALINK CONFIG INVALID	Validity check of the FMC datalink configuration file has failed.	Contact maintenance personnel.
DESCENT FORECASTS UPLINK	An FMC descent forecasts uplink message has been loaded on the DESCENT FORECASTS page, and is ready for flight crew review.	Review the descent forecasts uplink, and execute or **ERASE**.
INVALID TAKEOFF XXX/YYY (runway or runway/intersection identifier)	Runway (RTE page) or runway / intersection (TAKEOFF REF page) has been entered that matches runway takeoff data in FMC memory. However, the aircraft is performance limited for the selected runway.	Clear the message. Enter correct takeoff data, request new takeoff data uplink, or enter new runway or runway / intersection identifier.
NAV DATA LOADING	An FMC supplemental navigation data uplink message has been received and is loading.	Wait for load to complete.

NAV DATA UPLINK	An FMC supplemental navigation data uplink message has been loaded on the SUPP NAV DATA page, and is ready for flight crew review.	Review the supplemental navigation data uplink, and execute or **ERASE**.
PARTIAL FORECASTS UPLINK	An FMC descent forecasts uplink message has been loaded on the DESCENT FORECASTS page, but errors were encountered during the loading process.	Review the descent forecasts uplink, and execute or **ERASE**.
PARTIAL NAV DATA UPLINK	An FMC supplemental navigation data uplink message has been loaded on the SUPP NAV DATA page, but errors were encountered during the loading process.	Review the supplemental navigation data uplink, and execute or **ERASE**.
PARTIAL PERF INIT UPLINK	An FMC performance initialization uplink message has been loaded on the PERF INIT page, but errors were encountered during the loading process.	Review the performance initialization uplink, and execute or **ERASE**.
PARTIAL ROUTE UPLINK	An FMC route uplink message has been loaded on the RTE page, but errors were encountered during the loading process.	Review the route uplink, and execute or **ERASE**.
PERF INIT UPLINK	An FMC performance initialization uplink message has been loaded on the PERF INIT page, and is ready for flight crew review.	Review the performance initialization uplink, and execute or **ERASE**.
PERF INIT UPLINK READY	An FMC performance initialization uplink message has been received and is available for loading on the PERF INIT page.	Select PERF INIT page, LOAD performance initialization data, and execute or **ERASE**.
PERF LIMITS UPLINK	An FMC performance limits uplink message has been loaded on the PERF LIMITS page, and is ready for flight crew review.	Review the performance limits uplink, and execute or **ERASE**.

PERF LIMITS UPLINK READY	An FMC performance limits uplink message has been received and is available for loading on the PERF LIMITS page.	Select PERF LIMITS page, LOAD performance limits, and execute or **ERASE**.
RESEND MESSAGE	An FMC downlink message was attempted, but the FMC was unable to deliver the message to the ACARS MU.	Re-send the downlink message.
ROUTE DATA UPLINK	An FMC route uplink message has been loaded on the RTE page, and is ready for flight crew review.	Review the route uplink, and execute or **ERASE**.
ROUTE UPLINK LOADING	An FMC route uplink message is loading (after LOAD selected on the RTE page).	Wait for load to complete.
ROUTE UPLINK READY	An FMC route uplink message has been received and is available for loading on the RTE page.	Select RTE page, LOAD route, and execute or **ERASE**.
RTA DATA UPLINK	An FMC RTA uplink message has been loaded on the RTA PROGRESS page, and is ready for flight crew review.	Review the RTA uplink, and execute or **ERASE**.
RTA UPLINK READY	An FMC RTA uplink message is has been received and is available for loading on the RTA PROGRESS page.	Select RTA PROGRESS page, LOAD RTA data, and execute or **ERASE**.
TAKEOFF DATA LOADED	Uplink takeoff data matching Runway (RTE page) or runway / intersection (TAKEOFF REF page) has been loaded on the TAKEOFF REF page, and is ready for flight crew review.	Select TAKEOFF REF page, accept or reject takeoff data.
TAKEOFF DATA UPLINK	An FMC takeoff data uplink message containing one or more sets of runway takeoff data has been received and loaded in FMC memory.	Enter appropriate runway (RTE page) or runway / intersection (TAKEOFF REF page) to access runway takeoff data.

FMC Data Link Advisory Messages (As Installed)

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID CRZ WIND UPLINK	An FMC cruise wind uplink message was received, but was rejected due to errors.	Clear the message.
INVALID FORECASTS UPLINK	An FMC descent forecasts uplink message was received, but was rejected due to errors.	Clear the message.
INVALID NAV DATA UPLINK	An FMC supplemental navigation data uplink message was received, but was rejected due to errors.	Clear the message.
INVALID PERF INIT UPLINK	An FMC performance initialization uplink message was received, but was rejected due to errors.	Clear the message.
INVALID ROUTE UPLINK	An FMC route uplink message was received, but was rejected due to errors.	Clear the message.
INVALID RTA UPLINK	An FMC RTA uplink message was received, but was rejected due to errors.	Clear the message.
INVALID TAKEOFF UPLINK	An FMC takeoff data uplink message was received, but was rejected due to errors.	Clear the message.

NAVIGATION

VHF NAV

Two NAV receivers and control panels are installed. The panels are used to tune related VOR and ILS frequencies. The NAV receivers may be automatically tuned by the FMC when an FMC-controlled mode of navigation is selected. The pilot may select automatic or manual tuning by pressing the AUTO-MANUAL switch on the NAV Control Panel.

When operating the NAV radios in the automatic mode, the **AUTO** light illuminates and the frequency selected by the FMC appears in the Automatic Frequency Indicator. A red bar appears across the Manual Frequency Indicator. Frequencies may still be selected manually but they are not active until the manual mode is selected, the switch illuminates **MAN** and the Automatic Frequency Indicator goes blank.

7 8 9 The control panels on these aircraft do not have the AUTO-MANUAL switch. Switching is accomplished automatically and internally.

VOR/ILS information is displayed on the Radio Distance Magnetic Indicators (RDMIs) and the Electronic Horizontal Situation Indicators (EHSIs) VOR/ILS display mode.

The VHF NAV Transfer Switch is used to switch the EHSI to a functioning navigation receiver in the event of a failure of the number one or the number two navigation radio, or the loss of navigation information to an EFIS display.

INSTRUMENT LANDING SYSTEM (ILS)

Two ILS receivers are installed.

The ILS receivers are tuned manually on the VHF navigation control panel. The flight crew must manually tune the ILS for display on CDS. The ILS localizer and glideslope can also be displayed on the standby attitude indicator.

LOC updating of the FMC occurs only after the ILS is manually tuned. The tuned ILS frequency is displayed on the navigation display in the APP modes.

③ VHF NAV

Two NAV receivers and control panels are installed. The panel is used to tune related VOR and ILS frequencies. The NAV receivers are automatically tuned by the FMC when the related HSI is in the NAV mode and the auto / manual select switch is in AUTO on the NAV control panel.

VOR bearings can be displayed on the RDMI's. The bearings are also used in conjunction with a co-located DME by the FMC to refine inertial data. The HSI displays the manually selected course and course deviation when operating in the VOR/ILS mode.

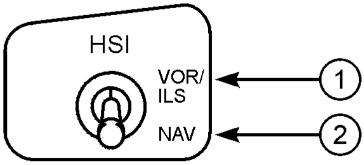
The NAV receivers can be tuned manually if the related HSI is in the VOR/ILS mode. The NAV receiver can also be tuned manually when the related HSI is in the NAV mode. The AUTO-MAN switch must be pressed to illuminate **MAN**. This overrides the HSI switch logic.

When the HSI is in the VOR/ILS mode with ILS frequencies, the HSI displays localizer and glideslope deviation along with the selected course. The FMC uses the localizer deviation signals to refine inertial data.

The VHF NAV transfer switch is used to switch all associated systems to the good receiver if the HSI is in VOR/ILS mode.

The pilot must be aware of the VHF NAV frequency on the control panel to which he is switching. This is especially true if that control panel is in AUTO-TUNE mode.

③ HSI SWITCH



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① VOR/ILS – The HSI is in the VOR/ILS mode.

- The HSI course pointer reflects the course set by the course selector on the mode control panel.
- VHF navigation frequencies must be tuned manually.

② NAV – The HSI is in the NAV mode.

- The HSI course pointer is automatically positioned by the FMC.
- VHF navigation frequencies are selected automatically but may be manually selected if the AUTO/MANUAL switch has been switched to the MANUAL mode.

3 5 7 8 9 DME

Two DME systems are installed. Each may be tuned automatically or manually depending on the mode selected on the NAV radio.

DME distance is displayed on the Radio Distance Magnetic Indicators (RDMIs) and the Electronic Horizontal Situation Indicators (EHSIs) VOR/ILS display mode.

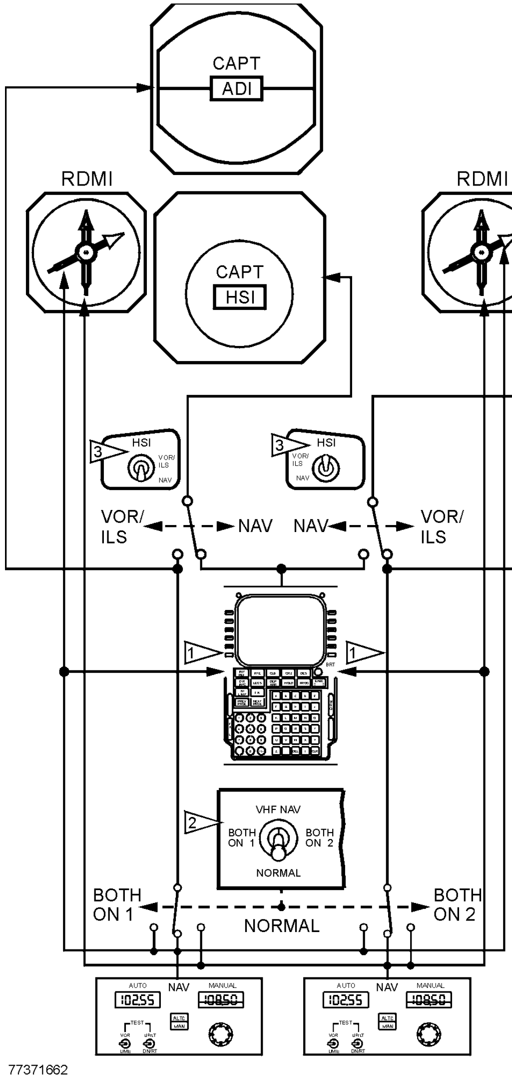
③ DME

Two DME systems are installed. Each is automatically tuned by the FMC when the NAV receivers are operating in the AUTO mode.

When the HSI is selected to the VOR/ILS mode, the NAV panel automatically reverts to the MAN mode. FMC tuning of the NAV panel stops. Manual VOR-DME tuning is then available via the NAV control panel.

DME distance is displayed on the radio distance magnetic indicators (RDMI).

③ VHF NAVIGATION SYSTEMS SCHEMATIC

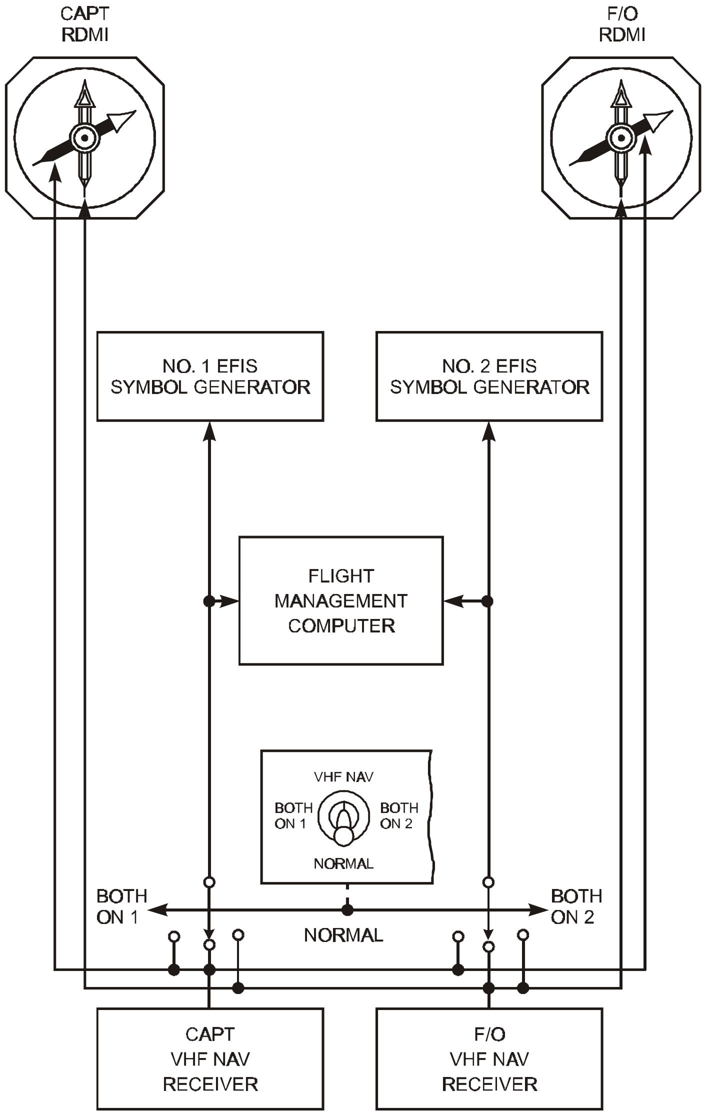


1 FMC can utilize both VHF NAV and both DME receivers.

2 CAUTION: VHF NAV receivers are normally tuned automatically when the HSI is in the NAV mode.

3 NOTE: When the HSI Switch is in the NAV position with a NAVIGATION failure flag in view, switch the HSI to the VOR/ILS mode.

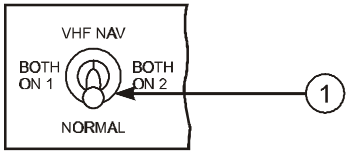
3 5 7 8 9 VHF NAVIGATION SYSTEM SCHEMATIC



VHF NAVIGATION SYSTEM SCHEMATIC

7376-10001

VHF NAVIGATION



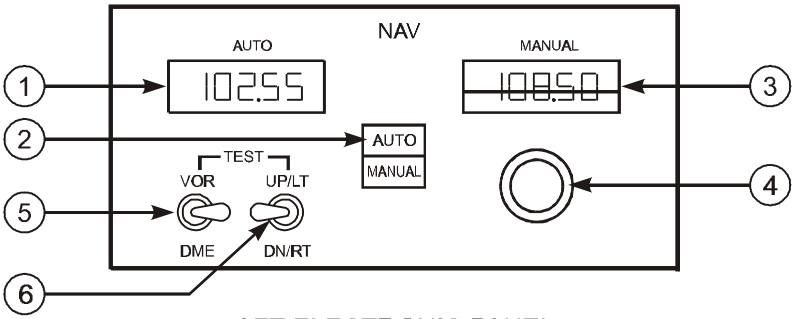
FWD OVERHEAD PANEL

7376-10002

① VHF NAV Transfer Switch

Enables selection of opposite the VHF NAV receiver in the event of receiver failure.

③ 3 5



AFT ELECTRONIC PANEL

7376-10003

① Automatic Frequency Indicator

- Indicates the frequency which has been tuned automatically by the FMC.
- The display is blank when manual tuning has been selected.
- Displays dashes during Agility – Tuning.

② AUTO-MANUAL Switch (alternate action)

AUTO (illuminated white) – Tuning is accomplished by the FMC.

- The HSI switch must be positioned to NAV (NON-EFIS).
- Pressing the switch will change the function from AUTO to MAN.

MANUAL (illuminated white) – Tuning must be accomplished manually by rotating the Frequency Selector.

- The HSI switch is positioned to VOR/ILS or NAV (NON-EFIS).

③ MANUAL Frequency Indicator

- Indicates the frequency which has been selected by rotating the Frequency Selector.
- A bar appears over the frequency when automatic tuning is selected.

④ Frequency Selector

ROTATE – Manually selects the desired frequency.

⑤ VOR/DME TEST Switch (spring-loaded to center)

VOR – With a VOR frequency tuned and a course of 000 selected:

- The Course Deviation Bar centers.
- The VOR Bearing Pointer indicates 180 degrees.
- The **TO/FROM** annunciator shows **FROM** ambiguity.

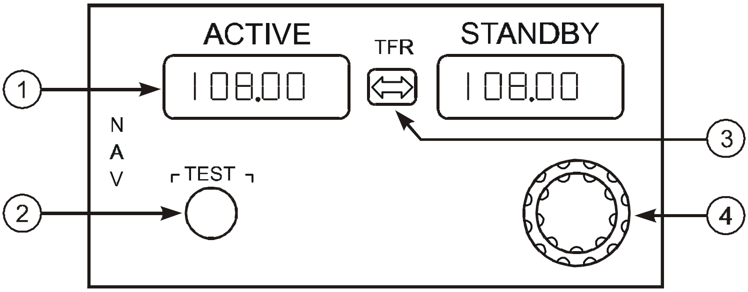
DME – The DME warning flag appears for two seconds, then dashes appear for two seconds, then all zeroes (not to exceed 000.5) appear for 12 seconds or until the VOR/DME TEST switch is released.

⑥ ILS TEST Switch (spring-loaded to center position)

UP/LT – With an ILS frequency selected, the glide slope indicates one dot up and the localizer indicates one dot left.

DN/RT – With an ILS frequency selected, the glide slope indicates one dot down and the localizer indicates one dot right.

7 8 9 VHF NAVIGATION CONTROL



AFT ELECTRONIC PANEL

7376-10004

① Frequency Indicator

Indicates the frequency selected by the frequency selector

- Tuned frequency displayed in STANDBY display
- TFR switch moves STANDBY frequency to ACTIVE frequency.

② TEST Switch

With a VOR frequency tuned and a course of 000 selected:

- Shows VOR fail flag
- Deviation bar biases out of view and then returns to centered position
- Bearing pointer slews to 180 degrees.
- DME displays:
  - DME fail flag
  - Dashes
  - Normal DME distance

With ILS frequency tuned and a course within 90 degrees of aircraft heading:

- Pointers display one dot up and one dot left
- Pointers then display one dot low and one dot right
- Pointers then return to normal display.
- DME displays:
  - DME fail flag
  - Dashes
  - Normal DME distance

③ Transfer (TFR) Switch

TFR – STANDBY frequency moved to ACTIVE frequency; ACTIVE frequency moved to STANDBY frequency.

④ Frequency Selector

ROTATE – Manually selects the standby frequency.

③ ADF

The No. 1 ADF uses the narrow pointer; the No. 2 ADF uses the wide pointer. The ADF bearing signals are sent to the pointers and flags on the RDMIs. The audio is heard by using the ADF receiver control on an audio selector panel.

An automatic direction finding (ADF) system enables automatic determination of magnetic and relative bearings to selected facilities.

ADF bearing pointers will not display correct magnetic bearing when the RDMI ADF warning flag is in view (electrical power failure). Relative bearings indicated by pointers may be correct, if the receiver is operating.

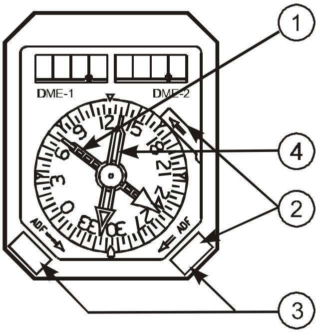
ADF

3 5 One ADF receiver is installed. The ADF bearing signals are sent to the pointers on the EHSIs and RDMIs. The audio is heard by using the ADF Receiver Control on an audio selector panel.

An automatic direction finding (ADF) system enables automatic determination of magnetic and relative bearings to selected facilities.

If heading or track information is lost or invalid, EHSI ADF bearing pointers will not be displayed, and RDMI ADF bearing pointers will not display correct magnetic bearing. Relative bearings indicated by pointers may be correct, if the receiver is operating.

③ 3 5 AUTOMATIC DIRECTION FINDING SYSTEM (ADF)



CAPT INST PANEL F/O INST PANEL

7376-10005

① ADF No. 1 Bearing Pointer

ADF Mode - Indicates relative bearing to the station selected by the ADF No. 1 Frequency Selector.

3 5

② ADF/VOR No. 2 Bearing Pointer Switch and Warning Flag

When the ADF position is selected with the switch, the No. 2 pointer flag will appear, and the bearing pointer will remain in its last position.

③ ADF/VOR No. 1 Bearing Pointer Switch

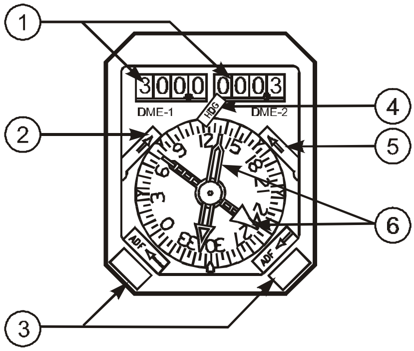
PRESS – Selects ADF or VOR for the bearing pointer.

③

④ ADF No. 2 Bearing Pointer

Indicates relative bearing to the station selected by the ADF No. 2 Frequency Selector.

③ [3] [5] RADIO DISTANCE MAGNETIC INDICATOR (RDMI)



CAPT INST PANEL F/O INST PANEL

7376-10006

① DME Indicators

- 300 nautical miles maximum search for all DME stations

Warning flag – Electrical power lost or invalid DME receiver. 

DME receiver powered, but not receiving a DME station, or during Agility-Tuning. 

② Bearing Pointer No. 1 Warning Flag In View

VOR Mode:

- Power failure.
- VHF NAV signal unreliable.

ADF Mode:

- Power failure.

③ ADF/VOR Bearing Pointer Switches

PRESS – Selects ADF or VOR for the bearing pointer.

④ Heading Warning Flag

IN VIEW – Selected compass signal is invalid.

- Power failure.

⑤ Bearing Pointer No. 2 Warning Flag In View

VOR Mode

- Power failure.
- VHF NAV signal unreliable.

ADF Mode

- ③ Power failure.
- 3 5 Always in view. ADF No. 2 not installed.

⑥ Bearing Pointers

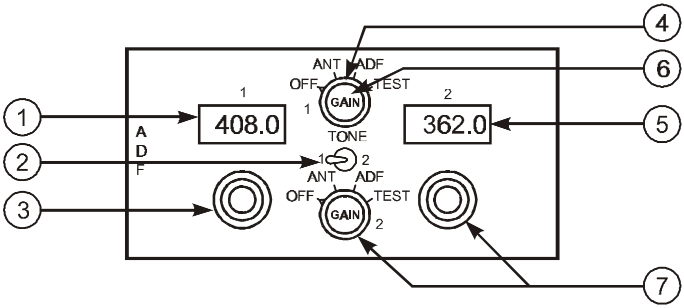
Signals to the VOR Bearing Pointers are not affected by the VHF NAV transfer switch.

Narrow Pointer – Uses signals from the VHF NAV receiver NO. 1 or ADF NO. 1 receiver.

Wide Pointer – Uses signals from VHF NAV receiver NO. 2 when in VOR mode.

- 3 5 ADF No. 2 receiver not installed.

③



AFT ELECTRONIC PANEL

7376-10007

① ADF No. 1 Frequency Indicator

② Tone Switch

1 – Adds tone to ADF receiver audio.

2 – Adds tone to ADF receiver audio.

CENTER – Disables tone.

③ ADF No. 1 Frequency Selector

④ ADF No. 1 Mode Selector

OFF – No electrical power to receiver.

ANT – Audio reception optimized.

- No ADF bearing sent to RDMIs.

ADF – Audio reception is possible.

- ADF bearing sent to RDMIs

TEST – ADF No. 1 Bearing Pointer indicates 45 degrees left of lubber line for valid test.

⑤ ADF No. 2 Frequency Indicator

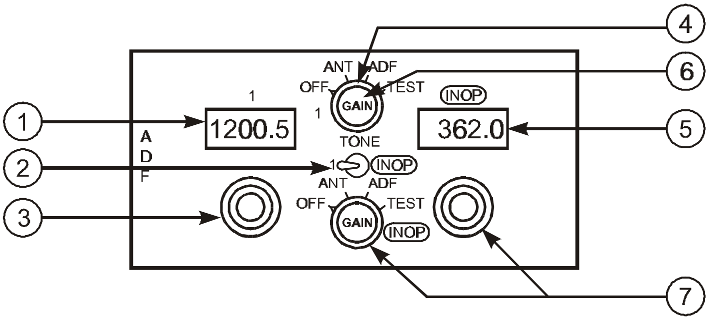
⑥ ADF No. 1 Gain Control

Adjusts receiver gain.

⑦ ADF No. 2 Mode, Gain and Frequency Selectors

Same functions as with ADF No. 1.

3 5



AFT ELECTRONIC PANEL

7376-10008

① TONE Switch

1 – Adds tone to ADF receiver No. 1 audio.

2 — INOP

CENTER – Disables tones.

② ADF No. 1 Frequency Indicator

③ ADF No. 1 Frequency Selector

④ ADF No. 1 Mode Selector

OFF – No electrical power to receiver.

ANT – Audio reception optimized.

- No ADF bearing sent to RDMIs.

ADF – Audio reception is possible.

- ADF bearing sent to RDMIs.

TEST – ADF No. 1 Bearing Pointer indicates 45 degrees left of lubber line for valid test.

⑤ ADF No. 2 Frequency Indicator

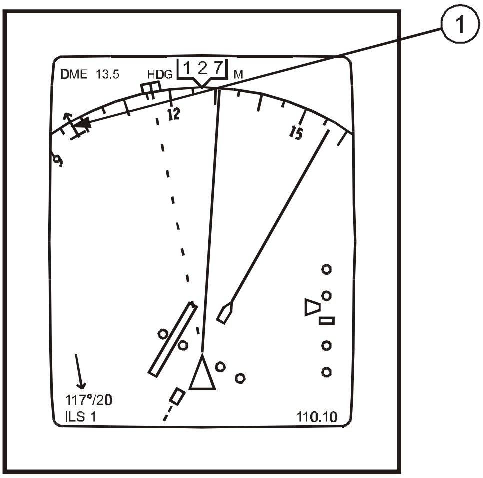
INOP

⑥ Gain Control

⑦ ADF No. 2 Mode, Gain and Frequency Selectors.

INOP

3 5 AUTOMATIC DIRECTION FINDING (ADF) SYSTEM



CAPT INST PANEL
F/O INST PANEL

7376-10009

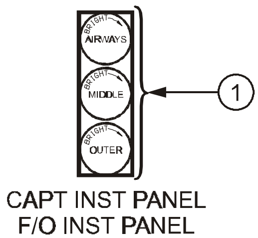
① ADF No. 1 Bearing Pointer (Head)

Indicates relative bearing to the station selected by the ADF No. 1 Frequency Selectors.

MARKER BEACON

Each pilot has a set of marker beacon lights that show outer, middle, and airways beacon passage. Both sets are operated by one marker beacon receiver. Receiver sensitivity is automatically increased below 1,500 feet radio altitude

③ 3 5



7376-10010

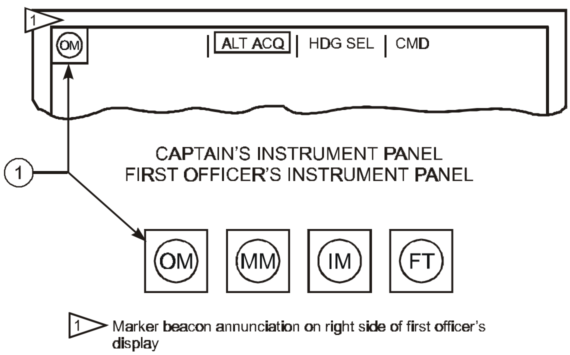
① Marker Beacon Lights

AIRWAYS (white) – Illuminates over an inner or airways marker beacon.

MIDDLE (amber) – Illuminates over a middle marker beacon.

OUTER (blue) – Illuminates over an outer marker beacon.

7 8 9



7376-10011

① Marker Beacon Lights

OM (cyan) – Illuminates over an outer marker beacon.
MM (amber) – Illuminates over a middle marker beacon.
IM (white) – Illuminates over an inner marker beacon.
FT (white) – Illuminates during self-test. (functional test)

INERTIAL REFERENCE SYSTEMS

General

Two independent Inertial Reference Systems (IRSs) are installed, consisting of Inertial Reference Units (IRUs) located in the E & E compartment, plus Mode Selectors and one IRS Display Unit (ISDU) located on the flight deck. Each IRS has three sets of laser gyros and accelerometers that replace the conventional mechanical gyros and compass systems. The IRSs are the aircraft's sole source of attitude and heading information, except for the standby attitude indicator and standby magnetic compass.

③ [3] [5] In their normal navigation mode, the IRSs provide attitude, true and magnetic heading, acceleration, vertical speed (as installed), ground speed, track, present position, and wind data to appropriate aircraft systems.

[7] [8] [9] The inertial system computes aircraft position, ground speed, and attitude data for the displays, flight management system, autoflight system and other systems. The major components of the inertial system are the air data inertial reference units (ADIRU), an inertial system display unit (ISDU), IRS mode select unit (MSU), and an IRS transfer switch. The ADIRUs provide inertial position and track data to the FMC, and attitude, altitude, and airspeed data to the CDS. Each ADIRU has an IRS section and an air data section.

IRS outputs are independent of external navigation aids.

Alignment (On the Ground)

An IRS must be aligned and initialized with the aircraft position before it can enter the NAV mode. The position is normally entered through the FMC CDU during alignment. If the position cannot be entered through the FMC CDU, it may be entered through the ISDU keyboard. The aircraft must remain stationary during alignment. Alignment time varies from five minutes to seventeen minutes depending on aircraft latitude.

Normal alignment, between 70º12' north and 70º12' south latitudes, is initiated by rotating the IRS Mode Selector from OFF directly to the NAV position. The IRS performs a short DC power test, during which the **ON DC** light illuminates. When the **ON DC** light extinguishes and the **ALIGN** light illuminates, the IRS has begun the alignment process. Aircraft present position should be entered at this time. The IRS will automatically enter the NAV mode after approximately 10 minutes, and the **ALIGN** light will extinguish.

High latitude alignment, at latitudes between 70º12’ and 78º15’, requires an extended alignment time. The Mode Selector must be left in the ALIGN position for 17 minutes, then rotated to the NAV position. The IRS will then immediately enter the **NAV** mode.

③ 3 5 Magnetic variation between 73º north and 60º south latitudes is stored in each IRS memory.

7 8 9 Magnetic variation between 82° north and 82° south is stored in each IRS memory.

The data corresponding to the present position are combined with true heading to determine magnetic heading. If magnetic information is unavailable, special navigation equipment is required to provide true heading to the EHSIs.

7 8 9 If the latitude / longitude position is not within 4 NM of the origin airport, the CDU scratchpad message **VERIFY POSITION** is displayed. If the entered latitude / longitude position does not pass the IRS internal comparison tests, the scratchpad message **ENTER IRS POSITION** is displayed.

Fast Realignment (On the Ground)

During transit or through-flight stops with brief ground times, a thirty-second realignment and zeroing of ground speed error may be performed by selecting ALIGN from NAV while the aircraft is parked. Present position should be simultaneously updated by manually entering latitude and longitude prior to reselecting NAV.

Note: If the aircraft is moved during alignment or fast realignment (**ALIGN** light illuminated), then: Park, position the Mode Selector OFF (**ALIGN** light extinguished) and reaccomplish alignment. If the **IRS MOTION** message is present on the FMC/CDU, the IRSs have automatically begun a full realignment, and shutdown is unnecessary.

Loss of Alignment

If an IRS loses both AC and DC power, the alignment is lost. Alignment can also be lost if the Mode Selector is moved out of the NAV position.

If alignment is lost in flight, the navigation mode (including present position and ground speed outputs) is inoperative for the remainder of the flight. However, selecting ATT allows the attitude mode to be used to relevel the system and provide ADI attitude. The attitude mode requires approximately thirty seconds of straight and level unaccelerated flight to complete the releveling. Some attitude errors may occur during acceleration, but will be slowly removed after acceleration.

The attitude mode can also provide heading information, but to establish compass synchronization the crew must manually enter the initial magnetic heading. Thereafter, drift of the IRS heading will occur (up to 15º per hour). Therefore, when in the **ATT** mode, an operating compass system must be periodically cross-checked and an updated magnetic heading entered in the IRS, as required.

IRS Entries

Manual IRS entries of present position or magnetic heading are normally accomplished on the POS INIT page of the FMC/CDU. If desired, the IRS Display Unit (ISDU) may also be used.

Electrical Power

Either IRS can operate on either AC or DC power. The left IRS is normally powered from the AC standby bus, and the right IRS from transfer bus No. 2. If AC power is not normal, either or both systems automatically switch to backup DC power from the switched hot battery bus. Backup DC power to the right IRS is automatically terminated if AC power is not restored within five minutes.

Caution: During flight, navigational reference is lost if the MSU mode select switch is set to any position other than NAV.

The IRS uses the latitude and longitude entered during the alignment mode as the starting point for position computation. The IRS determines inertial present position by dead-reckoning from the initial starting position.

Thus, no external updating of the computed pure inertial latitude and longitude is performed in the navigate mode. Therefore, system navigation performance is directly affected by the proper initial starting position.

Alignment Tests

The IRS conducts two tests, a reasonableness test and a system performance test, on the data that the operator has entered.

Reasonableness Test:

- The IRS conducts a reasonableness test on latitude and longitude immediately after each has been entered. To pass the reasonableness test, the entered data must compare within a specified limit of position data stored at the last power down.
- If the reasonableness test fails, the **ALIGN** annunciator flashes. Any subsequent entry must also pass or override the reasonableness test. A subsequent entry of correct data passes the reasonableness test and causes the flashing **ALIGN** annunciator to go steady. A subsequent entry of data identical to that which causes the **ALIGN** annunciator to flash overrides the reasonableness test and causes the flashing **ALIGN** annunciator to go steady.
- A proper entry may fail the reasonableness test if a new IRS has been installed or if the aircraft has been moved to a different location.

System Performance Test:

- At the end of alignment, the entered latitude must pass a system performance test. This test requires that the latitude entered by the operator must be within a specified limit of that computed by the IRS. If the entered latitude passes the system performance test, alignment is completed.
- A flashing **ALIGN** annunciator at the end of alignment indicates that the entered latitude has failed the system performance test, and that entry into the navigate mode is inhibited. Additional latitude entries are still allowed until the test passes; however, new latitude entries must also pass the reasonableness test. If two consecutive, identical latitudes are entered and the system performance test fails, the flashing **ALIGN** annunciator goes steady and the fault annunciator lights.
- One correct latitude entry passes the system performance test and turns the warning annunciator off. If the mode select switch is set to ALN, the **ALIGN** annunciator remains illuminated. If the mode select switch is set to NAV, the **ALIGN** annunciator goes out, and the IRS enters the NAV mode.

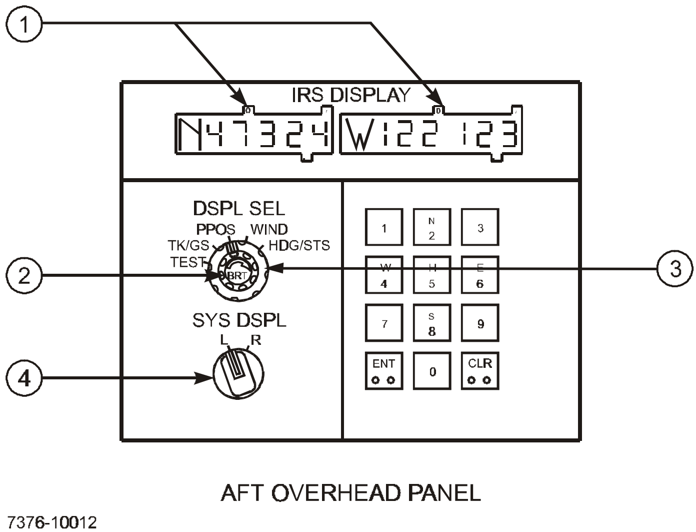
If the pilot has not entered latitude and longitude by the end of alignment, the **ALN** annunciator flashes, and the IRS inhibits entry into the NAV mode until valid data is received.

The pilot can update the current latitude and longitude entry any number of times without delaying alignment as long as the IRS has not entered the NAV mode. Each successive latitude and/or longitude entry writes over the previous entry. Only the current entry is used for navigation.

IRS Transfer Switch (EFIS Aircraft)

Should either IRS fail, the IRS transfer switch is used to switch all associated systems to the functioning IRS.

IRS DISPLAY UNIT



① Data Displays (See Note)

- Two windows display data for the IRS selected with the System Display Selector. The type of data displayed is normally determined by the Display Selector; however, keyboard entry of present position or magnetic heading will override the selected display.
- The last digit of each window is for a decimal place (tenths).

② Brightness Control

ROTATE – Adjusts brightness of the Data Displays

③ Display Selector

Selects the desired function or data for the Data Displays. Displays are for the IRS selected with the System Display Selector.

TEST (spring-loaded to TK/GS) – Use only during alignment. All lights in the Data Displays and on the Mode Selector Unit momentarily illuminate, followed by a 10 second internal self-test. See Note.

TK/GS (Track / Ground Speed) – The left window displays present true track (course). The right window displays present ground speed (knots).

PPOS – (Present Position) – Present latitude and longitude are displayed.

WIND – The left window displays present inflight true wind direction. The right window displays present inflight wind speed (knots).

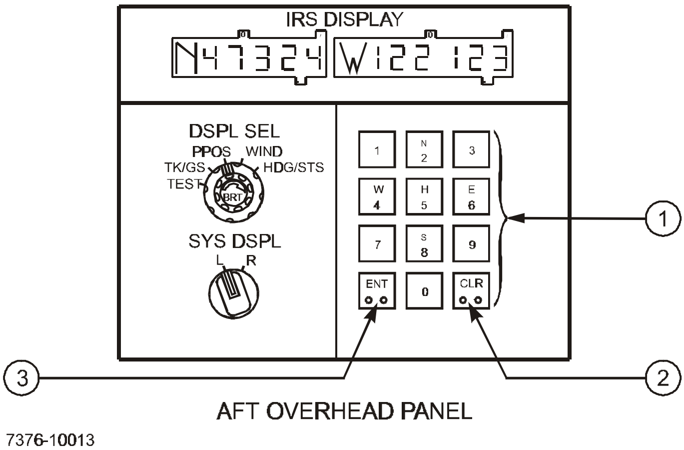
HDG/STS (Heading / Status) – The left window displays present true heading. The right window displays any applicable maintenance status codes (last two digits).

- During IRS alignment, the right window also displays the minutes remaining until alignment is complete. The window displays 7 (at the third digit) until the time remaining reaches six minutes. The display then counts down in one-minute intervals.

Note: Positioning the Master Lights Switch on the center instrument panel to TEST illuminate all lights in the Data Displays and on the Mode Selector Unit.

④ System Display Selector

Selects the left (L) or right (R) IRS for the Data Displays.



① Keyboard

Provides for manual IRS entry of present position or magnetic heading. The keyboard functions independently from the Display Selector position and the L or R position of the System Display Selector.

Alpha Keys -

PRESS – The Data Displays are controlled by the keyboard when the N, S, E, or W (latitude / longitude), or H (heading) key is pressed. Arms the keyboard for numeric entries.

Numeric Keys -

PRESS – Permits manual entry of present position (latitude and longitude) when either **ALIGN** light is illuminated.

- Permits manual entry of present <u>magnetic</u> heading when either Mode Selector is in ATT.

② Clear Key

ILLUMINATED – The integral cue lights illuminate following an ENT operation if the self-test determines the data to be of an unreasonable value (entry not accepted by the IRSs).

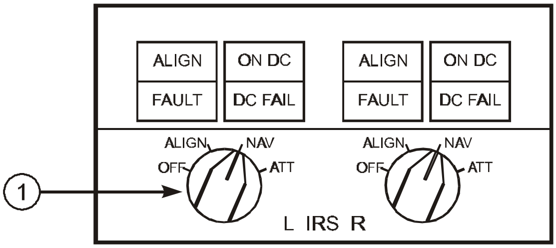
PRESS – Extinguishes the cue lights. If the cue lights are already extinguished, pressing CLR clears the associated Data Display of data keyed-in but not yet entered (or not accepted). The Data Displays are again controlled by the Display Selector.

③ Enter Key

Illuminated – The integral cue lights illuminate when N, S, E, W, or H entries are being keyed. When keying is completed:

PRESS - The cue lights extinguish and the keyed data is simultaneously entered into each IRS following completion of a valid self-test for data reasonableness. The Data Displays are again controlled by the Display Selector.

IRS MODE SELECTOR UNIT



AFT OVERHEAD PANEL

7376-10014

① IRS Mode Selector

Controls the operating mode of the respective Inertial Reference System (Left or Right).

OFF – Alignment is lost. All electrical power is removed from the system after a 30-second shutdown cycle.

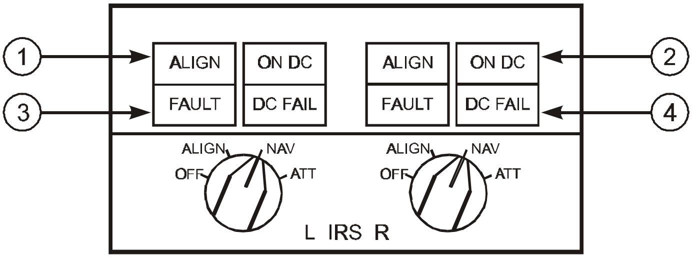
ALIGN – Used for initial alignment or fast realignment. The aircraft must be parked.

- From OFF to ALIGN initiates the alignment cycle.
- The selector may be moved to NAV during the cycle.
- From NAV to ALIGN automatically updates alignment and zeroes ground speed error (fast realignment). Present position should be manually updated, but is not required. Return the selector to NAV.

NAV (Navigation) – Detented position. The system enters the NAV mode after completion of the alignment cycle and entry of present position. Provides full IRS data to aircraft systems for normal operations.

ATT (Attitude) – A backup mode providing only attitude and heading information.

- Attitude information is invalid (Attitude Flag in view) until **ALIGN** light is extinguished.
- Heading information is invalid (Heading Flags in view) until the actual magnetic heading is manually entered and the **ALIGN** light is extinguished.
- Position and ground sped information is lost until the IRS is aligned on the ground. The selector must be cycled through OFF before reselecting ALIGN or NAV.



AFT OVERHEAD PANEL

7376-10015

① ALIGN Light (white)

ILLUMINATED (steady) – The respective IRS is operating normally in either the ALIGN mode, the initial ATT mode, or the shutdown cycle.

ILLUMINATED (flashing) – Alignment cannot be completed due to IRS detection of one of the following errors:

- Aircraft movement (some non-EFIS aircraft),
- Significant difference between previous and entered positions or an unreasonable present position entry,
- No present position entry.

EXTINGUISHED – IRS is not in the ALIGN mode.

- (Mode Selector in NAV) Alignment completed. Full IRS data is available.
- (Mode Selector in ATT) Attitude information is available, Heading information is also available following entry of the initial magnetic heading.

② ON DC Light (amber)

ILLUMINATED – The respective IRS is operating on DC power from the switched hot battery bus (AC power not normal).

- If on the ground: The ground-call horn in the nose wheel well sounds, providing an alert that a battery-drain condition may exist.
- Momentary illumination is normal during alignment self-test (DC power normal).

③ **FAULT** Light (amber)

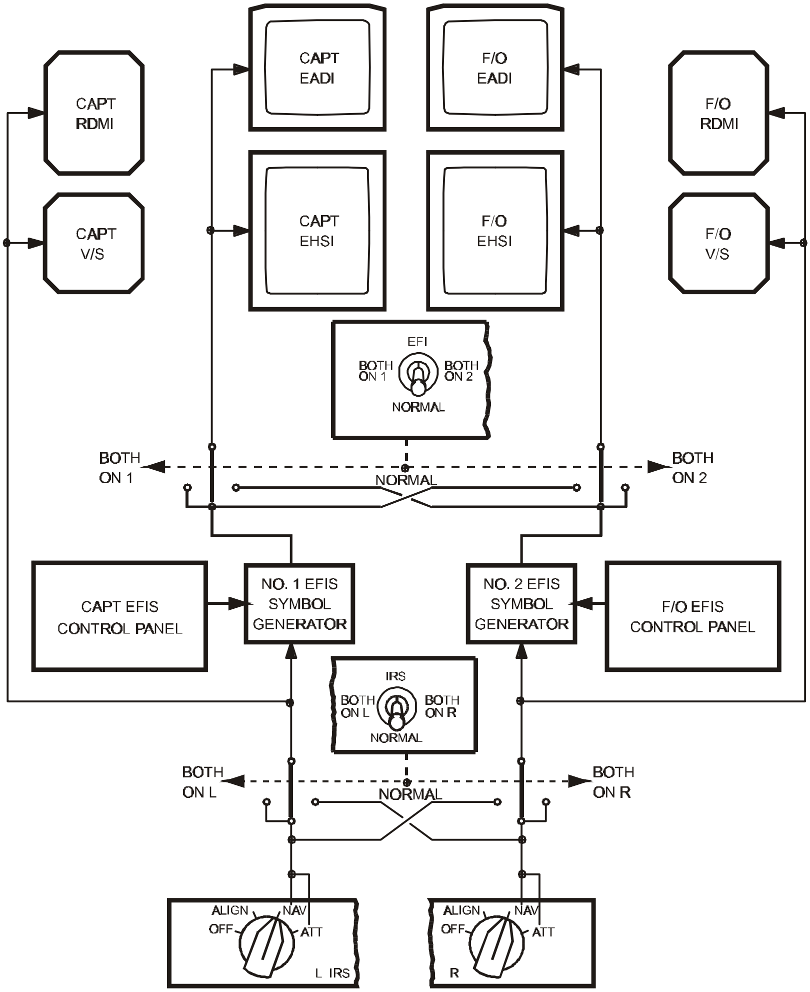
ILLUMINATED – A system fault which affects the respective IRS ATT and/or NAV mode(s) has been detected.

④ **DC FAIL** Light (amber)

ILLUMINATED – DC power for the respective IRS is not normal.

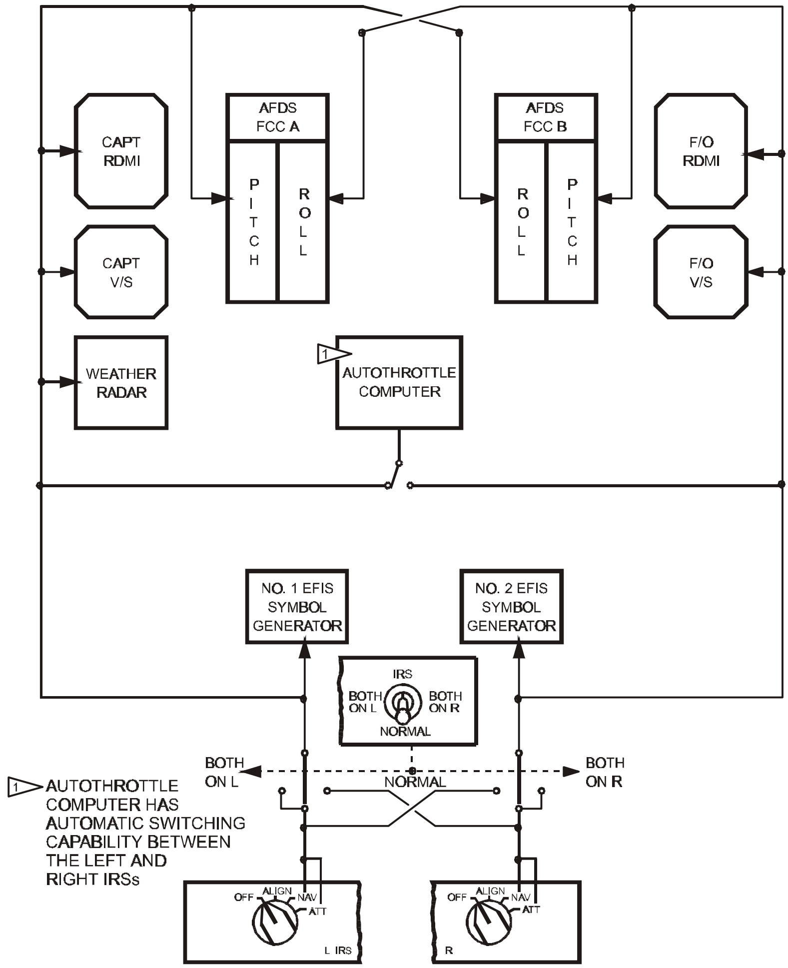
- If the other lights are extinguished, the IRS is operating normally on AC power.

3 5 EFI / IRS TRANSFER SWITCHING SCHEMATIC



7376-10016

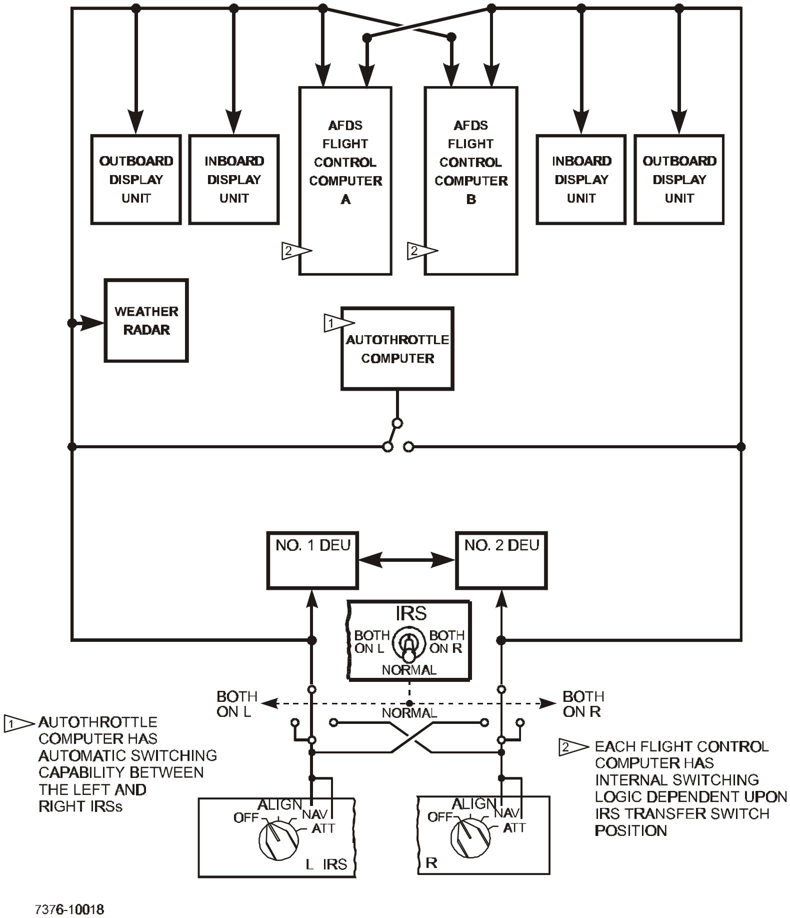
3 5 IRS INSTRUMENT TRANSFER SWITCHING SCHEMATIC



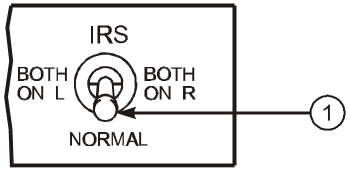
1 AUTOTHROTTLE COMPUTER HAS AUTOMATIC SWITCHING CAPABILITY BETWEEN THE LEFT AND RIGHT IRSs

7376-10017

7 8 9 IRS INSTRUMENT TRANSFER SWITCHING SCHEMATIC



3 5 7 8 9 IRS TRANSFER SWITCH



FWD OVERHEAD PANEL

7376-10019

1 IRS Transfer Switch

Should either IRS fail, the IRS Transfer Switch is used to switch the flight instruments attitude and heading source to the functioning IRS.

7 8 9 GLOBAL POSITIONING SYSTEM (GPS)

Two GPS receivers receive GPS satellite positioning signals. The left and right GPS receivers are independent and each provides an accurate aircraft geographical position to the FMC. GPS operation is automatic.

GPS Displays

The left and right GPS position is displayed on the POS REF page 2/3. The GPS symbols can be displayed on the navigation display by selecting the PLAN mode on the EFIS control panel and simultaneously selecting the POS SHIFT page 3/3. The two GPS symbols are the same shape and can appear as a single symbol when both GPS receivers indicate the same position.

GPS position relative to FMC position is displayed on the POS SHIFT page 3/3. NAV STATUS page 1/2 displays the GPS currently selected.

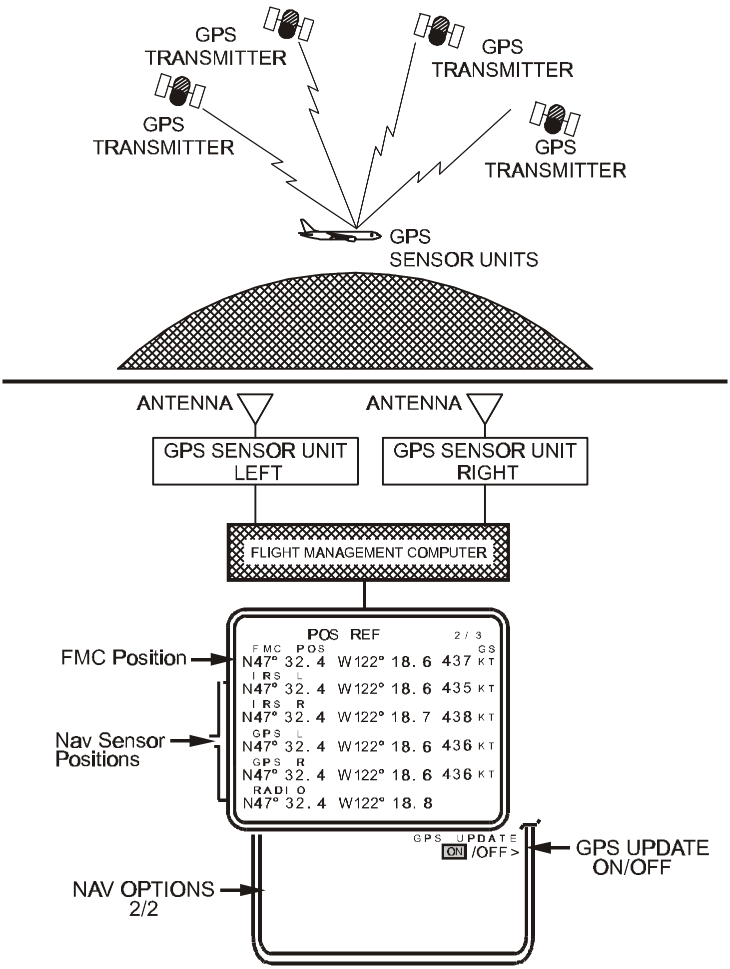
An amber GPS light illuminates to indicate failure of both GPS sensor units. Failure of a single GPS sensor will illuminate the light when the MASTER CAUTION recall is activated.

GPS Data

FMC logic selects the position from one of the GPS sensor units as the primary update to the FMC position. When GPS position data is available, radio updating can also occur. If all GPS data becomes unavailable, the FMC position will be determined by radio or inertial (IRS) updating.

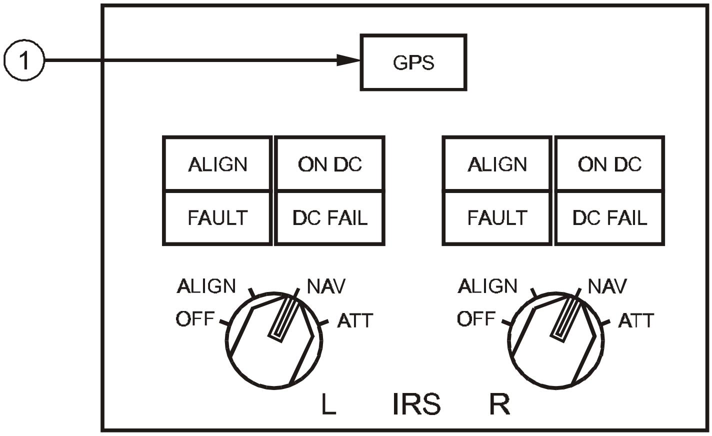
GPS navigational information can be manually deselected on the NAV OPTIONS page 2/2. No other controls are provided because the operation of the GPS is completely automatic.

7 8 9 GPS SYSTEM SCHEMATIC



7376-10020

7 8 9 GLOBAL POSITIONING SYSTEM LIGHT



AFT OVERHEAD PANEL

7376-10021

① Global Positioning System (**GPS**) Light

ILLUMINATED (amber)

- Indicates failure of both GPS sensor units.
- Indicates failure of a single GPS sensor unit when **MASTER CAUTION** light recall is activated. Light will extinguish when the master caution system is reset.

ATC TRANSPONDER

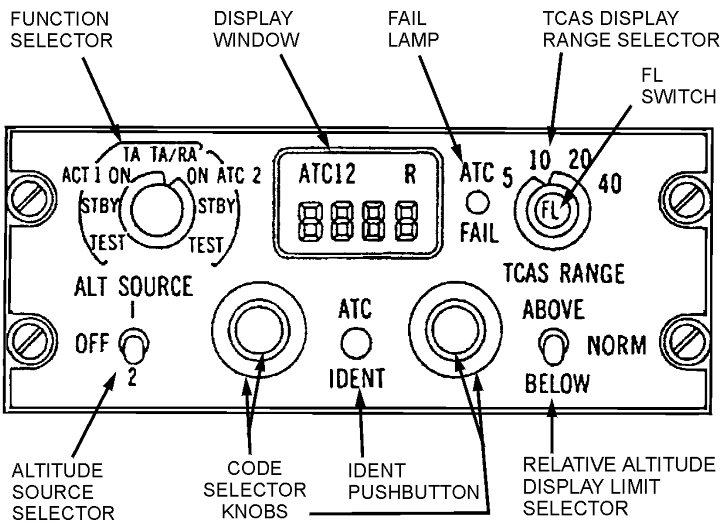
Two ATC transponders are installed and are controlled by a single control panel. The ATC transponder system transmits a coded radio signal when interrogated by ATC ground radar. Altitude reporting capability is provided.

Transmissions are automatically enabled when the air / ground system indicates air mode.

On aircraft with TCAS, TCAS is controlled from the transponder panel.

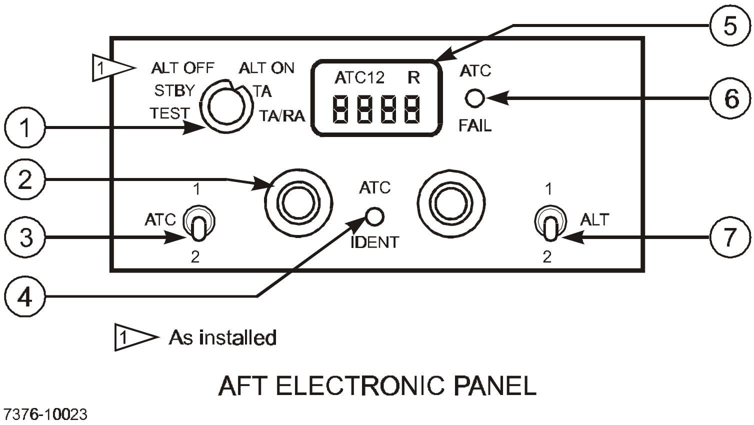
Transponder Panel

③



7376-10022

3 5 (As Installed)



① Transponder Switch

TEST – The **ATC FAIL** light illuminates to indicate the selected transponder is operational.

STBY – Disables transponder modes.

Note: Transponder modes are enable d only when the aircraft is airborne, except for mode S, which operates continuously when the transponder mode selector is out of STBY.

ALT OFF – Transponder operates without altitude reporting.

ALT ON – Transponder operates with attitude reporting.

TA – Enables display of traffic advisory TCAS targets.

TA/RA – Enables display of traffic advisory and resolution advisory TCAS targets.

Refer to Section 6.15, WARN SYSTEMS.

② Air Traffic Control (ATC) Code Selector

ROTATE – Sets transponder code in transponder.

③ Transponder Selector

1 – Selects transponder No. 1.

2 – Selects transponder No. 2.

④ Identification (ATC IDENT) Switch

PUSH – Transmits an identification signal.

⑤ ATC Code Indicator

Shows transponder code.

Shows operating transponder (1 or 2).

⑥ Transponder (**ATC**) **FAIL** Light

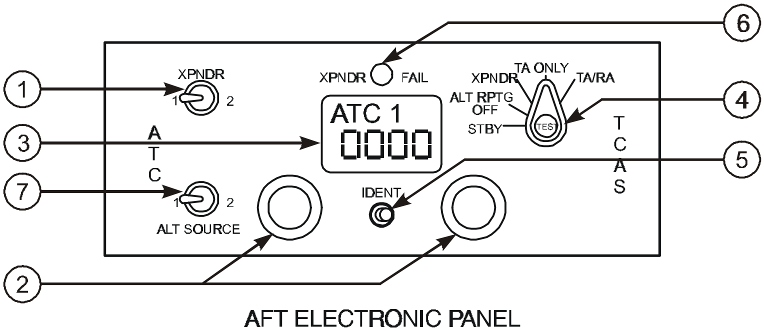
ILLUMINATED – Indicates transponder malfunction or test.

⑦ Altitude Reporting Switch

1 – Enables altitude reporting from ADC No. 1.

2 – Enables altitude reporting from ADC No. 2.

5 (As Installed)



7376-10024

① Transponder (XPNDR) Selector

1 – Selects transponder No. 1.

2 – Selects transponder No. 2.

② Air Traffic Control (ATC) Code Selector

ROTATE – Sets transponder code in transponder.

③ Air Traffic Control (ATC) Code Indicator

Shows transponder code.

Shows operating transponder (1 or 2).

④ Transponder Mode Selector

TEST – Starts ATC transponder functional test.

STBY (standby)– Does not transmit.

ALT RPTG (altitude reporting) OFF – Transponder operates without altitude reporting.

XPNDR (transponder) – Transponder operates with altitude reporting.

TA (traffic advisory) ONLY, and TA/RA (resolution advisory) – Refer to Section 6.15, WARN SYSTEMS.

⑤ Identification (IDENT) Switch

PUSH – Transmits an identification signal.

⑥ Transponder (**XPNDR**) **FAIL** Light

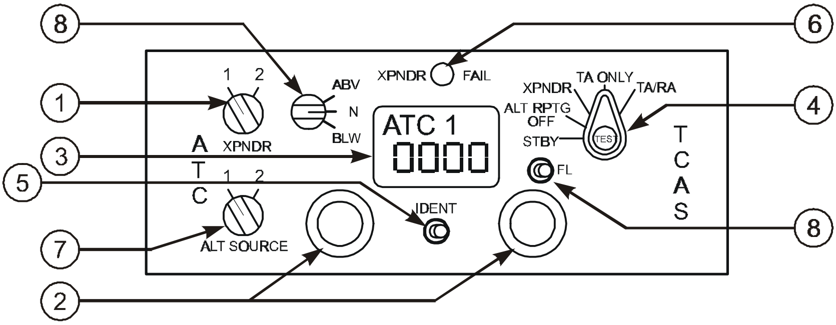
ILLUMINATED (amber) – Indicates transponder malfunction.

⑦ Altitude (ALT) SOURCE Selector

1 – Enables altitude reporting from air data computer No. 1.

2 – Enables altitude reporting from air data computer No. 2.

7 8 9



AFT ELECTRONIC PANEL

7376-10025

① Transponder (XPNDR) Selector

1 – Selects transponder No. 1.

2 – Selects transponder No. 2.

② Air Traffic Control (ATC) Code Selector

ROTATE – Sets transponder code in transponder.

③ Air Traffic Control (ATC) Code Indicator

Shows transponder code.

Shows operating transponder (1 or 2).

④ Transponder Mode Selector

TEST – Starts ATC transponder functional test.

STBY (standby)– Does not transmit.

ALT RPTG (altitude reporting) OFF – Transponder operates without altitude reporting.

XPNDR (transponder) – Transponder operates with altitude reporting.

TA (traffic advisory) ONLY, and TA/RA (resolution advisory) – Refer to Section 6.15, WARN SYSTEMS.

⑤ Identification (IDENT) Switch

PUSH – Transmits an identification signal.

⑥ Transponder (**XPNDR**) **FAIL** Light

ILLUMINATED (amber) – Indicates transponder malfunction.

⑦ Altitude (ALT) SOURCE Selector

1 – Enables altitude reporting from air data computer No. 1.

2 – Enables altitude reporting from air data computer No. 2.

⑧ Traffic Collision Avoidance System (TCAS) Functions

Refer to Section 6.15, WARN SYSTEMS.

WEATHER RADAR

The Bendix RDR-4B and the Collins WXR 7000X are X band color radar systems used for weather detection, analysis, and for ground mapping. The system detects and locates various types of precipitation bearing clouds along the flight path of the aircraft, and gives the pilot a visual indication in colors of their intensity.

The radar indicates the cloud's rainfall intensity by displaying colors contrasted against a black background. Areas of heaviest rainfall appear in red, the next level of rainfall in yellow, and the least rainfall in green.

Range / mode alphanumerics to facilitate evaluation of data are displayed on normally unused areas of the indicator.

In MAP mode, the radar displays surfaces in red, yellow, and green (most reflective to least reflective).

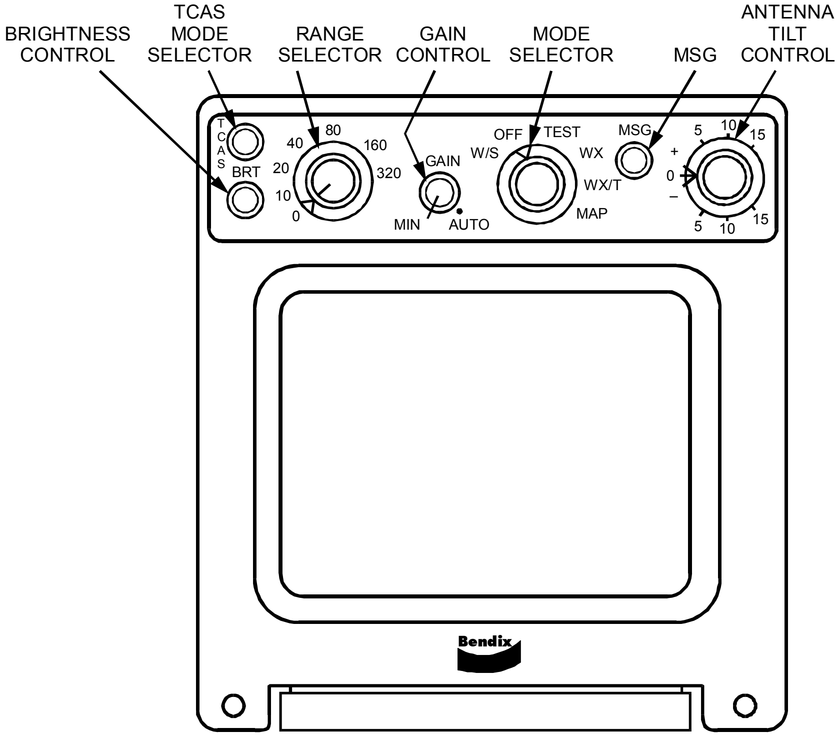
These displays enable identification of coastlines, hilly or mountainous regions, cities or large structure. Ground mapping mode can be useful in areas where ground-based navigation aids are limited. The radar system performs only the functions of weather detection and ground mapping. It should not be used, or relied upon, for proximity warning or anti-collision protection.

In the WX mode the system detects types of weather along the flight path of the aircraft, and gives the pilot a visual indication in colors of their intensity. Weather intensity levels are displayed in colors contrasted against a black background. Areas of heaviest rainfall will appear in red, the next level of rainfall in yellow, and the least rainfall in green. Range / mode alphanumerics to facilitate evaluation of data are displayed on normally unused areas of the indicator.

The WX/TURB mode displays normal precipitation and precipitation associated with turbulence. When the radar detects a horizontal flow of precipitation, with velocities of 5 or more meters per second, toward or away from the radar antenna, that target display becomes magenta. This magenta area is associated with heavy turbulence.

Example: WX mode has been selected. The indicator displays green, yellow and red precipitation areas. Selecting WX/TURB mode, the appearance of magenta in the green, yellow or red areas indicates the presence of heavy turbulence. The detection of turbulence is automatically limited to a 40 nautical mile range regardless of the selected range.

③ WEATHER RADAR

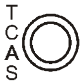


37371669

③ 3 5 7 8 9

Storm Level	Turbulence	Returns	In / Hour	Mm / Hour	Radar Color
1		Very Light or No	Less than 0.03	Less than 0.7	Black
2	Weak	Light	0.03 to 0.15	0.7 to 4.0	Green
3	Moderate	Medium	0.15 to 0.5	4.0 to 12	Yellow
4	Strong to Very Strong	Strong	0.5 to 2.0	12 to 51	Red
5	Intense to Extreme	Turbulence	More than 51	More than 51	Magenta

③ Weather Radar Operating Controls



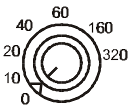
TCAS MODE SELECTOR

Windshear has priority over TCAS alerts. While in TCAS Only mode, a windshear event pops the system into WX/TCAS overlay mode displaying both windshear and TCAS information.

The crew can change mode by pressing the TCAS button again. Refer to appropriate TCAS operating handbook for instructions.

BRIGHTNESS CONTROL

Adjusts picture brightness.



RANGE SELECTOR

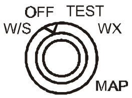
Selects radar display range.

GAIN

Controls receiver gain. Rotate fully clockwise for automatic gain. Gain is automatic in windshear mode.

7376-10063

③ Weather Radar Operating Controls (Continued)



MODE SELECTOR

W/S — Windshear only mode, icon only, no weather returns. W/S ONLY annunciated, tilt and gain removed. When above 2300’, NO W/S DATA AVAILABLE appears at the screen center indicating inappropriate mode selection

OFF — Indicator is off unless turned on by ACARS or TCAS.

Additionally, below 1500’ AGL a windshear event automatically turns on the PPI-4B, the antenna sweeps (±60° display), TILT and GAIN are removed and the display shows the windshear icon only.

<u>Note:</u> Windshear icon overlays test pattern and radar returns in all modes.

TEST — Selects TEST mode.

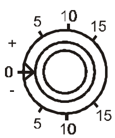
WX — Radar is in weather mode.

WX/T — Combine weather and turbulence mode.

MAP — Ground mapping mode.

MSG

Enables ACARs mode. While in ACARS mode, a windshear event pops the system into WX/TCAS overlay mode. When advisories clear, the system reverts back to MSG mode.

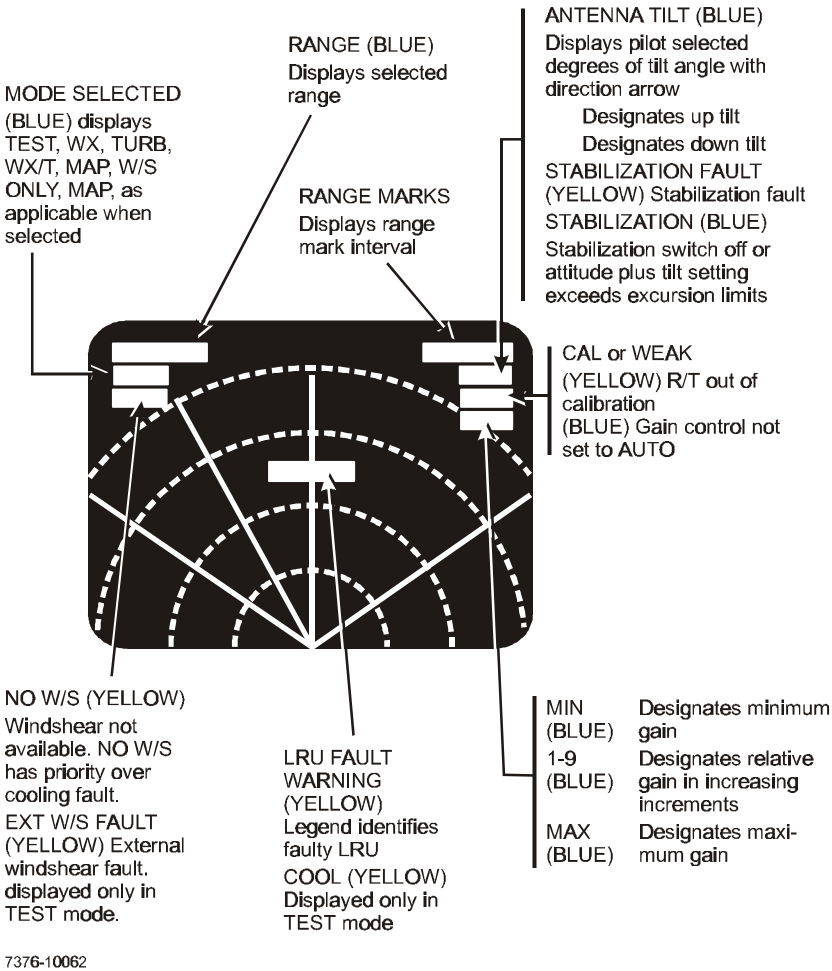


TILT

Controls antenna tilt ±15°. Automatic tilt windshear only mode.

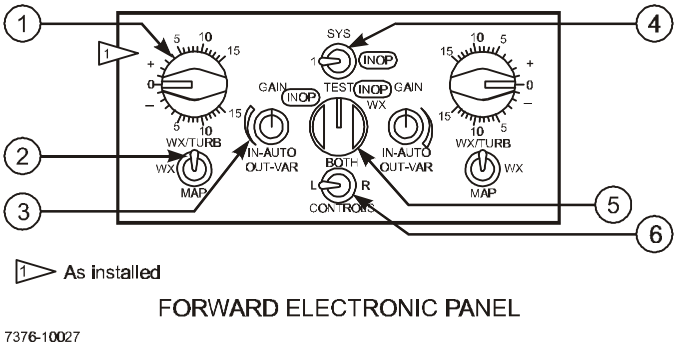
7376-10064

Display Alphanumerics



7376-10062

3 5 Weather Radar Panel (As Installed)



① Antenna Tilt Control

Rotate clockwise – Radar antenna tilts up to selected degrees above horizon.

Rotate counterclockwise – Radar antenna tilts down to selected degrees below horizon.

② Mode Switch

WX/TURB – Activates display of detected turbulence (within 40 nm) along with display of detected precipitation.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

WX – Activates display of detected precipitation.

MAP – Activates display of detected ground returns.

③ GAIN Control

IN-AUTO – Presets an optimum receiver sensitivity for best weather radar display.

OUT-VAR – Manually sets receiver gain.

④ Radar System (SYS) Switch

Selects transmitter / receiver system for operation when radar is on.

⑤ Mode Selector

TEST – Displays maintenance test pattern.

WX – Displays selected radar mode switch returns.

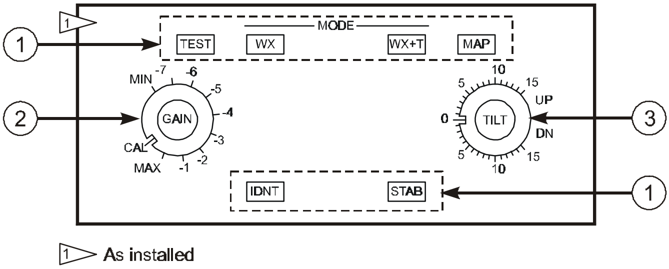
⑥ Radar Control (CONTROLS) Switch

L – Displays weather radar returns to both pilots based on left weather radar control settings.

BOTH – Allows each pilot to update the respective weather radar displays based on related control settings.

R – Displays weather radar returns to both pilots based on right weather radar control settings.

5 Weather Radar Panel (As Installed)



FORWARD ELECTRONIC PANEL

7376-10028

① Weather Radar Mode Switches

Push – Selects mode. Left mode switches control the Captain's radar display; right mode switches control the First Officer's radar display.

- TFR (transfer) – Transfers other map display selections to related map.
- WX+T (turbulence) – Shows weather radar returns and turbulence. Turbulence display is available on the EHSI if the selected map range is 50 nautical miles or less.
  Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.
- WX – Shows weather radar returns at selected gain level.
- MAP – Shows ground returns at selected gain level.
- GCS – Suppresses ground return in WX and WX+T modes.
  Note: Continuous operation is not recommended because weather return intensity may be reduced.
- TEST – Shows test pattern on map display with WX selected (except in PLAN mode) and tests transmitter (transmits only up to one second).
- PWR – Applies power to system.

② CAL GAIN Control

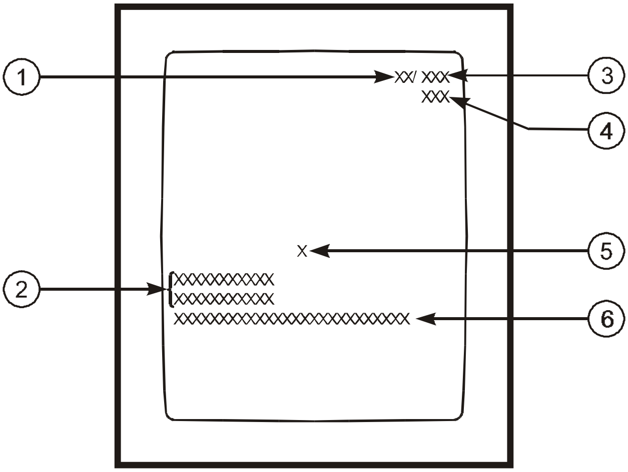
Rotate – Sets gain in WX, WX/T and MAP modes.

③ TILT Control

Rotate clockwise – Radar antenna tilts up to selected degrees from horizon.

Rotate counterclockwise – Radar antenna tilts down to selected degrees from horizon.

3 5 Weather Radar



CAPT INST PANEL F/O INST PANEL
(EHSI)

7376-10029

① GAIN

Annunciates **VAR** when variable gain is in use.

② WXR Annunciations (left justified, two lines)

WXR FAIL – Indicates weather radar has failed (no weather data displayed).

WXR WEAK – Indicates weather radar calibration fault.

WXR ATT – Indicates loss of attitude input for antenna.

WXR STAB – Indicates antenna stabilization is off.

WXR DSPY – Indicates loss of Display Unit cooling or an overheat condition of the HSI. Weather Radar display is blanked.

③ MODE Annunciations

WX – Indicates weather display has been selected.

WX+T – Indicates weather display, with detected turbulence overlaid within 40 nautical miles is being displayed.

MAP – Indicates ground mapping has been selected.

④ TILT

Displays selected tilt angle.

⑤ TEST

A test pattern is generated.

- MAGENTA – Heavy turbulence.
- RED – Heavy precipitation.
- YELLOW – Light to moderate precipitation.
- GREEN – Light precipitation.

⑥ RANGE DISAGREEMENT Annunciations

MAP/WXR RANGE DISAGREE

- Indicates selected range on the EFIS Control Panel is different than the **MAP** and **WXR** display range.

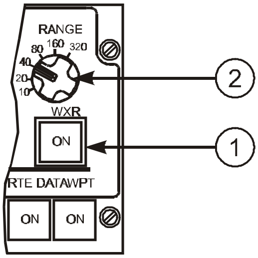
MAP RANGE DISAGREE

- Indicates selected range on the EFIS Control Panel is different than the **MAP** display range.

WXR RANGE DISAGREE

- Indicates selected range on the EFIS Control Panel is different than the **WXR** display range.

3 5



AFT ELECTRONIC PANEL

7376-10030

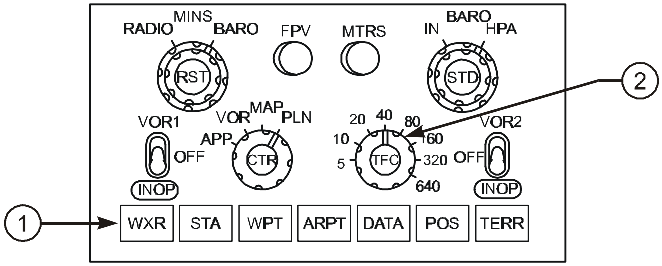
① Weather Radar Switch

Press to activate radar display.

② HSI/Weather RANGE Selector

Selects desired nautical mile range for HSI MAP, PLAN, and weather radar displays.

7 8 9 Weather Radar



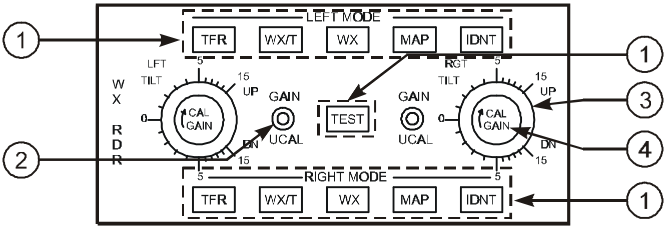
GLARESHIELD

7376-10031

① WXR (weather radar) – Energizes weather radar transmitter and displays weather radar returns in MAP, center MAP, expanded VOR, and expanded APP modes. When the 640 nm range is selected, weather radar returns are limited to 320 nm.

② Range Selector (Outer) – Selects desired display range in nautical miles for APP, VOR, MAP, or PLN mode.

7 8 9 Weather Radar Panel



AFT ELECTRONIC PANEL

① Weather Radar Mode Switches

Push – Selects mode. Left mode switches control the Captain's radar display; right mode switches control the First Officer's radar display.

- TFR (transfer) – Transfers other map display selections to related map.
- WX/T (turbulence) – Shows weather radar returns and turbulence. Turbulence display is available on displays of 50 nm or less.
  Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.
- WX – Shows weather radar returns at selected gain level.
- MAP – Shows ground returns at selected gain level.
- IDNT – Suppresses ground return in WX and WX/T modes.
- TEST –
  - Tests weather radar system operation without transmitting.
  - Shows test pattern and any fault messages on navigation display MAP, center MAP, VOR, and APP modes, with WXR selected.

  Note: If the aircraft is on the ground and the thrust levers are not advanced for takeoff, WXR tests the predictive windshear system (PWS) indications. These include PWS caution, PWS FAIL, and PWS warning. Deactivating WXR on the EFIS control panel will not discontinue the test and can result in automatic WXR activation on both pilot displays. The PWS test lasts approximately 15 seconds.

② Gain Uncalibrated (**GAIN UCAL**) Lights

Illuminated – Related gain control is in an uncalibrated position.

③ TILT Control

Rotate clockwise – Radar antenna tilts up to selected degrees from horizon.

Rotate counterclockwise – Radar antenna tilts down to selected degrees from horizon.

④ GAIN Control

Rotate – Sets gain in WX, WX/T, and MAP modes.

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*	126	11/15/02	*	159	11/15/02	*	192	11/15/02

* Asterisk indicates page(s) revised or added by the current revision.

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FLIGHT INSTRUMENTS, DISPLAYS

TABLE OF CONTENTS

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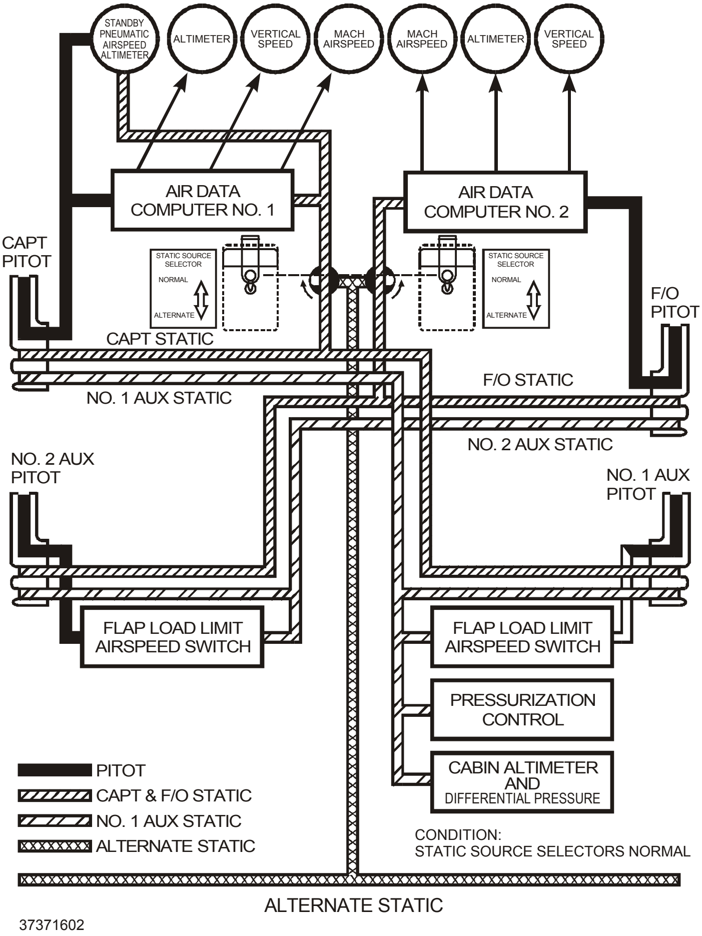
③ FLIGHT INSTRUMENTS

③ PITOT-STATIC SYSTEM

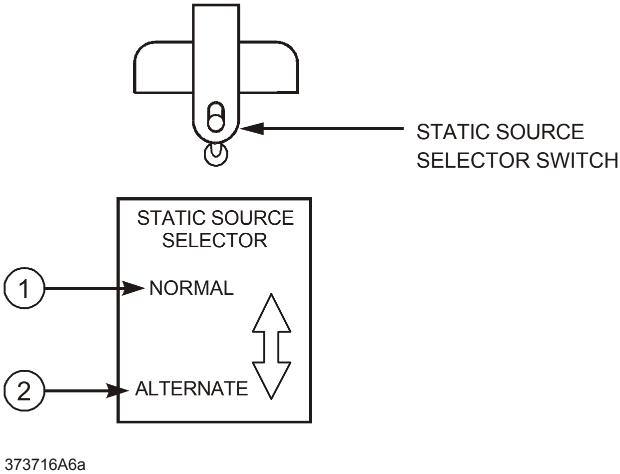
The left side (Captain) pitot-static probe and right side (No. 1 AUX) pitot-static probe supply uncorrected pressures to the standby airspeed indicator and altimeter.

An alternate static system with a port on each side of the aircraft is the backup static pressure source for the ADCs. A static source selector on each pilot side panel provides selection of alternate static pressure for the respective ADC.

The standby airspeed indicator and altimeter can be selected to the alternate static system with the left static source selector.


STANDBY PNEUMATIC AIRSPEED ALTIMETER
ALTIMETER
VERTICAL SPEED
MACH AIRSPEED
MACH AIRSPEED
ALTIMETER
VERTICAL SPEED
AIR DATA COMPUTER NO. 1
AIR DATA COMPUTER NO. 2
CAPT PITOT
STATIC SOURCE SELECTOR
NORMAL
ALTERNATE
STATIC SOURCE SELECTOR
NORMAL
ALTERNATE
F/O PITOT
CAPT STATIC
F/O STATIC
NO. 1 AUX STATIC
NO. 2 AUX STATIC
NO. 2 AUX PITOT
NO. 1 AUX PITOT
FLAP LOAD LIMIT AIRSPEED SWITCH
FLAP LOAD LIMIT AIRSPEED SWITCH
PRESSURIZATION CONTROL
CABIN ALTIMETER AND DIFFERENTIAL PRESSURE
PITOT
CAPT & F/O STATIC
NO. 1 AUX STATIC
ALTERNATE STATIC
CONDITION:
STATIC SOURCE SELECTORS NORMAL
ALTERNATE STATIC
37371602

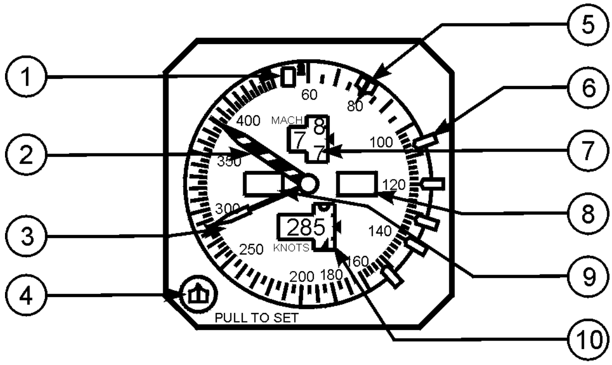
③ STATIC SOURCE SELECTOR



① NORMAL (guarded position) – Primary pitot-static system provides static inputs to respective ADC.

② ALTERNATE – Alternate static system provides static inputs to respective ADC left side selector. Alternate static system selected to standby altimeter and airspeed indicator.

③ MACH / AIRSPEED INDICATOR



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① Airspeed Cursor Annunciator

- Auto mode: Out of view when the cursor control is in the “PUSH IN” position.
- Manual mode: In view when cursor control is in the “PULL OUT” position.

② V_{MO}/M_{MO} Pointer (Red and White)

- Indicates the maximum operating airspeed in knots.

③ Airspeed Pointer

- Indicates airspeed in knots.

④ Airspeed Cursor Control

- PUSH IN – Auto mode. Airspeed cursor positioned by FMC in VNAV mode or by MCP Mach airspeed control.
- PULL OUT – Manual mode. Airspeed cursor is positioned by rotating cursor control.

⑤ Airspeed Cursor

- Indicates target airspeed.
- Positioned manually as selected by the airspeed cursor control is pull to the out position.
- Positioned automatically by FMC when in VNAV mode.

⑥ External Airspeed Markers (Bugs)

- Positioned manually to the desired airspeed references.

⑦ Mach Digital Counter

- Shows Mach number, from .40 to .99 Mach, in digital form.
- Masked below .40 Mach.
- Digits are covered by a warning flag **MACH** when the display is unreliable.

⑧ Airspeed Cursor Flag

- Manual mode: Flag is retracted.
- Auto mode: Flag in view if airspeed cursor signals are unreliable.

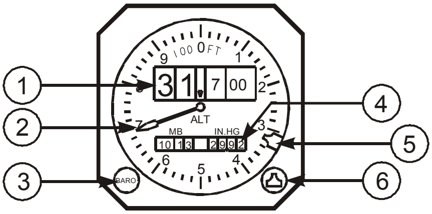
⑨ V_{MO} Flag In View **V_{MO}** – Indicates the V_{MO} / M_{MO} pointer is inoperative.

⑩ Airspeed Digital Counter

- Digital display of indicated airspeed in knots.
- Warning flag **A/S** covers the counter when the airspeed pointer and airspeed digital counter are unreliable.

③ ALTIMETER

Altimeters display respective ADC corrected altitude. Range from –1000 to 50,000 feet.



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① Digital Counter

- Displays altitude in increments of thousands, hundreds and twenty feet.
- Warning flag **OFF** appears whenever the ADC signal is lost or a malfunction exists.
- Green flag appears in the left window when altitude is below 10,000 feet.
- A **NEG** flag appears in the two left-hand windows when altitude below zero feet is displayed.

② Altitude Pointer

- Makes one revolution each one thousand feet.

③ Barometric Setting Control

- ROTATE – Adjusts the barometric correction in the barometric setting window.

④ Barometric Setting Windows

- Right: Reflects barometric correction in inches of mercury as set by the barometric setting control.
- Left: Reflects barometric pressure in millibars as set by the barometric setting control.

⑤ Reference Altitude Marker

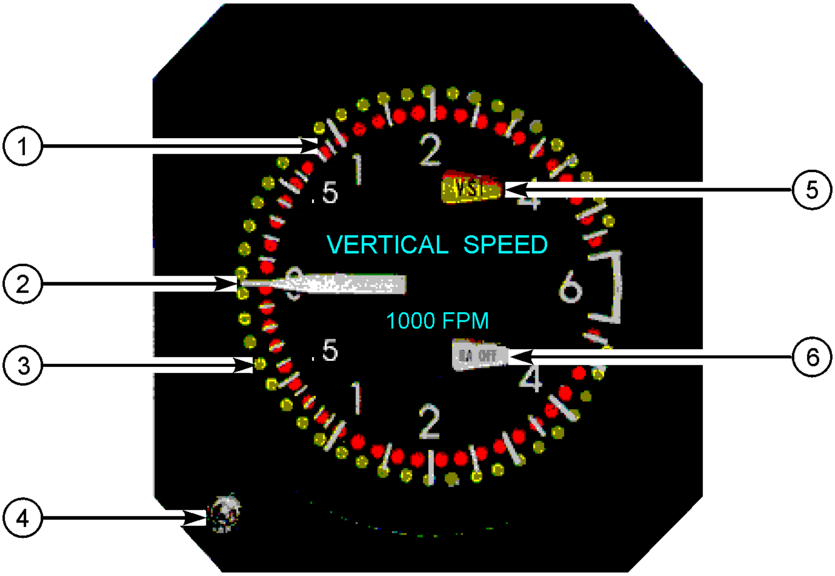
- Manually positioned to the desired reference altitude using the reference altitude marker control.

⑥ Reference Altitude Marker Control

- Used to manually set the reference altitude marker.

③ VERTICAL SPEED INDICATOR

Electric vertical speed indicators display instantaneous vertical speed derived from the respective air data computer. TCAS RA/TAs also displayed (see Warnings, Section 6.15).



① (RA) Resolution Advisory (red)

② Vertical Speed Pointer

③ (RA) Resolution Advisory (green)

④ Ambient Light Sensor

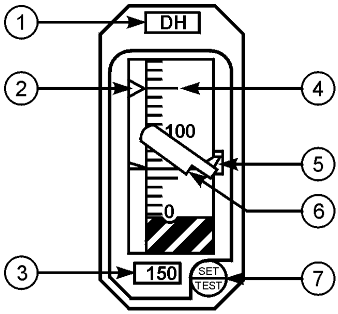
⑤ Vertical Speed Flag

- RA / VSI failure.
- Power failure.

⑥ RA Off Flag

- TCAS in standby.
- TA only.
- Power failure.

③ RADIO ALTIMETER



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① Decision Height (DH) Light (amber)

- ILLUMINATED – When aircraft descends through decision height.
- Push to extinguish.

② Decision Height Pointer

- Moves in response to rotation of SET / TEST switch; after pointer is set, moves with altitude tape.

③ Decision Height Indicator

- Indicates decision height selected by the SET / TEST switch.

④ Altitude Tape

- Moveable tape read against altitude reference line.

⑤ Altitude Reference Line (Under Warning Flag)

- Altitude tape moves past stationary reference line to indicate height above ground up to 2500 feet.

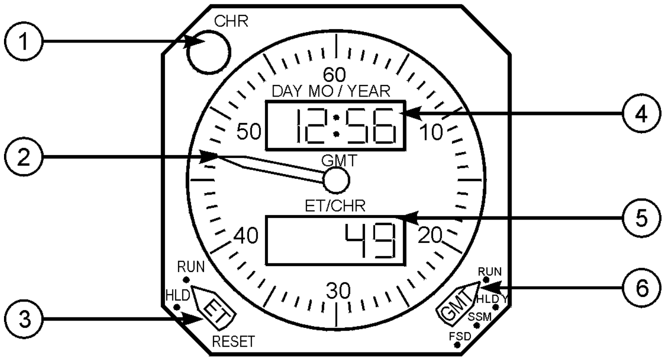
⑥ Warning Flag (in view)

- When TEST switch pressed.
- Power is off.
- Altitude signal is not valid.

⑦ SET / TEST Switch

- SET – Rotation moves DH pointer along the tape.
- DH altitude is shown on DH indicator.
- TEST – When pushed, altitude tape drives to 40 feet and warning flag appears.

③ CLOCK



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① Chronograph (CHR) Control

- PRESS – Controls the start, stop and reset functions of the CHR display and second hand with successive "push" operations.
- Overrides any existing ET display.

② Chronograph Second Hand

- Indicates chronograph seconds.
- Controlled by the CHR control.

③ Elapsed Time (ET) Control (spring loaded to HLD)

- RESET – Returns the ET display to zero time.
- HLD (Hold) – Stops the ET display at the indicated time.
- RUN – Starts the ET display counting time. Continues to count from HLD time when selected to RUN.

④ Time / Date Display

- Displays time in 24-hour format (hours and minutes) / date in numerical format.

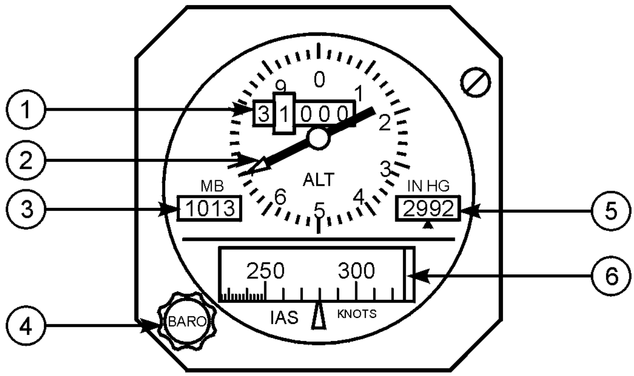
⑤ **ET / CHR** Display

- Displays elapsed time or chronograph time.
- ET Display Range: Zero to 99 hours 59 minutes.
- CHR Display Range: Zero to 99 minutes.

⑥ Time Control

- Controls the Time / Date display.
- RUN – Starts the Time / Date display counting.
- HLD (Hold) – Stops the Time / Date display, sets seconds to zero, and advances years.
- SS (Slow Slew) – Advances the Time / Date display minutes / months.
- FS (Fast Slew) – Advances the Time / Date display hours / days.

③ STANDBY ALTIMETER / AIRSPEED INDICATOR



CENTER INSTRUMENT PANEL

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① Altitude Indicator

- Indicates altitude in increments of twenty feet.
- Uncorrected.
- Green flag appears in left window when altitude is below 10,000 feet.
- A striped flag appears in the left window when the altitude is below zero feet.

② Altitude Pointer

- Makes one revolution each one thousand feet.

③ Baro Set Window

- Barometric pressure in millibars as set by baro set control.

④ Baro Set Control

- Rotate – Adjusts barometric settings.

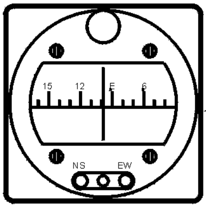
⑤ Baro Set Window

- Barometric pressure in inches of mercury as set by baro set control.

⑥ Indicated Airspeed

- Uncorrected.

③ STANDBY MAGNETIC COMPASS



May folded out of view for an unobstructed view through the windshield.

<u>CENTERPOST ABOVE GLARESHIELD</u>

373716100

③ HORIZONTAL SITUATION INDICATOR (HSI) AND RADIO DIRECTION MAGNETIC INDICATOR (RDMI)

The HSI switch on either side of the mode control panel determines the information provided by the respective HSI. If VOR/ILS is selected, conventional navigation information is displayed. When NAV is selected navigation information is relative to the FMC computed track between waypoints.

The RDMI displays conventional heading and VOR/ADF bearings with DME readouts in the upper left and right corners.

Compass System

The HSI and RMI cards receive heading information from respective inertial reference units (IRUs). When operating in the IRS NAV mode, the IRUs supply true heading corrected for local magnetic variation between latitude 73 degrees north and 60 degrees south to the respective HSIs and RMIs.

Flags And Associated Failures

If IRU heading information fails, the HSI HEADING and RDMI HDG flags appear. The COMPASS instrument transfer switch on the overhead panel is used to switch to the good IRU.

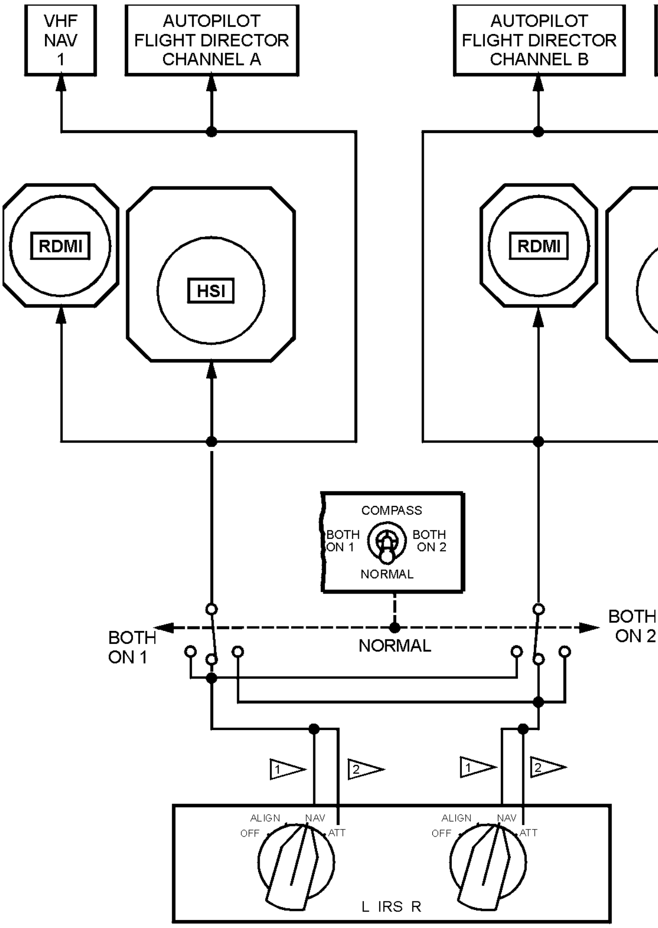
DG type heading reference can be supplied to HSI and RDMI cards if the IRS mode selector switch on the aft overhead panel is placed to the ATT position. When operating in ATT position the heading reference drifts, therefore updates of new compass headings must be made periodically using magnetic compass.

The HSI red and white stripe navigation flag is dependent on the HSI switch position. When selected to VOR/ILS, the VHF NAV instrument transfer switch on the overhead panel is used to switch to the good receiver. Switching is not available if a navigation flag appears when the HSI switch is selected to NAV.

The HSI VERT flag is also dependent on HSI switch position. When selected to VOR/LOC, the VHF NAV instrument transfer switch on the overhead panel is used to switch to the good receiver. Switching is not available if a **VERT** flag appears when the HSI switch is selected to NAV.

The **RDMI NAV** flags may be removed by switching to the good receiver via the VHF NAV instrument transfer switch.

③ COMPASS SYSTEM



1 IRS computes local variation, compass displays magnetic heading.

2 Magnetic Heading must be entered into the IRS by the pilot.

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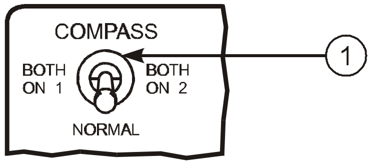
③ COMPASS TRANSFER SWITCH



FORWARD OVERHEAD PANEL

7376-10033

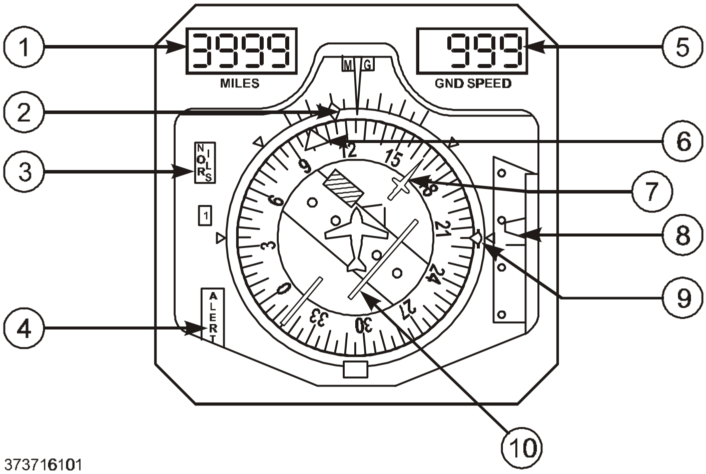
① Compass Transfer Switch

Enables selection of opposite compass systems in the event of a compass system failure.

Compass (IRU) Transfer

COMPASS BOTH ON 1 (RU) · NORMAL · BOTH ON 2 (RU)	EQUIPMENT / INPUT						
	CAPT RDMI	CAPT HSI	F/O RDMI	F/O HSI	A/P – F/D COMPUTERS		FLIGHT RECORDER
					A	B	
NORMAL	1	1	2	2	1	2	2
BOTH ON 1	1	1	1	1	1	1	1
BOTH ON 2	2	2	2	2	2	2	2

③ HORIZONTAL SITUATION INDICATOR (HSI)



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① Miles Display

- With HSI switch in NAV mode, FMC distance is displayed in miles to the next waypoint.
- Blank flag ( ) indicates power failure.
- Dashes (- - - -) indicates no computed data is available.

② Drift Angle Pointer

- Left or right drift display from respective IRS.
- Pointer moves to and remains at the bottom of HSI when the drift angle signal is lost.
- HSI Switch In VOR/ILS – Left or right drift displayed on the outer scale is provided by respective IRS.
- HSI Switch In NAV – Left or right drift displayed on outer scale is provided by respective IRS and FMC.

③ NAV Data Source Indicator

 - The VOR or ILS is supplying course deviation information.

 - The FMC is supplying course deviation information.

 - Source of navigation: VHF NAV 1 or 2, or FMC 1.

④ Alert Annunciator (amber)

- Signal generated by FMC.
- ILLUMINATED – Ten seconds before course change (actual waypoint passage).

⑤ Ground Speed Display

- Blank ($\boxed{}$) indicates power failure.
- HSI Switch In NAV – Ground speed from IRS and FMC.
- Dashes ($\boxed{- - - -}$) indicates computed data is not available.

⑥ Heading Marker

- Displays the heading set by the heading selector on mode control panel.

⑦ Course Pointer

- HSI Switch In VOR/ILS – The pointer is set with respective course selector on mode control panel.
- HSI Switch In NAV – The pointer is set automatically by FMC.

⑧ Vertical Deviation Pointer And Scale

- HSI Switch In VOR/ILS – Indicates displacement above or below glide slope.
  - Pointer in view when localizer frequency is tuned and HSI powered.
- HSI Switch In NAV – Path deviation from FMC VNAV path.
  - 1 dot = 400 feet above or below the vertical path.

⑨ Waypoint Bearing Pointer

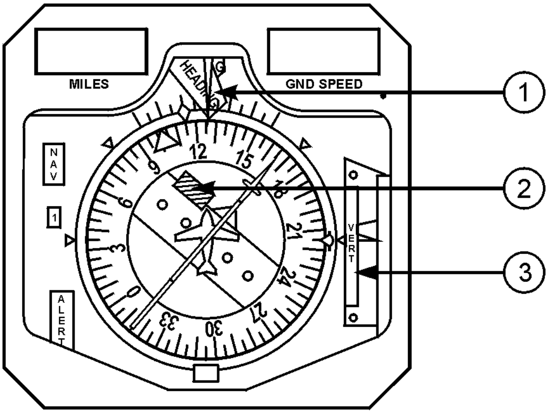
- HSI Switch In NAV – Indicates relative bearing of active waypoint on FMC track.
  - Signal generated by FMC.

⑩ Deviation Bar & Scale

- COURSE DEVIATION BAR

  VOR: 1 dot = 5 degrees.
  LOC: 1 dot = 1 degree.
  NAV: 1 dot = 2 nautical miles cross track deviation.

③ HSI FAILURE FLAGS



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① Heading Failure Flag In View – The selected IRU is invalid or HSI has lost power.

② Navigation Failure

- HSI switch in VOR/ILS – VHF Navigation signal not received.
- HSI switch in NAV – FMC failure to provide navigation signal to the HSI.

③ Vertical Failure Flag

- HSI switch in VOR/ILS –
  - LOC frequency set and glide slope signal not received.
  - Out of view with VOR frequency set.
- HSI switch in NAV – FMC failure to provide path deviation signal.

③ ATTITUDE DIRECTOR INDICATOR

Each ADI displays pitch and roll attitudes from respective inertial reference units. Flight director steering commands come from respective flight control computers.

A SLOW / FAST indicator receives information from the autothrottle computer. Localizer / rising runway indicator and glide slope deviation are also displayed for the respective NAV receiver.

Attitude System

Two inertial reference units (IRUs) or inertial reference systems supply attitude reference to the respective ADIs. Normally, IRU No. 1 supplies the left ADI and IRU No. 2 the right ADI. Attitude reference information can be supplied in both NAV and ATT IRS modes as selected by the respective IRS mode switch on the aft overhead panel.

If normal AC power is lost, No. 1 IRU operates on DC backup power via the aircraft battery for approximately 30 minutes. The No. 2 IRU operates for only 5 minutes.

Flags And Associated Failures

If an IRU is unable to generate attitude information an **ATT** flag appears in the respective ADI. The ATTITUDE instrument transfer switch on the left overhead panel is used to place the failed ADI over to the good unit.

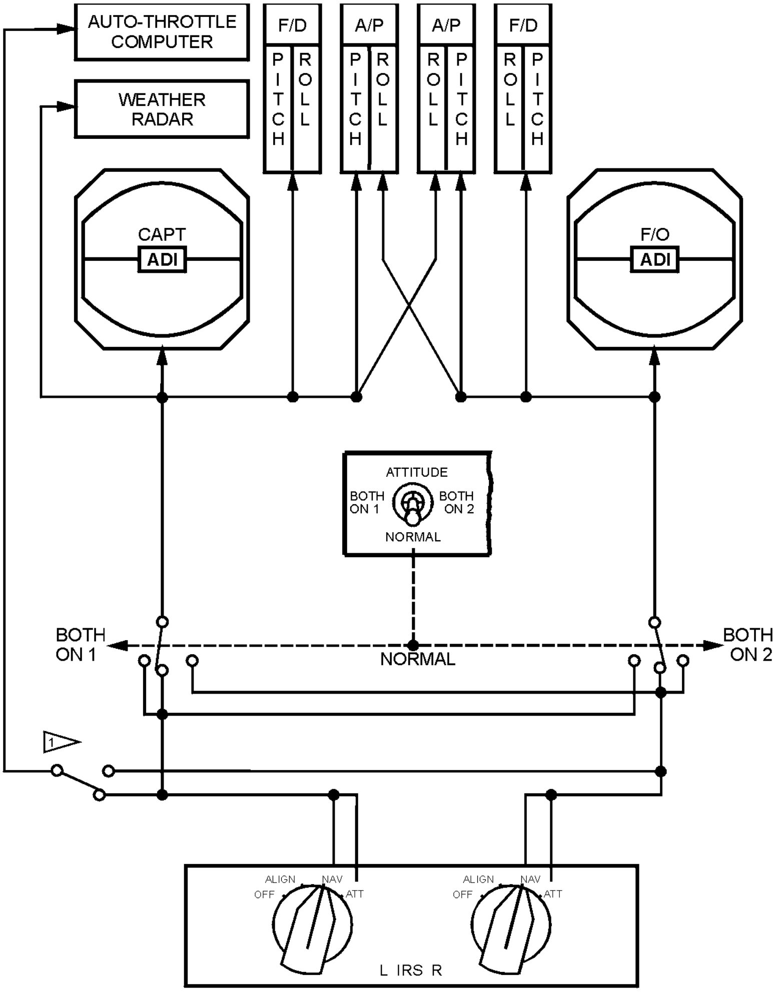
If all power is lost to an IRU and then restored, the IRS mode switch may be selected to ATT which then provides stabilized attitude information is restored to the respective ADI.

When a **GS** or RUNWAY (**LOC**) flag appears, the NAVIGATION instrument transfer switch is used to restore navigational information to the failed side.

Loss of a respective radio altimeter prevents the rising runway indication, however localizer function is not impaired.

The **CMPTR** flag monitor the flight director system. Switching is not installed for this condition.

③ ATTITUDE SYSTEM



1 Automatically switches for loss of IRS attitude.

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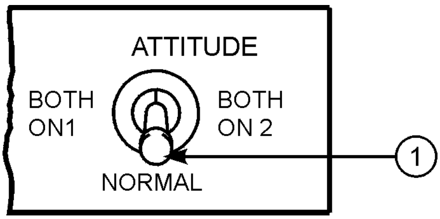
③ ATTITUDE TRANSFER SWITCHING

Compass (IRU) Transfer Switch



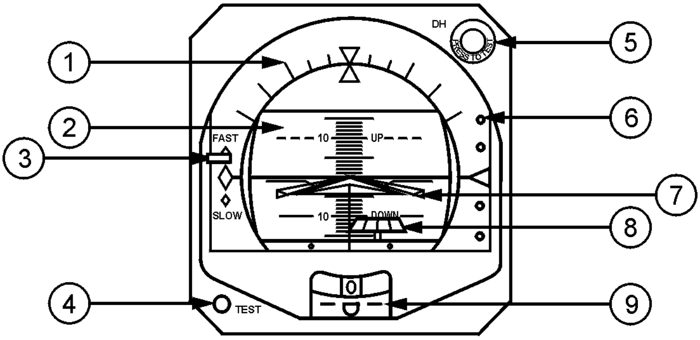
37371640R

① Enables selection of the opposite inertial reference unit in the event of failure.

Attitude (IRS) Transfer

ATTITUDE BOTH ON 1 (IRS) BOTH ON 2 (IRS) NORMAL	EQUIPMENT INPUT										
	CAPT ADI	F/O ADI	WX Radar	Flight Director				Autopilot			
				A		B		A		B	
				Pitch	Roll	Pitch	Roll	Pitch	Roll	Pitch	Roll
NORMAL	1	2	1	1	1	2	2	1	2	2	1
BOTH ON 1	1	1	1	1	1	1	1	1	1	1	1
BOTH ON 2	2	2	2	2	2	2	2	2	2	2	2

③ ATTITUDE DIRECTOR INDICATOR (ADI)



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① Bank Indicator And Scale

- Index indicates roll angle against calibrated scale.
- Scale has minor markings at 10 degrees and 20 degrees and major markings at 30 degrees, 45 degrees and 60 degrees.

② Attitude Display

- Tape moves relative to symbolic aircraft, displaying pitch and roll signals from the IRS.
- Pitch up or down scaled in 1 degree increments to 25 degrees, then every 5 degrees to 80 degrees.

③ Fast – Slow Pointer And Scale

- Driven by the autothrottle computer.
- SMALL DIAMOND – Represents 5 knots fast or slow.
- POINTER AT FAST OR SLOW – Represents 10 knots fast or slow.

④ TEST Switch

- PRESS – Displays 20 degrees roll to right and 10 degrees pitch up from present attitude.
- ATT flag appears.

⑤ Decision Height Light (amber)

- ILLUMINATED – The radio altimeter altitude pointer is at or below the altitude selected with the decision height cursor control.

⑥ Glide Slope Pointer And Scale

- Displays vertical position relative to the glide slope.
- The **GS** flag covers display when the signal is not valid.

⑦ Command Bars (yellow)

- Displays computed pitch and/or roll commands.
- BIASED OUT OF VIEW – Flight director switch is OFF.

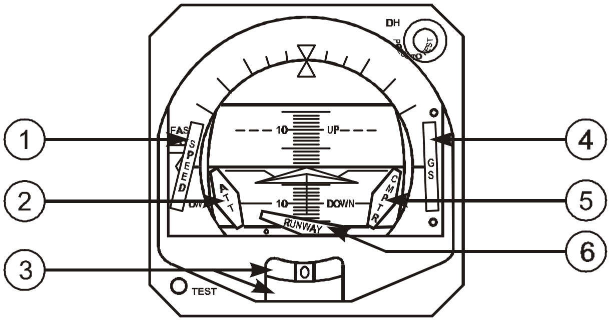
⑧ Runway Symbol In View – A localizer frequency is tuned and localizer signal is valid.

- Indicates localizer deviation of one dot or less (one dot is 1 degree displacement).
- Rises toward symbolic aircraft for last 200 feet or radio altitude during LOC or ILS approach if respective radio altimeter is valid.

⑨ Rate Of Turn Indicator

- Driven by ILS.
- One mark right or left is equal to 3 degrees per second.

③ ADI FAILURE FLAGS



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① Speed Flag In View – Autothrottle system is inoperative.

② Attitude Warning Flag In View – Display is unreliable (some failures cause indications of 90 degrees left bank).

- Instrument power failure.
- IRS failure.
- ADI TEST switch is pressed.

③ Slip / Skid Indicator Rate Of Turn Shutter

- Shutter covers rate of turn indicator when IRS fails to provide rate signal.

④ Glide Slope Warning Flag In View – Glide slope information is unreliable with ILS frequency tuned.

- Parallels the **VERT** warning flag on the HSI when the HSI switch is in VOR/ILS.

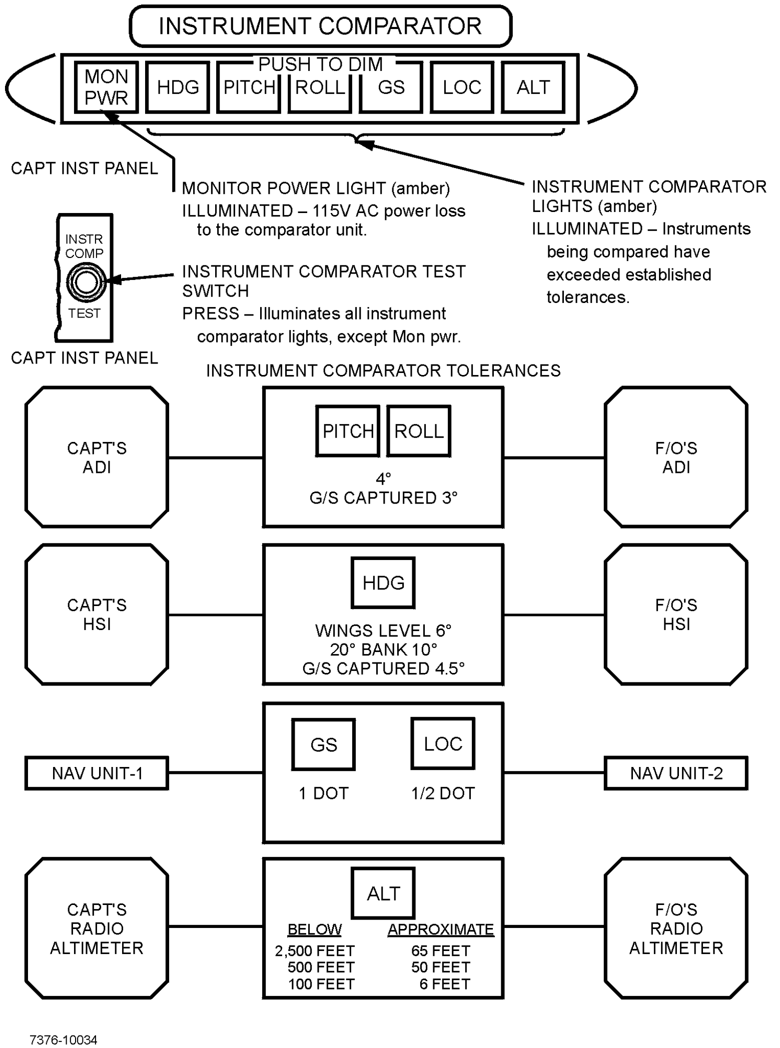
⑤ Computer Warning Flag In View – Indicates the flight director is inoperative.

- Electrical power loss.
- Causes flight director command bar to retract.

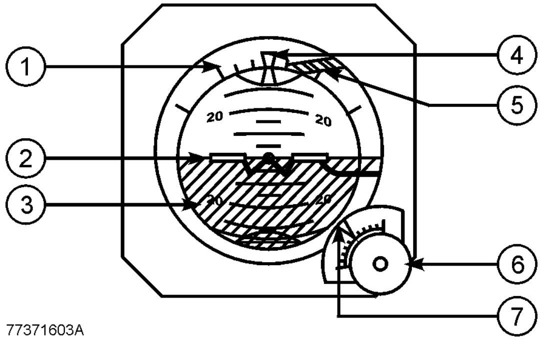
⑥ Runway Flag In View – A localizer frequency is tuned and localizer signal is not valid.

③ INSTRUMENT COMPARATOR

An instrument warning system is installed which provides comparison of the Captain's and First Officer's compass headings, pitch and roll attitude indications, localizer and glide slope deviation outputs from the No. 1 and the No. 2 VHF navigation unit and comparison of two radio altimeter output signals.



③ STANDBY HORIZON INDICATOR



① Bank Angle Scale

- Measures bank angles up to 60 degrees in 10 degree increments.
- Freedom in roll is 360 degrees.

② Horizon Bar And Symbolic Aircraft

- Provides an adjustable attitude reference.

③ Horizon Drum

- Provides indication of aircraft pitch attitude.
- Freedom in pitch is $\pm$ 90 degrees.

④ Bank Angle Indicator

- Indicates aircraft bank angle.
- Read opposite the bank angle scale.

⑤ Warning Flag In View – Loss of power.

⑥ Gyro Caging Control Out (Momentary) – Provides for fast erection (caging) of the gyro.

- The aircraft should be level during this procedure.

⑦ Pitch Trim Scale

- Provides a reference for adjusting the symbolic aircraft pitch presentation.
- Marked in 1 degree increments.

3 5 FLIGHT INSTRUMENTS

GENERAL

Flight instruments are electric except the standby airspeed indicator and altimeter. The left and right altimeters and airspeed indicators receive inputs from respective air data computers. Vertical speed indicators receive inputs from respective inertial reference units.

PITOT-STATIC SYSTEM AND AIR DATA COMPUTERS (ADCS)

There are four combination pitot-static probes, one <u>primary</u> and one <u>auxiliary</u> on each side of the nose. The probes sense ram and static pressure. Static lines are cross-connected for dynamic balance. The left (Captain) primary and right (First Officer) primary probes supply pitot and static information to respective left and right ADCs.

The ADCs correct and convert pitot-static pressures to electrical signals. This corrected data is input to the flight instruments. The ADCs are powered whenever the normal AC busses are powered.

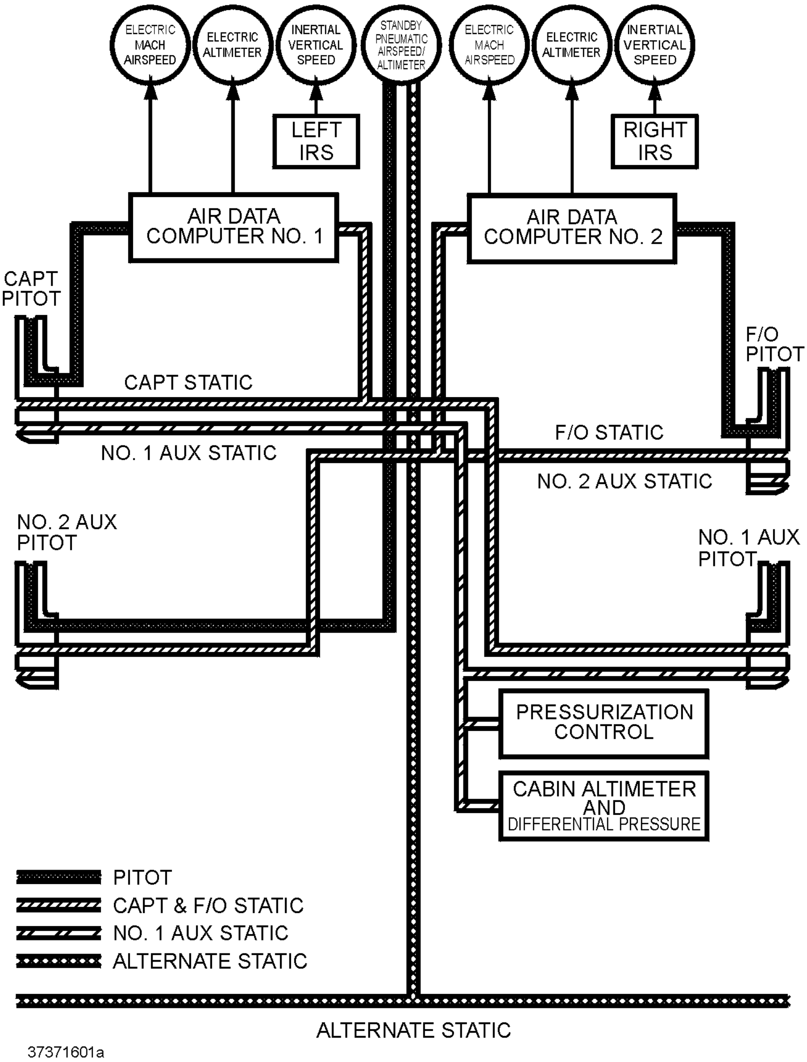
The left and right auxiliary probes provide balanced static pressure for the ADCs and uncorrected ram and static pressures for the pressurized control system indicators.

The left (# 2) <u>auxiliary</u> probe provides uncorrected ram pressure for the standby airspeed indicator and the <u>alternate</u> static system supplies uncorrected static pressure to the standby altimeter and airspeed indicator.

Blocked pitot and/or static pressure sensors may adversely affect the following components:

- Flight Control Computers
- Autothrottle
- Airspeed / Mach Indicator
- VMO/MMO Warning
- Altimeter
- Vertical Speed
- Inertial Reference Unit
- True Airspeed
- Static Air Temperature
- Flap Load Relief System
- Elevator Feel System
- Flight Management Computers
- Ground Proximity Warning System
- Altitude Alert
- Cabin Pressure
- Flight Recorder
- TCAS
- Stall Warning Computers
- Total Air Temperature
- Yaw Damper
- Mach Trim
- Symbol Generator

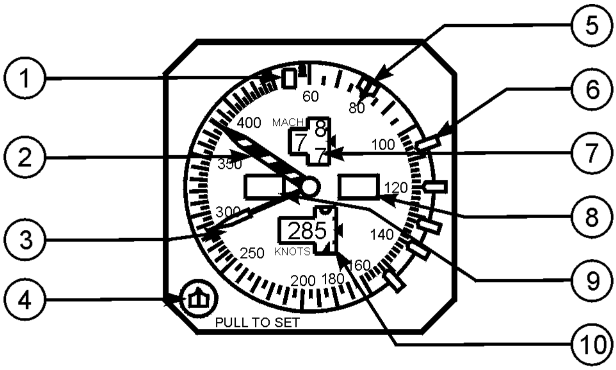
3 5 PITOT-STATIC SYSTEM



3 5 MACH / AIRSPEED INDICATOR

Mach / airspeed indicators display ADC corrected airspeed, Mach, and maximum operating airspeed.

The airspeed cursor in each indicator can be moved 3 ways. Both cursors move to follow selected Mach / airspeed in the mode control panel (MCP) Mach / airspeed window. Both cursors move automatically as signaled by the flight management computer (FMC) when in VNAV mode. Each cursor can be moved individually by pulling out on the respective airspeed cursor control knob and rotating to the desired airspeed.



37371603a

① Airspeed Cursor Annunciator

- Auto mode: Out of view when the cursor control is in the "PUSH IN" position.
- Manual mode: In view when cursor control is in the "PULL OUT" position.

② V_{MO} / M_{MO} Pointer (Red and White)

- Indicates the maximum operating airspeed in knots.

③ Airspeed Pointer

- Indicates airspeed in knots.

④ Airspeed Cursor Control

- PUSH IN – Auto mode. Airspeed cursor positioned by FMC in VNAV mode or by MCP Mach airspeed control.
- PULL OUT – Manual mode. Airspeed cursor is positioned by rotating cursor control.

⑤ Airspeed Cursor

- Indicates target airspeed.
- Positioned manually as selected by the airspeed cursor control if pulled to the out position.
- Positioned automatically by FMC when in VNAV mode.

⑥ External Airspeed Markers (Bugs)

- Positioned manually to the desired airspeed references.

⑦ Mach Digital Counter

- Shows Mach number, from .40 to .99 Mach, in digital form.
- Masked below .40 Mach.
- Digits are covered by a warning flag MACH when the display is unreliable.

⑧ Airspeed Cursor Flag

- Manual mode: Flag is retracted.
- Auto mode: Flag in view if airspeed cursor signals are unreliable.

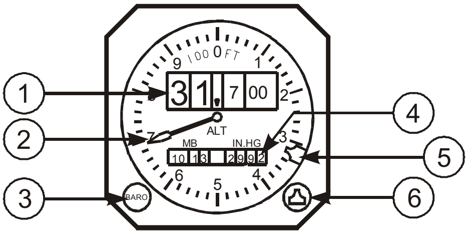
⑨ V_{MO} Flag In View V_{MO} – Indicates the V_{MO} / M_{MO} pointer is inoperative.

⑩ Airspeed Digital Counter

- Digital display of indicated airspeed in knots.
- Warning flag A/S covers the counter when the airspeed pointer and airspeed digital counter are unreliable.

(3)(5) ALTIMETER

Altimeters display respective ADC corrected altitude. Range is –1000 to 50,000 feet.



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① Digital Counter

Displays altitude in increments of thousands, hundreds and twenty feet.

- Warning flag **OFF** appears whenever the ADC signal is lost or a malfunction exists.
- Green flag appears in the left window when altitude is below 10,000 feet.
- A **NEG** flag appears in the two left-hand windows when altitude below zero feet is displayed.

② Altitude Pointer

- Makes one revolution each one thousand feet.

③ Barometric Setting Control

- ROTATE – Adjusts the barometric correction in the barometric setting window.

④ Barometric Setting Window

- Reflects barometric correction (in millibars and inches of mercury) as set by the barometric setting control.

⑤ Reference Altitude Marker

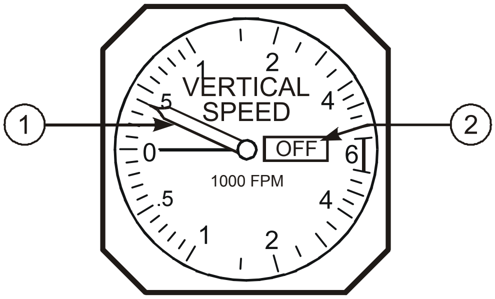
- Manually positioned to the desired reference altitude using the reference altitude marker control.

⑥ Reference Altitude Marker Control

- Used to manually set the reference altitude marker.

3 5 VERTICAL SPEED INDICATOR

Inertial vertical speed indicators display instantaneous vertical speed derived from the respective inertial reference system.



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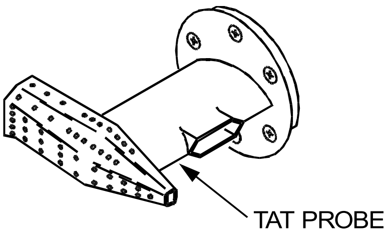
① Vertical Speed Pointer

- Depicts rate of climb or descent from 0 to 6000 feet per minute.
- Indicates zero when IRS vertical speed is unreliable.

② **OFF** Flag In View – Selected IRS vertical speed data are unreliable or indicator has failed.

3 5 TOTAL AIR TEMPERATURE (TAT) SYSTEM

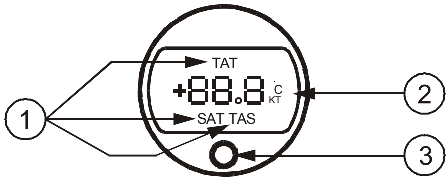
The TAT probe has three sensing elements. It provides temperature data to both ADCs. TAT or TAT derived data from ADC No. 1 is used by both IRSs, FMC, A/T, FCC A and air temp / true airspeed indicator. TAT derived data from ADC No. 2 is used by both IRSs, the FMC, A/T and FCC B.



37371608

③ 3 5 AIR TEMP / TRUE AIRSPEED INDICATOR

The indicator provides selectable displays of total air temperature (TAT), static air temperatures (SAT) and true airspeed (TAS) from ADC No. 1. Approximate outside air temperature (OAT) is displayed while on the ground with pitot heat OFF.



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① **TAT** / **SAT** / **TAS** Annunciators Illuminated – Identifies the type of data being displayed on the Digital Display.

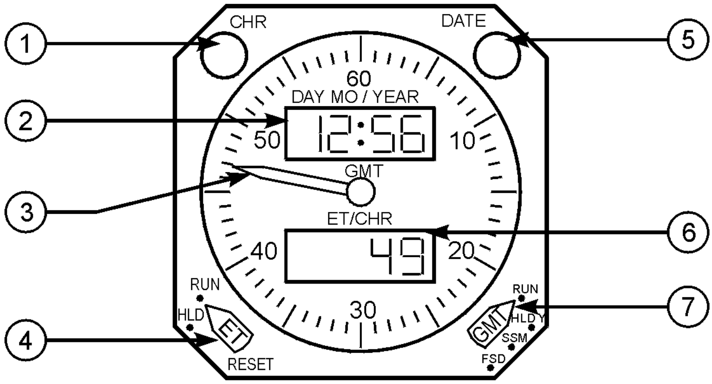
② Digital Display

- Displays TAT (°C), SAT (°C), or TAS (knots) indications in digital form.

③ Selector Push Button

- PRESS – Sequences the display from **TAT**, to **SAT**, to **TAS**.

3 5 CLOCKS



LEFT and RIGHT FORWARD
PANELS

37371610a

① Chronograph (CHR) Control

- PUSH -
  - Controls the start, stop and reset functions of the **CHR** display and second hand with successive pushing.
  - Overrides any existing ET display.

② Time / Date Window

- Displays time (hours, minutes) when time is selected with the date control.
- Alternately displays day – month and year when date is selected with the date control.

③ Chronograph Second Hand

- Indicates chronograph seconds.
- Controlled by the CHR control.

④ Elapsed Time (ET) Selector (three position, rotary)

- Controls the elapsed time function.
- RESET – Returns ET display to zero (spring loaded to HLD).
- HLD (hold) – Stops the elapsed time display.
- RUN – Starts the elapsed time display.
- SS M (slow slew, month) –
  - Advances minutes when time is selected with the date control.
  - Advances months when date is selected with the date control.
- HLD Y (hold, year) –
  - Stops the time indicator and sets the seconds to zero when time is selected with the date control.
  - Advances years when date is selected with the date control.
- RUN – Starts the time indicator.

⑤ Date Control

- Controls the date display.
- PUSH – Displays date (day, month) alternating with year.
- PUSH – Returns display to time.

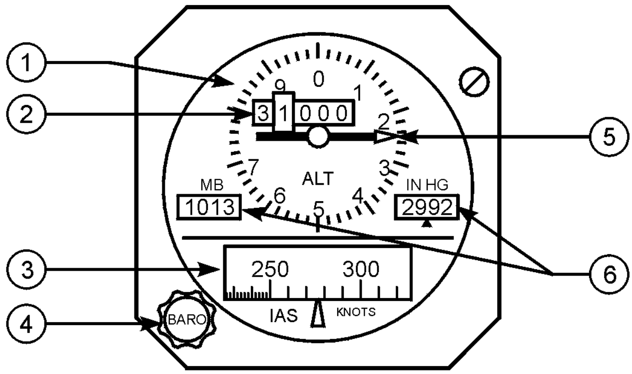
⑥ Elapsed Time (ET) / Chronograph Window

- Displays elapsed time (hours, minutes) or chronograph minutes.
- The chronograph display replaces the elapsed time display.
- Elapsed time continues to run in the background and displays after the chronograph is reset.

⑦ Time Control (four position, rotary)

- Sets the time and date when the time or date is selected with the date control.
- FS D (fast slew, day) –
  - Advances hours when time is selected with the date control.
  - Advances days when date is selected with the date control.

3 5 7 8 9 STANDBY ALTITUDE / AIRSPEED INDICATOR



CENTER INSTRUMENT PANEL

77371644b

① Standby Altimeter

Receives static pressure from the alternate static ports.

② Digital Counter

- Indicates thousand foot increments of current altitude
- A green flag appears in the left window when altitude is less than 10,000 feet
- A striped flag appears in the left window when altitude is less than zero feet.

③ Standby Airspeed Indicator

Receives ram pressure from the auxiliary pitot probe and static pressure from the alternate static ports.

④ Barometric Setting Control

ROTATE – Adjusts the barometric correction in both barometric windows.

⑤ Altitude Pointer

Indicates twenty foot increments of current altitude.

⑥ Barometric Setting Windows

Indicates barometric correction in millibars and inches of mercury as set by the barometric setting control.

3 5 ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS)

GENERAL

Two symbol generators (SGs) are the heart of the EFIS. SGs use navigational data from aircraft electronic systems and pilot controls to generate visual displays for respective EADIs and EHSIs.

EFIS CONTROL PANELS

Two control panels are used to select displays on the EHSIs, and EADI radio altimeter decision height. Brightness controls are also on the panels.

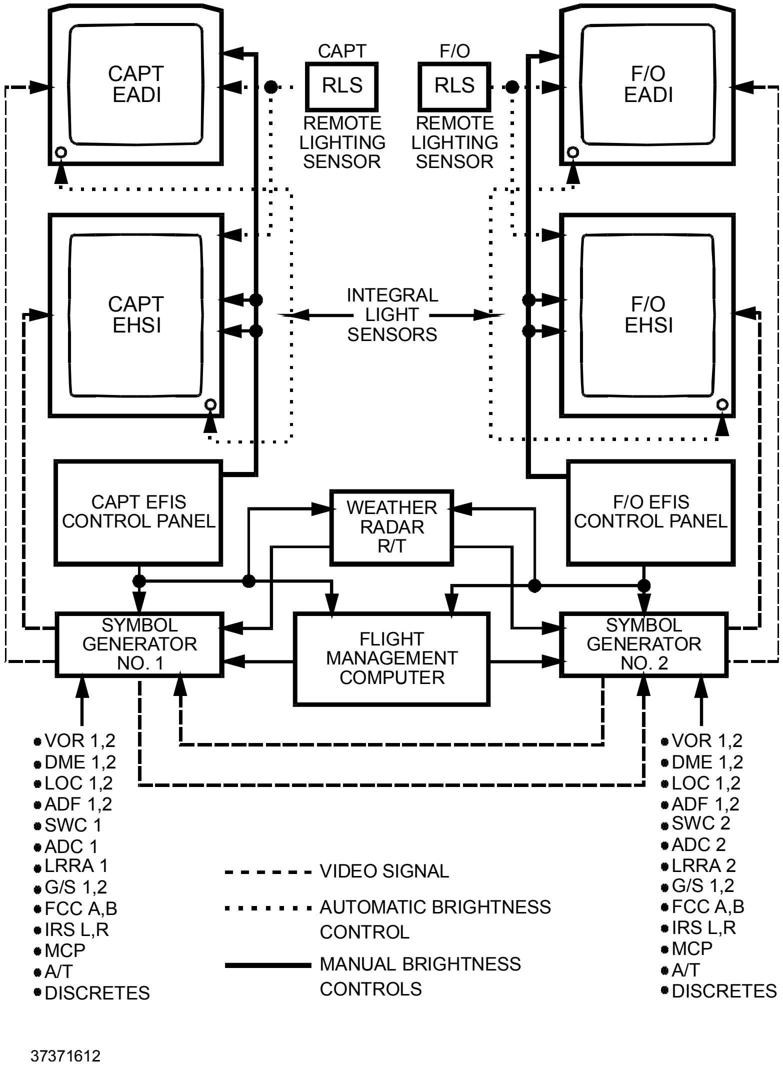
ELECTRICAL POWER

The left EFIS is powered by No. 1 transfer bus. The right EFIS is powered by transfer bus No. 2. If normal power is lost, the left VHF NAV receiver, RDMI card and No. 1 needle are operative in addition to magnetic compass, standby IAS, altimeter and horizon.

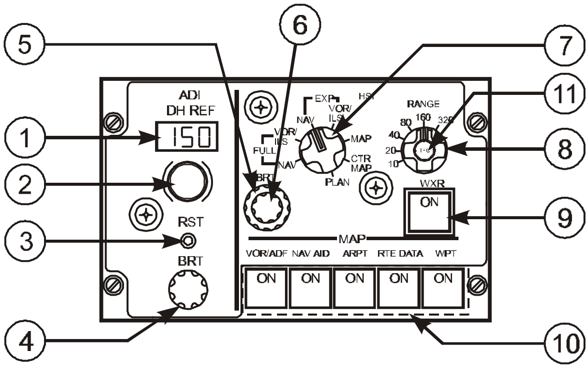
EFIS FAILURE INDICATIONS

Failures are indicated by flags, annunciations and removal of data or affected portions of a respective display. VHF NAV failure is indicated by removal of the localizer or glide slope deviation bar and/or pointer. ADF failure causes the associated symbol(s) pointers or vectors to be removed from view.

3 5 EFIS INTEGRATION



3 5 EFIS CONTROL PANEL



AFT ELECTRONIC PANEL

7376-10035

① Decision Height Reference Indicator

- Displays selected decision height.
- Displays on EADI blanks when a negative decision height is selected.

② Decision Height Selector

Rotate - Selects decision height for DH alerting.

③ Decision Height Reset Switch

Push –

- Resets DH alert on related EADI.
- Changes RA display from yellow to white.

④ EADI Brightness Control

Rotate - Adjusts brightness of EADI display.

⑤ EHSI Brightness (outer)

Rotate – Adjusts brightness of EHSI display.

⑥ EHSI Brightness (inner)

Rotate – Adjusts brightness of weather radar display.

⑦ EHSI Mode Selector

- (See following pages)

⑧ EHSI Range Selector

Rotate - Selects nautical mile range for MAP, CTR MAP, PLAN, and weather radar displays.

⑨ Weather Radar Switch

Push – Displays weather radar information (refer to Section 6.11, Flight Management, Navigation).

⑩ Map Switches

Push –

- Selects detailed information displays
- Displays can be selected simultaneously
- Illuminated white when selected
- Second push removes the information

VOR/ADF –

- Displays VOR and/or ADF relative bearing radials if VOR/ADF receivers are tuned to usable stations and valid data is being received
- Suppresses MAP mode displayed ADF pointer.

Navigation Aids (NAV AID) –

- Displays FMC data base high altitude navigation aids on map scales 80, 160, or 320 NM
- Displays all FMC data base navigation aids if on map scales 10, 20, or 40 NM.

Airports (ARPT) – Displays all airports stored in FMC data base which are within viewable map area of EHSI.

Route Date (RTE DATA) – Displays waypoints in FMC data base not in flight plan route if selected range is 40 NM or less.

⑪ Traffic (TFC) Switch

- Displays or removes TCAS information on EHSI
- Removes **TCAS FAIL** message, if displayed.

3 5 ELECTRONIC ATTITUDE DIRECTOR INDICATOR

GENERAL

The EADI displays pitch and roll attitudes, flight director commands, localizer / glide slope deviation and flight mode annunciator (FMA). An IAS tape, Mach, ground speed, decision height, and radio altitude are also on the EADI.

ATTITUDE DISPLAY

Attitude data comes from the respective IRS. Pitch and roll information is valid through 360 degrees of rotation in each axis.

F/D COMMANDS

Flight director guidance comes from the selected FCC and displayed by individual pitch and roll bars.

GLIDE SLOPE AND LOCALIZER DEVIATION DISPLAYS

Glide slope and localizer scales appear when a localizer frequency is selected on the associated VHF NAV receiver. LOC deviation bar and G/S pointer appear when a valid signal is received.

The localizer deviation scale is one degree per dot. When course deviation is approximately 5/8 degree with VOR/LOC engaged, the scale automatically expands to 1/2 degree deviation per dot. The scale remains expanded until after landing rollout or 200 feet RA during go-around.

Back - Course Approach

The SGs reverse "polarity" for the localizer deviation pointer. This reversal occurs when aircraft track differs from selected MCP course by more than 90 degrees. When a front – course is set in a MCP course window, the respective EADI (and EHSI) course deviation agrees on front – course or back – course approaches. The glide slope scale does not appear.

ILS DEVIATION WARNING

ILS deviation warning operates for single or dual A/P approaches. The warning is armed during descents below 1,500 feet RA when LOC and G/S are engaged.

If Captain or First Officer LOC deviation exceeds one-half dot on the expanded scale or one-fourth dot standard scale, the respective LOC display changes from white to yellow and the rising runway stem flashes.

If Captain or First Officer G/S deviation exceeds one dot, the respective G/S scale changes from white to yellow and the G/S pointer flashes. G/S deviation warning does not occur below 100 feet RA. However, if the warning was triggered prior to descent below 100 feet RA, the warning continues to operate below 100 feet RA.

TESTS

System self-tests occur at approximately 1,500 feet RA when LOC and G/S engaged. This self-test causes a two-second flashing of LOC and G/S deviation scales on both EADIs.

RISING RUNWAY INDICATOR

The rising runway indicator near the bottom of the EADI but at the top of the LOC deviation pointer is integral to the LOC display. The indicator is in view below 2500 RA when a valid ILS frequency is selected. Vertical movement starts at 200 feet RA and displays the last 200 feet of descent. Zero RA is indicated when the top of the rising runway symbol touches the base of the aircraft symbol.

Pitch / Roll Comparator

Yellow **PITCH** or **ROLL** annunciations appear near the bottom of the EADIs if either symbol generator detects a difference of more than 3 degrees between pitch or roll displays.

DIGITAL RADIO ALTITUDE AND DECISION HEIGHT

Radio altitude appears in the lower right corner of the EADIs when RA is 2500 feet or less. When an altitude is selected on the EADI section of the EFIS control panel, DH and selected altitude appear above the RA indication.

Descents below 1,000 feet AGL cause a round RA indicator to appear and a magenta pointer replaces the DH readout.

When descending through selected DH, the indicator and DH pointer change to flashing yellow, then steady yellow as descent continues.

The DH alert is reset when the DH reset switch on the EFIS control panel is pressed, RA increases to DH + 75 feet or zero RA at touchdown.

Electrical power interruption causes DH default to 200 feet.

MACH NUMBER

Mach comes from the respective ADC.

GROUND SPEED

Ground speed is from the FMC via respective symbol generator. The respective IRS supplies ground speed if the FMC fails.

PITCH LIMIT INDICATOR (PLI)

The PLI shows pitch where stick shaker occurs. The PLI appears when flaps are out of up position. The stall warning computer supplies the signal.

The PLI is fixed at 15 degrees pitch until approximately 100 knots. Commands are limited to a maximum of 30 degrees.

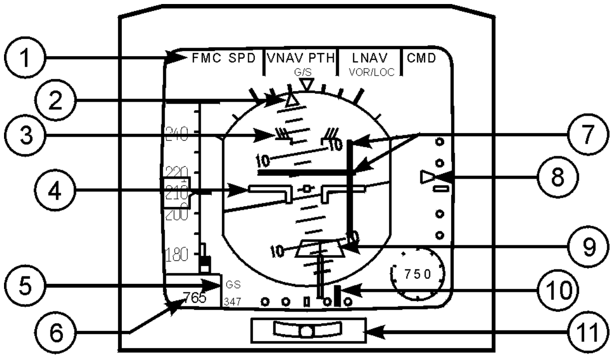
When a rapid pull-up is made, pitch attitude may exceed PLI indication briefly without initiating the stick shaker.

Stick shaker may be activated at lighter weights by stall warning computer low speed limit logic even though the PLI is positioned slightly above the aircraft symbol.

SPEED TAPE

The speed tape moves relative to a fixed reference pointer. The pointer contains a boxed rolling digit readout of current airspeed. Symbols related to aircraft speed are positioned on the speed tape. The speed tape scale has a range of 84 knots with numbers spaced at 20 – knot intervals from 40 to 420 knots.

3 5 ELECTRONIC ATTITUDE DIRECTOR INDICATOR DISPLAYS



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① Flight Mode Annunciations

② Bank Indicator And Scale (white)

③ Pitch Limit Symbol (yellow)

- Indicates pitch attitude corresponding to stick shaker activation.

④ Aircraft Symbol (black with white outline)

⑤ Ground Speed (white)

- Displays FMC/IRS ground speed in knots.

⑥ Mach (white)

- Displayed when Mach increases above .40 Mach.
- Display is blanked when Mach decreases below .38 Mach.

⑦ Flight Director Command Bars (magenta)

- Displayed when respective FD switch is ON and valid command steering is available or during automatic operation of the FD.
- Blanked when the respective FD switch if OFF, or command steering becomes invalid.

8 Glide Slope Pointer And Deviation Scale (magenta / white)

- Pointer indicates glide slope position.
- Scale indicates deviation.
- Pointer is not displayed when the glide slope signal is unusable or when track and the front course on the MCP differ by more than 90 degrees (backcourse).

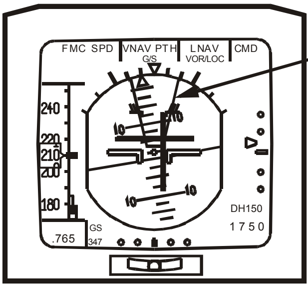
9 Rising Runway (green)

- Displayed when localizer pointer is in view and radio altitude is valid.
- Rises towards aircraft symbol when radio altitude is below 200 feet AGL.

10 Localizer Pointer And Deviation Scale (magenta / white)

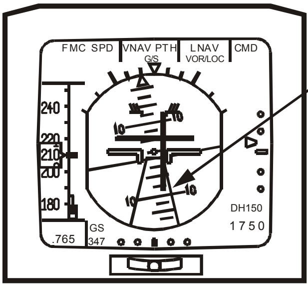
- Pointer indicates localizer position.
- Scale indicates deviation.
- When LOC is engaged and deviation is slightly more than one half dot, scale expands (not shown here).
- Pointer is blank when ILS LOC signal is too weak to be usable.

11 Slip Indicator



TCAS RA PITCH COMMAND (red)
(Down Advisory)

- Displayed during a RA condition.
- Indicates pitch attitudes to be avoided for traffic separation.



TCAS RA PITCH COMMAND (red)
(Up Advisory)

- Displayed during a RA condition.
- Indicates pitch attitudes to be avoided for traffic separation.

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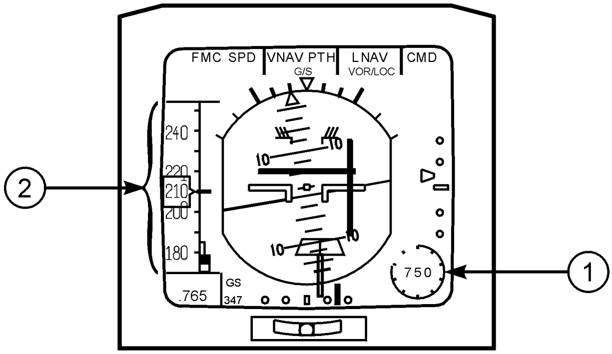
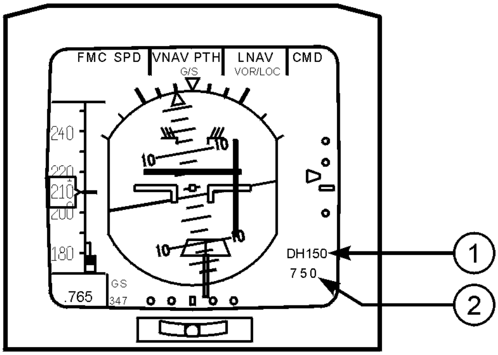


37371615b

① Radio Altitude Dial (Dial - White, DH Pointer - Magenta)

- Displayed when the aircraft is at or below 1000 feet AGL.
- DH pointer replaces digital DH display.
- The circumference of the dial is added to or taken away from to depict aircraft's radio altitude.
- Display changes color to yellow and flashes momentarily when aircraft descends below the decision height.
- DH alert is reset automatically if aircraft climbs 75 feet or more above the select DH, or after the aircraft lands.
- DH alert is manually reset if the RST switch on the EFIS control panel is pressed. (Yellow display reverts to white.)

② Speed Tape



37371615d

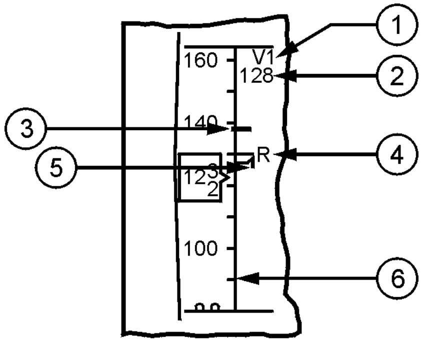
① Decision Height (green)

- Displays selected decision height as set on the EFIS control panel when radio altitude is above 1000 feet AGL.
- Blank when negative DH is selected.

② Radio Altitude (white)

- Displays radio altitude below 2,500 feet AGL.
- Blanked above 2,500 feet AGL.
- Changes color from white to yellow when below selected DH on descent.
- Changes to white when passing selected DH plus 75 feet during go-around, after touchdown, or after pressing RST switch on EFIS control panel.

3 5 EADI SPEED TAPE



37371617a

① V_1 (green)

- Displayed after manual entry on the CDU TAKEOFF REF page.

② V_1 Speed (green)

- Displayed in this location during initial takeoff roll when V_1 is beyond the displayed range.

③ FMC / MCP Command Speed (magenta)

- Displays speed selected on MCP, or
- FMC commanded speed.
- Double line cursor when speed is within displayed speed tape range.
- Displayed as number equivalent above or below speed tape scale if command speed not within displayed speed tape range.

④ V_R (green)

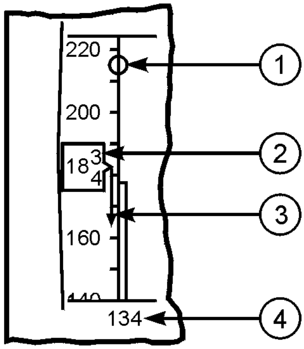
- Displayed after manual entry on the FMC / CDU TAKEOFF REF page.
- Blanked if rotation speed not within displayed range.

⑤ V_1 (green)

- This symbol replaces digital V_1 display (upper right corner of the speed tape) when the V_1 speed is within the displayed range.

⑥ Speed Tape Scale (white)

- Scrolls up or down in response to ADC calibrated airspeed.
- Range is 45 to 420 knots.



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① Flaps-Up Maneuvering Speed (green)

- Displayed when flaps are up.
- Best airspeed (climb or driftdown) for clean configuration.
- Computed by stall warning computer.
- FMC must operate and be able to compute gross weight.
- Enabled when flaps are up.

② Rolling Digits Display (white)

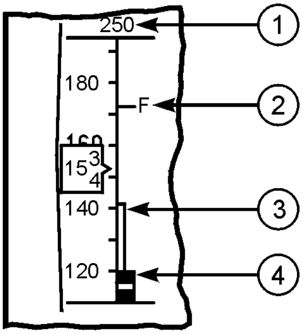
- Indicates current airspeed.
- Position is fixed relative to ADI display.

③ Airspeed Trend Arrow (green)

- Variable length.
- Tip of arrow depicts predicted airspeed within the next 10 seconds based on present airspeed and acceleration.
- Displayed when magnitude is greater than 4 knots.
- Remove when magnitude is less than 3 knots.

④ FMC / MCP Command Speed (magenta)

- Displayed in this location when the FMC / MCP command speed is below or above displayed range.



37371617c

① FMC / MCP Command Speed (magenta)

- Displayed in this location when the FMC / MCP command speed is above displayed range.

② Minimum Flap Retraction Speed (green)

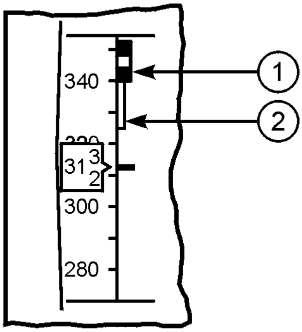
- Displayed on speed tape during takeoff or go-around.
- Computed by the stall warning computer.
- Minimum maneuver speed for next normal flap position.
- Responds to extension of flight spoilers.

③ Minimum Maneuver Speed (yellow)

- Top of hollow yellow bar indicates minimum maneuver speed.
- At low altitudes this speed provides .3G margin above stick shaker (40 degree bank in level flight).
- At high altitudes this speed provides .3G margin to low speed buffet.
- Computed by the stall warning computer.
- Responds to extension of flight spoilers.
- FMC must be operative and able to compute gross weight.

④ Stick Shaker Speed (red and black)

- Top of barber pole indicates speed at which stick shaker is activated.
- Computed by the stall warning computer.
- Responds to extension of flight spoilers.



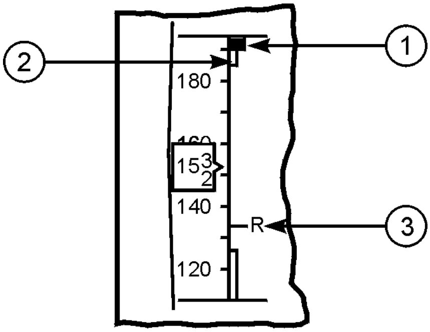
37371617d

① Max Operating Speed (red and black)

- Indicates V_{mo}/M_{mo}, or
- Flaps / gear placard speeds, whichever is lower.
- Computed by the stall warning computer.

② High Speed Buffet Margin (yellow)

- Bottom of hollow yellow bar indicates speed that provides a .3G maneuver margin to high speed buffet at altitudes above 25,000 feet.
- FMC must be operative and able to compute gross weight.



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① Placard Speed (red and black)

- Indicates gear extended placard speed or flap extended placard speed for selected flap position, as applicable.

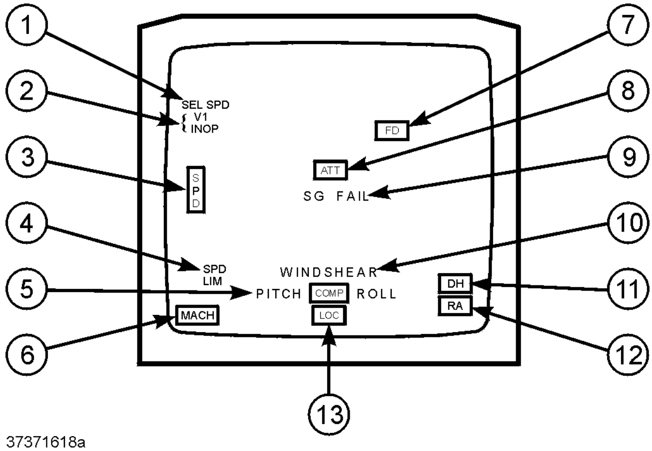
② Next Flap Position Placard Speed (yellow)

- Bottom of hollow yellow bar indicates the flap extended placard speed for the next normal flap position.
- Displayed during flap extension.
- Displayed for flap positions normally used during approach and landing.
- Blanked when current flap position equals flap configuration selected on CDU APPROACH REF page.

③ V_{REF} Speed (green)

- Indicates the V_{REF} speed for the landing flap configuration as selected on the CDU APPROACH REF page.
- Based on current / entered gross weight for 15, 30, 40 landing flaps.
- Does not update after selected on APPROACH REF page.
- Manually enter gross weight not updated as fuel is burned off.

3 5 EADI SYSTEM FAILURE FLAGS AND ANNUNCIATIONS



Flags and annunciations are yellow. Windshear warning is red.

① Selected Speed Annunciation

- Command speed symbol and displays are inoperative.

② V_1 Inoperative Annunciation

- V_1 display is inoperative.

③ Speed Flag

- Speed tape display is inoperative.

④ Speed Limit Annunciation

- Displays when associated stick shaker, and maximum operating speeds have failed.

⑤ Pitch Comparator Annunciation

- Left and right pitch angle displays differ by more than 3 degrees.
- ATTITUDE COMPARATOR FUNCTION FLAG
  - Comparator function has failed.
- ROLL COMPARATOR ANNUNCIATION
  - Captain and First Officer’s bank angle displays differ by more than 3 degrees.

⑥ Mach Flag

- Mach number display has failed.

⑦ Flight Director Flag

- Both pitch and roll flight director command bars have failed.

⑧ Attitude Flag

- Attitude display has failed.

⑨ Symbol Generator Fail Annunciation

- The selected symbol generator has failed.

⑩ Reactive Windshear Warning

- The IRS has detected the aircraft is in a decreasing performance windshear.

⑪ Decision Height Flag

- Selected decision height display has failed.

⑫ Radio Altitude Flag

- Radio altitude display has failed.

⑬ Localizer Flag

- Localizer deviation display in the EADI has failed.

3 5 ELECTRONIC HORIZONTAL SITUATION INDICATOR

General

Each EHSI presents an electronically generated color display of conventional HSI navigation data (VOR/ILS and NAV modes). Each EHSI is also capable of displaying the airplane's flight progress on a plan view map (MAP and CTR MAP modes), or the airplane's flight plan on a plan view map oriented to true north (PLAN mode).

Excluding operation in the FULL NAV**,** FULL VOR/ILS, and PLAN modes, each EHSI also serves as a weather radar display when the WXR switch on the respective EFIS Control Panel is ON.

During normal operation, each EHSI receives information from its own symbol generator. Each symbol generator receives data from a variety of aircraft systems to support the EHSI displays.

Display Orientation

The various displays on the EHSI are oriented in one of two ways, either "heading-up" or "track-up". With "heading-up" orientation, all displayed data is referenced to aircraft heading as shown at the twelve o'clock position on the compass rose. With "track-up" orientation, all displayed data is referenced to aircraft track as shown at the twelve o'clock position on the compass rose.

During normal operation, heading reference data is supplied to each EHSI from the respective IRS.

Airplane track data is supplied by the FMC. If the FMC track data should become unreliable, track data is automatically supplied by the respective IRS.

EFIS Control Panel

The EFIS Control Panels provide selection of the EHSI display mode, display range, display brightness, weather radar display (ON or OFF and display brightness), and MAP data options. During normal operation, each panel controls the display for the respective EHSI.

The selectable display modes are FULL ROSE NAVIGATION (**FULL NAV**), **FULL ROSE VOR/ILS**, EXPANDED ROSE NAVIGATION (**EXP NAV**), **EXPANDED ROSE VOR/ILS** , **MAP**, CENTER MAP (**CTR MAP**), and **PLAN**.

FULL and EXP NAV Modes

The navigation mode is used when a conventional display of FMC navigation course deviation is desired. In addition to the conventional FMC course deviation data displayed, the NAV mode also displays distance to the active waypoint, active waypoint identifier, ETA's or ETE's, ADF bearing pointers (if an ADF bearing is being received), wind direction and magnitude, and system source annunciation.

The NAV mode may be displayed with a conventional, full compass rose, or with a simplified, expanded compass rose format.

The NAV mode display is a "track-up" oriented display.

FULL and EXP VOR/ILS Modes

The VOR/ILS mode is useful when tracking or referencing VHF radio navigation signals using a VHF navigation receiver. The VOR/ILS mode displays course deviation using conventional EHSI presentations.

In addition to the conventional navigation data displayed, the VOR/ILS mode also displays DME distance to the navaid, ADF bearing pointers (if an ADF bearing is being received), wind direction and velocity, system source annunciation, and selected frequency (not displayed if in auto tune mode).

The VOR/ILS mode may be displayed with a conventional, full compass rose, or with a simplified, expanded compass rose format.

The VOR/ILS mode display is a "heading-up" oriented display.

MAP Mode

The MAP mode displays a plan view of the airplane's position relative to the FMC flight plan and/or FMC data base waypoints and navaids. The FMC flight plan and/or FMC data base waypoints and navaids and other map symbols are displayed on the map background. The map background moves relative to the fixed airplane symbol. Displayed information includes airplane heading; airplane track; route of flight; curved trend vector(s); range to altitude; wind direction and velocity; distances; ETA's; altitude constraints; FMC database airports, navaids, waypoints; VOR/ADF bearing radials; and weather radar displays.

The map display is a "track-up" oriented display.

CTR MAP Mode

The CENTER MAP mode provides the same data as the MAP mode with the exception that the airplane symbol is located at the center of the display so that map data behind the airplane is within the viewing area.

PLAN Mode

The PLAN mode is a map display which may be used to view an FMC flight plan route, either in total for a short route, or waypoint-by-waypoint for a longer route. The PLAN mode display is oriented to true north.

Weather Radar Display

Display of weather radar returns on the EHSI is enabled or disabled by the WXR switch on the respective EFIS Control Panel. Radar returns can be displayed in all EHSI modes except the FULL NAV, FULL VOR/ILS and PLAN modes.

Instrument Transfer Switching

During normal operation, each pilot's EFIS displays utilize independent IRS and Symbol Generator (SG) inputs. The switching schematic illustrates the instrument transfer switching logic in the event an IRS or SG failure causes loss of data to one pilot.

The EFI Transfer switch determines the SG source for the Captain's and F/O's EADI and EHSI displays. With the EFI Transfer switch in the NORMAL position, the No. 1 SG provides display symbols for the Captain's EFIS displays, and the No. 2 SG provides display symbols for the F/O's EFIS displays. If the EFI transfer switch is in the BOTH ON 1 position, both sets of displays utilize symbols provided by the No. 1 SG, and the No. 2 SG is turned off. If the EFI transfer switch is in the BOTH ON 2 position, both sets of displays utilize symbols provided by the No. 2 SG, and the No. 1 SG is turned off.

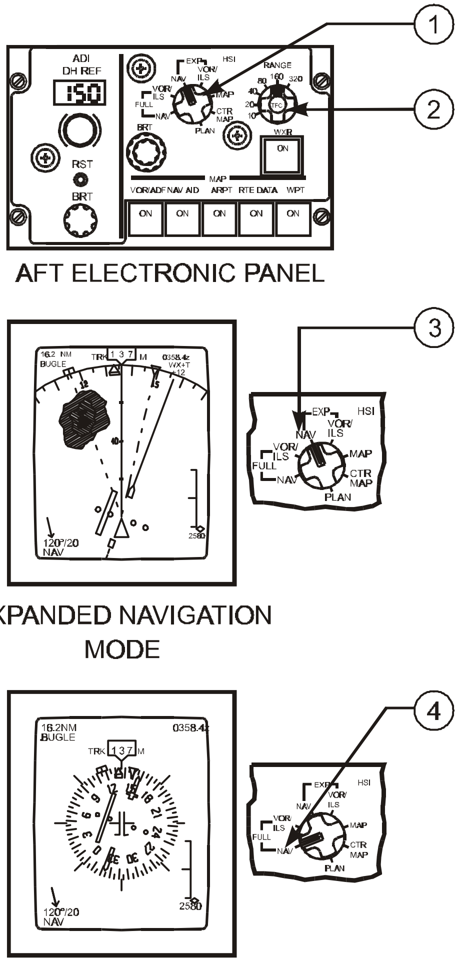
The autopilot will use data only from a single IRU source when the EFI transfer switch is in either the BOTH ON 1 or BOTH ON 2 positions.

The IRS transfer switch selects the IRS that supplies inputs to the respective SG as well as to other airplane systems. With the IRS transfer switch in the NORMAL position, the left IRS provides inputs to the No. 1 SG and the right IRS provides inputs to the No. 2 SG. If the IRS transfer switch is positioned to BOTH ON L, the left IRS provides data to both SGs. If the IRS transfer switch is positioned to BOTH ON R, the right IRS provides data to both SGs.

Light Sensing and Brightness Control

There are two sets of ambient light sensors that automatically adjust the brightness of the EADI and EHSI displays. The Captain's and F/O's displays are independently adjusted. Two remote light sensors, located on the instrument glare shield, adjust brightness of the associated EADI and EHSI as a function of light coming through the forward windows. Two integral light sensors, located in the EADI and EHSI instrument bezels (one per display unit), work in parallel to adjust the brightness of the EADI and EHSI displays as a function of ambient light shining on the face of either display. Manual adjustment of the display brightness, above and below the brightness level set by the automatic system, is accomplished by adjusting the brightness controls on the associated EFIS control panel.

3 5 EHSI MODE SELECTION AND DISPLAYS



AFT ELECTRONIC PANEL

EXPANDED NAVIGATION MODE

FULL NAVIGATION MODE

7376-10036

① EHSI Mode Selector

General – Selects the type of data and symbols displayed on the EHSI.

② Traffic Switch (momentary action)

PUSH – If **TFC** not displayed on EHSI, displays a TCAS information on EHSI.

- If **TFC** displayed on EHSI, removes TCAS information from EHSI.
- With **TCAS FAIL** displayed on EHSI, removes **TCAS FAIL** message.

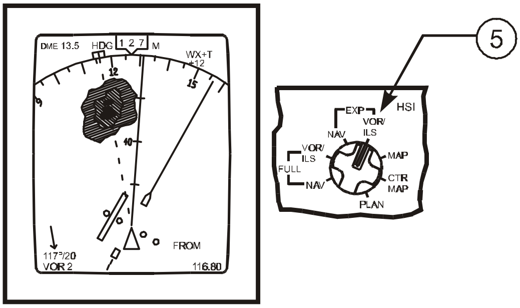
③ **EXP NAV** – Displays lateral and vertical navigation guidance information similar to a conventional HSI bus is oriented to aircraft track. The FMC is the primary source of the guidance data.

- Weather radar return data and range arcs are displayed when the WXR switch is ON.

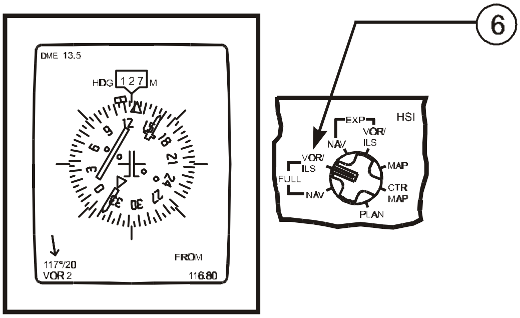
④ FULL NAV – Displays same data as expanded navigation mode with the following exceptions:

- Weather radar displays are not available.
- A full compass rose is shown in place of the expanded compass rose.
- Alternate symbols are used for aircraft symbol and course pointer.

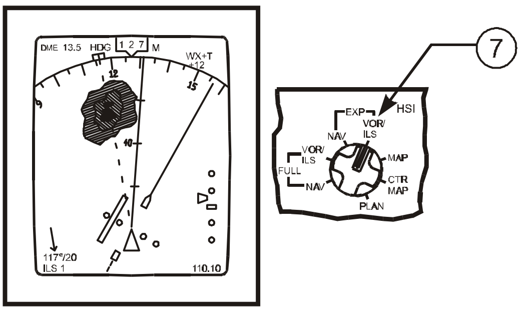
For symbol description on the displays refer to 789 Navigation Displays within this section.



EXPANDED VOR MODE



FULL ROSE VOR MODE



EXPANDED ILS MODE

7376-10037

⑤ EXP VOR/ILS – With a VOR frequency selected, displays VOR navigation data oriented to the aircraft heading.

- Displays the source of navigation data as VOR 1 or VOR 2 in the lower left corner of the EHSI.
- Displays **TO/FROM** annunciation and the navigation source frequency in the lower right corner of the EHSI.
- Weather Radar return data is displayed when the WXR switch is ON.

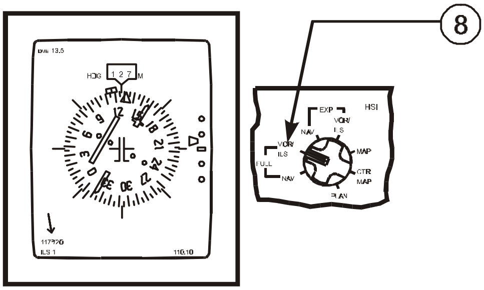
⑥ FULL VOR/ILS – With a VOR frequency selected, displays the same data as the expanded VOR mode with the following exceptions:

- Weather radar displays are not available.
- A full compass rose is shown in place of the expanded compass rose.
- Drift angle pointer replaces the track line.
- TO/FROM pointer is shown in addition to the **TO/FROM** annunciation.
- Alternate symbols are used for aircraft symbol and course pointer.

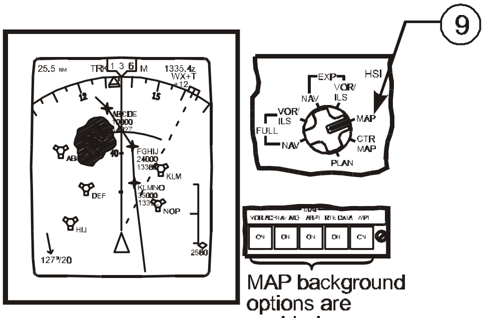
⑦ EXP VOR/ILS – With an ILS LOC frequency selected, displays ILS navigation data oriented to the aircraft heading.

- Displays the source of navigation data as ILS 1 or ILS 2 in the lower left corner of the EHSI.
- Displays the navigation source frequency in the lower right corner of the EHSI.
- Weather radar return data is displayed when the WXR switch is ON.

For symbol description on the displays refer to 7 8 9 Navigation Displays within this section.

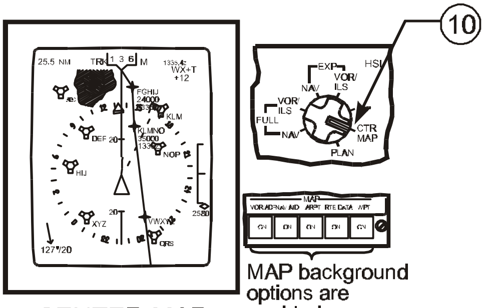


FULL ROSE ILS MODE



MAP background options are enabled.

MAP MODE



MAP background options are enabled.

CENTER MAP MODE

7376-10038

⑧ FULL VOR/ILS – With an ILS LOC frequency selected, displays the same data as the expanded ILS mode with the following exceptions:

- Weather radar displays are not available.
- Full compass rose is shown in place of expanded compass rose.
- Drift angle pointer replaces track line.
- Alternate symbols are used for aircraft symbol and course pointer.

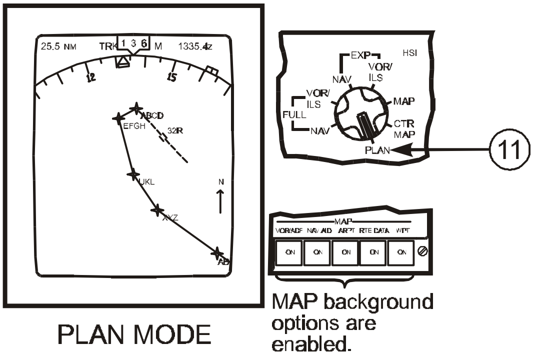
⑨ MAP – Displays plan view of flight progress. Displays a fixed aircraft symbol superimposed on a moving map background. The basic map background data includes origin / destination airports, flight plan route, and display of navaids in use. Optional background data includes off-route navigation aids, airports and named waypoints; tuned VOR/ADF relative bearing radials; and flight plan route waypoint ETAs and altitude constraints.

- Weather radar return data is displayed when the WXR switch is ON.

⑩ CTR MAP – Displays the same data and symbols as the MAP mode, with the following exceptions:

- Aircraft symbol is positioned at the center of the map area so that map information behind the aircraft is in view.
- Full compass rose is shown in place of the expanded compass rose.
- Range numerics correspond to ¼ the selected range.

For symbol description on the displays refer to 7 8 9 Navigation Displays within this section.



PLAN MODE

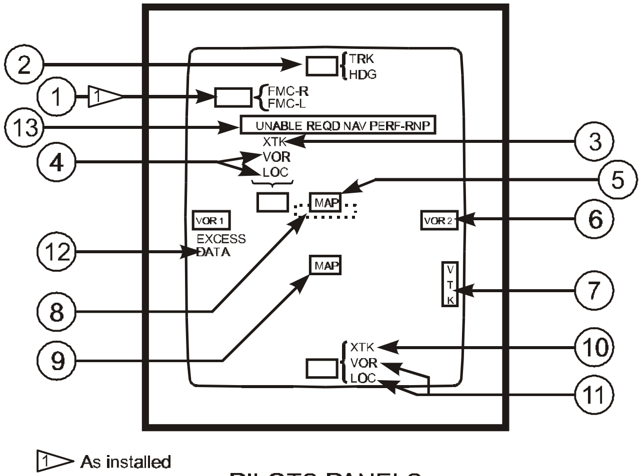
7376-10039

(11) PLAN – Displays a static map, which is oriented to true north. The top portion of the EHSI remains the same as in the MAP mode.

- Allows the pilot to review the planned route by using the FMC/CDU LEGS page CENTER STEP line select key.
- Weather radar display data is inhibited.

For symbol description on the displays refer to (7)(8)(9) Navigation Displays within this section.

3 5 EHSI SYSTEM FAILURE FLAGS AND ANNUNCIATIONS



PILOTS PANELS

7376-10040

① Source Select Annunciation

Displayed on the offside EHSI to indicate the FMC source select switch is not in the NORMAL position (single FMC operation). (Displayed here if the MAP or CTR MAP mode is selected.)

② Track or Heading Flag

Track or heading data has failed.

③ Crosstrack Deviation Flag

Indicates failure of he FMC crosstrack deviation data. (Displayed here if the FULL NAV mode is selected.)

④ VOR, LOC Flag

Indicates failure of the EHSI VOR or LOC display. (Displayed here if the FULL VOR/ILS mode is selected.)

⑤ MAP Flag

Indicates failure of associated FMC generated map display. (Displayed here if CTR MAP mode is selected.)

⑥ VOR Flag

Indicates failure of a VOR display on the EHSI. (Displayed here if the MAP or CTR MAP mode is selected and the VOR/ADF map switch is ON.)

⑦ Vertical Track Flag (typical location)

Indicates failure of the FMC vertical track data.

⑧ Symbol Generator Fail Annunciation

SG FAIL – Indicates failure of the symbol generator.

⑨ MAP Flag

(Displayed here if MAP mode is selected.)

⑩ Crosstrack Deviation Flag

(Displayed here if the EXP NAV mode is selected.)

⑪ VOR, LOC Flag

(Displayed here if the EXP VOR/ILS mode is selected.)

⑫ **EXCESS DATA** Annunciation

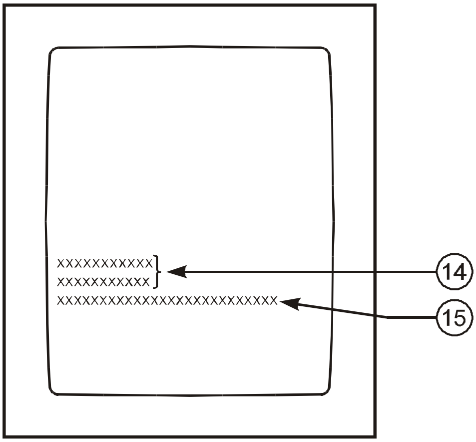
Refresh rate of MAP display has dropped below limit.

Display may flicker at lower refresh rates.

⑬ NAV Advisory Message

UNABLE REQD NAV PERF-RNP – Indicates that FMC actual navigation performance is not sufficient for the current special RNP. (Displayed here if the MAP or CTR MAP mode is selected.)

Note: All flags and annunciations are shown in yellow color.



PILOTS PANELS

7376-10041

(14) **WXR** Annunciations (left justified, two lines)

WXR FAIL – Indicates weather radar has failed (no weather data displayed).

WXR WEAK – Indicates weather radar calibration fault.

WXR ATT – Indicates loss of attitude stabilization for antenna.

WXR STAB – Indicates antenna stabilization if off.

WXR DSPY – Indicates loss of display unit cooling or an overheat condition of the HSI weather radar display is blanked.

(15) Range Disagreement Annunciations:

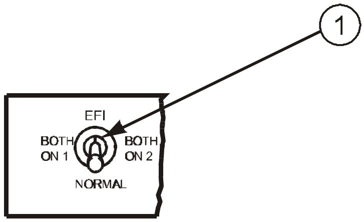
MAP/WXR RANGE DISAGREE - Indicates selected range on the EFIS control panel is different than the **MAP** and WXR display range.

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the **MAP** display range.

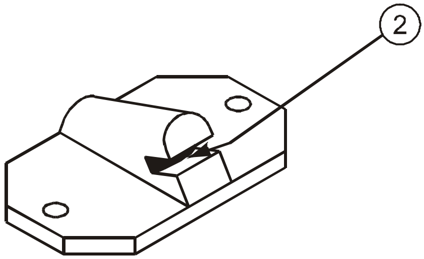
WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the **WXR** display range.

Note: All flags and annunciations are shown in yellow color.

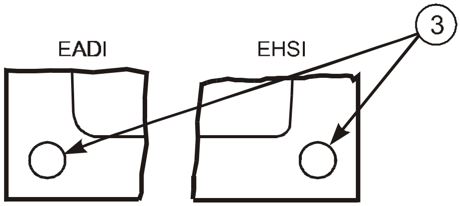
3 5 EFI TRANSFER SWITCH AND EFIS LIGHT SENSORS



FORWARD OVERHEAD PANEL



INSTRUMENT GLARE SHIELD (2)



CAPT INSTRUMENT PANEL
F/O INSTRUMENT PANEL

37376-10042

① Electronic Flight Instrument (EFI) Transfer Switch

Provides a means of manually switching to the operating symbol generator should one of the symbol generators fail or to restore one or more inoperative displays.

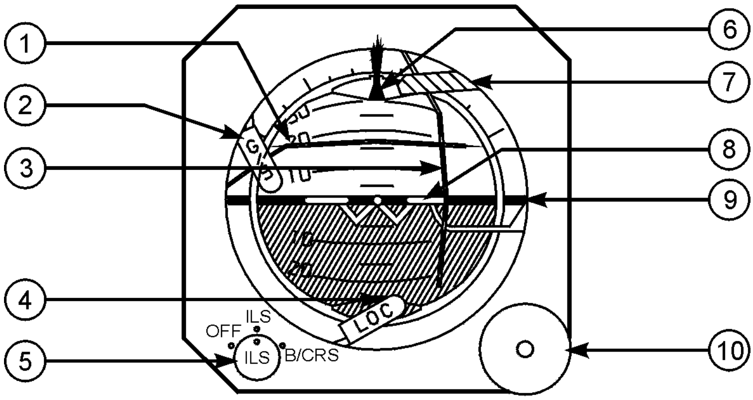
② Remote Light Sensor

Provides automatic adjustment of EADI and EHSI display brightness as a function of ambient light coming through the associate forward window.

③ Integral Light Sensors

Provide automatic control of EADI and EHSI display brightness as function of ambient light striking the face of the display units.

③⑤ STANDBY HORIZON INDICATOR



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① Glide Slope Pointer And Deviation Scale

- Pointer indicates glide slope position.
- Pointer not displayed when ILS selector is OFF or no command data exists.
- Scale indicates deviation.

② Glide Slope Flag

- Glide slope receiver has failed.

③ Localizer Pointer And Deviation Scale

- Pointer indicates localizer position.
- Pointer not displayed when ILS selector is OFF or no computed data exists.
- Scale indicates deviation.
- Expanded localizer scale not available.

④ Localizer Flag

- No. 1 localizer receiver has failed.

⑤ ILS Selector

- OFF – Pointers and failure flags retracted from view.
- ILS – Pointers indicate position by localizer and glide slope signals from the No. 1 ILS receiver.
- B/CRS – Reversers sensing for localizer pointer signal from the No. 1 ILS receiver.
  - Used during back course approach.

⑥ Bank Indicator And Scale

⑦ Gyro Flag

- Attitude is unreliable.

⑧ Aircraft Symbol

⑨ Horizon Line And Pitch Angle Scale

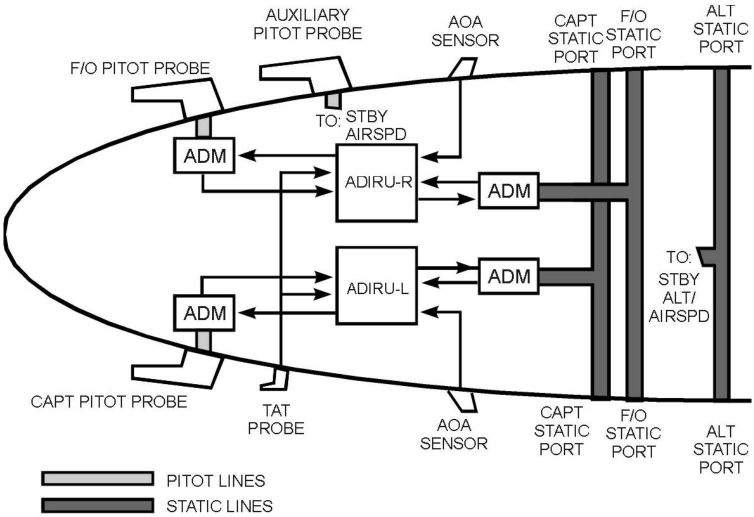
⑩ Caging Control

- PULL – Levels horizon with aircraft symbol.
- RELEASE – Control retracts.

The ADIRS produces flight data such as position, speed, altitude and attitude for the flight displays, flight management computers, flight controls, engine controls and all other systems requiring inertial and air data.

The major components of the ADIRS are:

- Two air data inertial reference units (ADIRUs)
- Four air data modules
- One inertial system display unit (ISDU)
- One dual mode select unit (MSU)
- Six static ports
- Three pitot probes
- Two angle-of-attack sensors
- One total air temperature probe



The ADIRUs provide inertial position and track data to the FMC as well as attitude, altitude, and airspeed data to the displays. The ADIRUs process information measured by internal gyros and accelerometers, and from air data module inputs, the angle-of-attack sensors, and other systems.

7 8 9 AIR DATA INERTIAL REFERENCE SYSTEM (ADIRS)

Air Data

The pitot static system is comprised of three separate pitot probes and six flush static ports. Two pitot probes and four static ports interface with the air data modules. The remaining auxiliary pitot probe and alternate static ports provide pitot and static pressure to the standby instruments. The auxiliary pitot probe is located on the First Officer's side of the aircraft.

The air data modules convert pneumatic pressure to electrical signals and send these data to the ADIRUs. Each pitot air data module is connected to its on-side pitot probe; there is no cross connection. The air data module connected to the Captain's pitot probe sends information to the left ADIRU, while the air data module connected to the First Officer's pitot probe sends information to the right ADIRU. The remaining air data modules are located at the balance centers of the Captain' and First Officer's static ports. The air data module connected to the Captain's static ports sends information to the left ADIRU, while the air data module connected to the First Officer's static ports sends information to the right ADIRU.

Angle-of-Attack

There are two angle-of-attack sensors, one located on each side of the forward fuselage. The vanes measure aircraft angle-of-attack relative to the air mass.

Total Air Temperature

A total air temperature probed is mounted outside the aircraft to sense air mass temperature. The temperature sensed by the probe is used by the ADIRUs to compute total air temperature.

Static Air Temperature

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADIRUs, using total air temperature probed information.

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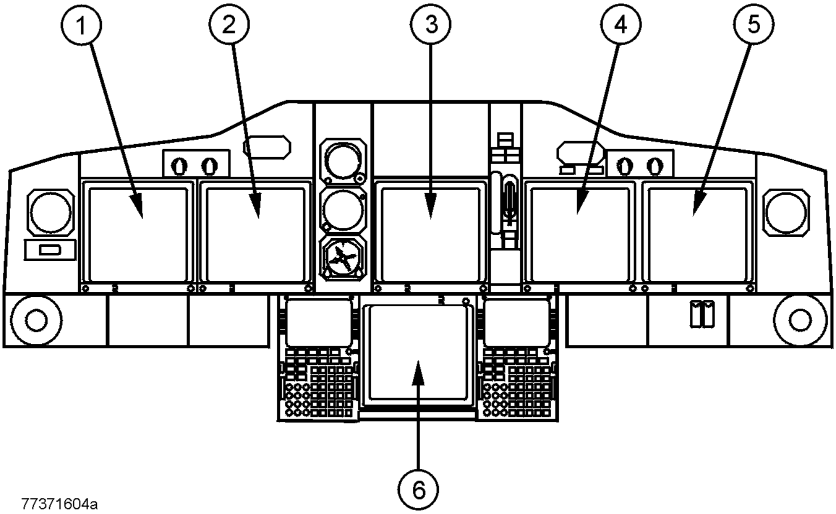
7 8 9 CONTROLS AND INDICATORS – EFIS / MAP

DISPLAY UNITS



LEFT, CENTER AND RIGHT FORWARD PANELS

① Captain Outboard Display Unit

② Captain Inboard Display Unit

③ Upper Display Unit

④ First Officer Inboard Display Unit

⑤ First Officer Outboard Display Unit

⑥ Lower Display Unit

EFIS CONTROL PANELS

The EFIS control panels display options, mode, and range for the related pilot's displays. Refer to this section for detailed information.

If an EFIS control panel fails, the displays can be controlled by the remaining control panel.

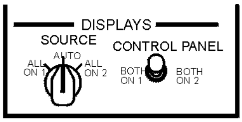
DISPLAY SELECT PANEL

The display select panel controls the displays on the inboard, outboard, and lower DUs. Normal operation is all selectors in the NORMAL position. The pilots' outboard and inboard DUs display primary flight and navigation data and the upper DU displays engine and systems data.

If a DU fails, automatic display switching ensures critical information remains available to the pilots at all times. If the system detects an operational failure on an outboard DU, the compact EFIS format automatically moves to the inboard DU and the failed outboard DU blanks. If the system detects a failure on an inboard DU, the compact EFIS format automatically moves to the outboard DU and the failed inboard DU blanks. If the upper DU fails, the engine display automatically moves to the lower DU.

Manual control of display formats is provided for undetected failures. The outboard rotary switch on the display select panel controls the formats displayed on either the outboard or inboard DUs. The inboard rotary switch controls the display format shown on the lower DU.

7 8 9 NORMAL DISPLAY CONFIGURATION



7376-10043

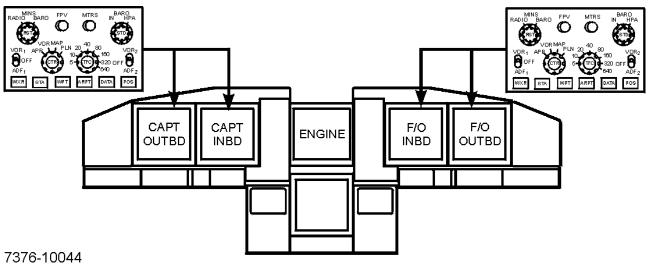
Display Source Panel

The display SOURCE select switch is in AUTO and the CONTROL PANEL select switch is in NORMAL.

The SOURCE switch controls the selection of a DEU display electronics unit and the CONTROL PANEL switch controls selection of the EFIS control panels.

EFIS Control Panel

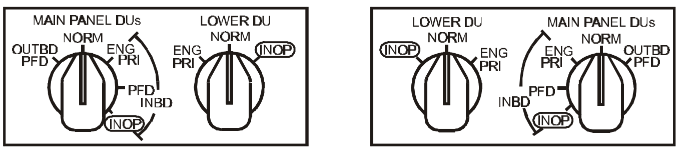
The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display unit.



7376-10044

Display Units

The pilot's outboard and inboard DUs show the normal EFIS / MAP displays.

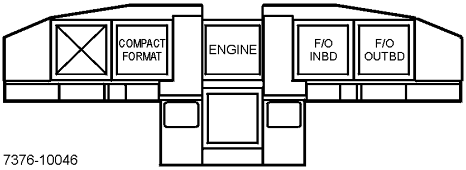


7376-10045

Display Select Panel

All selectors are in NORMAL.

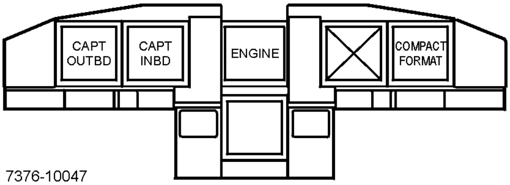
7 8 9 DISPLAY UNIT FAILURE AUTOMATIC SWITCHING



7376-10046

Outboard Display Unit Fails

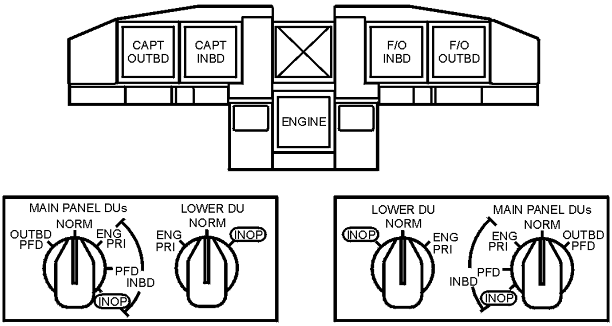
If an outboard display unit fails, the compact EFIS format is automatically displayed on the inboard display unit and the outboard display unit blanks.



7376-10047

Inboard Display Unit Fails

If an inboard display unit fails, the compact EFIS format is automatically displayed on the outboard display unit and the inboard display unit blanks.

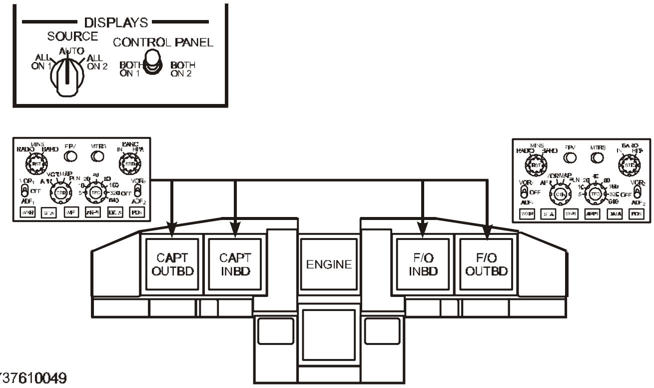


7376-10048

Upper Display Unit Fails

If an upper display unit fails, the engine display automatically moves to the lower display unit and the upper display unit blanks.

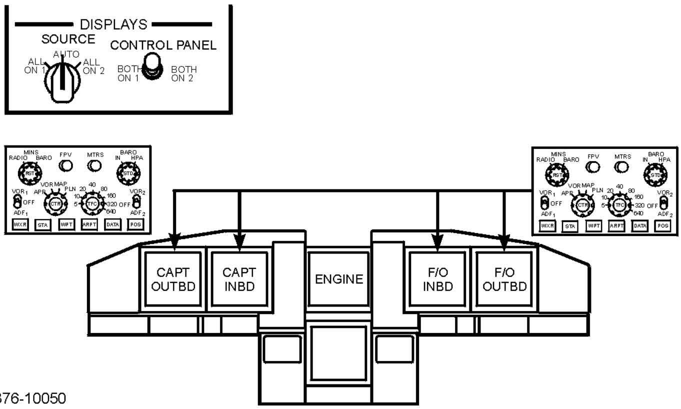
7 8 9 EFIS CONTROL PANEL



737610049

Control Panel Select Switch Both On 1

The left EFIS control panel controls both pilots' outboard and inboard display units.

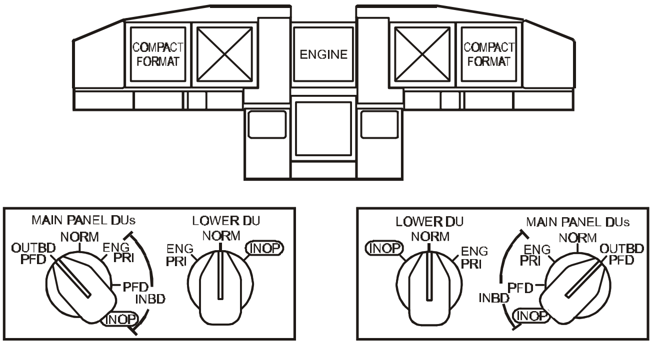


7376-10050

Control Panel Select Switch Both On 2

The right EFIS control panel controls both pilots' outboard and inboard display units.

7 8 9 OUTBOARD DISPLAY SWITCHING

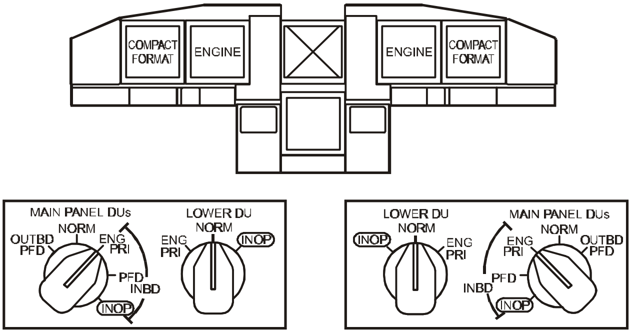


7376-10051

Main Panel DUs Switch To Outbd PFD

If the MAIN PANEL DUs switch is turned to Outboard Primary Flight Display (OUTBD PFD), the compact EFIS format is displayed on the outboard display unit and the inboard display unit blanks.

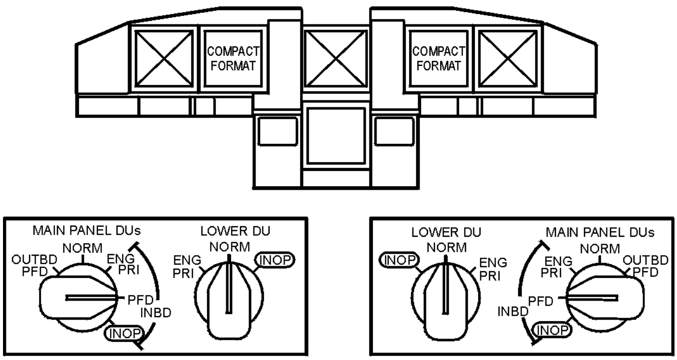
7 8 9 INBOARD DISPLAY SWITCHING



7376-10052

Main Panel DUs Switch To Inbd PRI

If the MAIN PANEL DUs switch is turned to INBD ENG PRI, the engine display moves to the inboard DU, the compact EFIS format is displayed on the outboard DU and the upper DU blanks.

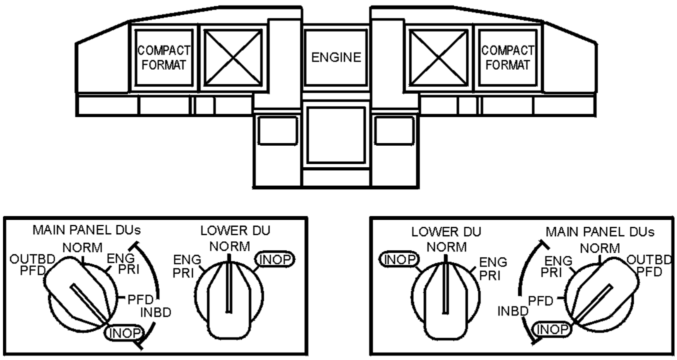


7376-10053

Main Panel DUs Switch To Inbd PFD

If the MAIN PANEL DUs switch is turned to INBD PFD, the engine compact EFIS format is displayed on the inboard DU and the outboard DU blanks.

7 8 9 INBOARD DISPLAY SWITCHING

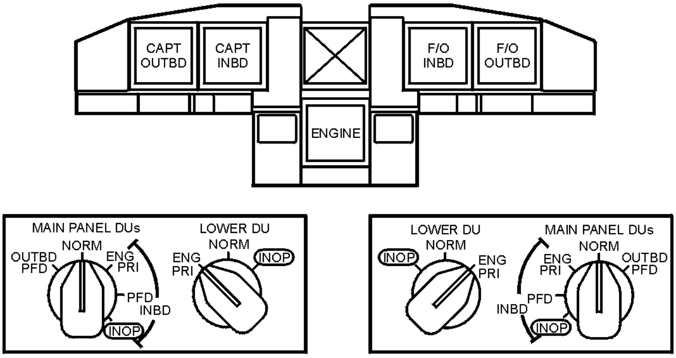


7376-10054

Main Panel DUs Switch To INOP

If the MAIN PANEL DUs switch is turned to INBD INOP, the compact EFIS format is displayed on the outboard DU and the inboard DU blanks.

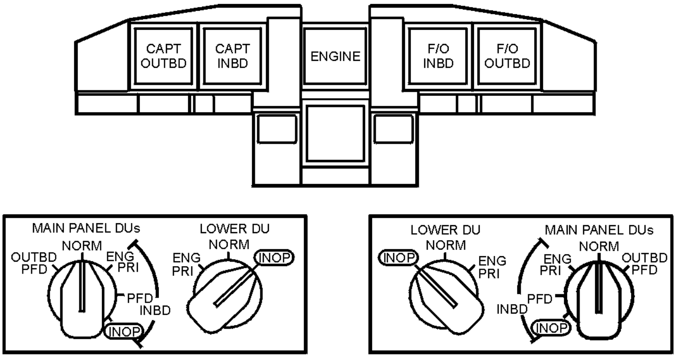
7 8 9 LOWER DISPLAY SWITCHING



77371611

Lower DU Switch To ENG PRI

If the LOWER DU switch is turned to ENG PRI, the engine display moves to the lower DU and the upper DU blanks.

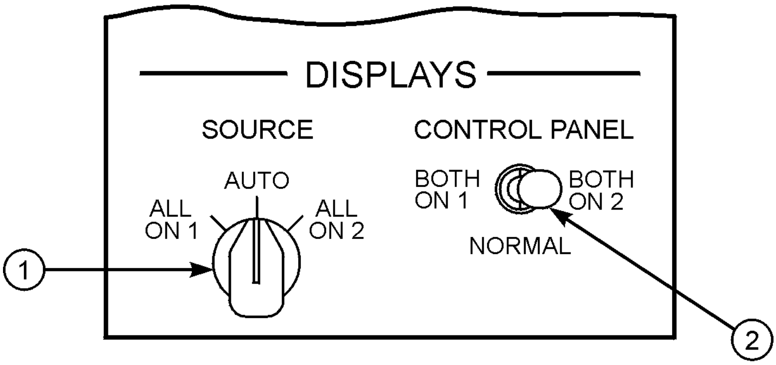


7376-10056

Lower DU Switch To INOP

If the LOWER DU switch is turned to INOP, the engine display is shown on the upper DU and the lower DU blanks.

7 8 9 INSTRUMENT SOURCE SELECT SWITCHES



FORWARD OVERHEAD PANEL

7376-10057

① Display Source Select Switch

AUTO – DEU 1 controls the Captain outboard Captain inboard, and the upper display units; DEU 2 controls the First Officer outboard, First Officer inboard, and lower display units.

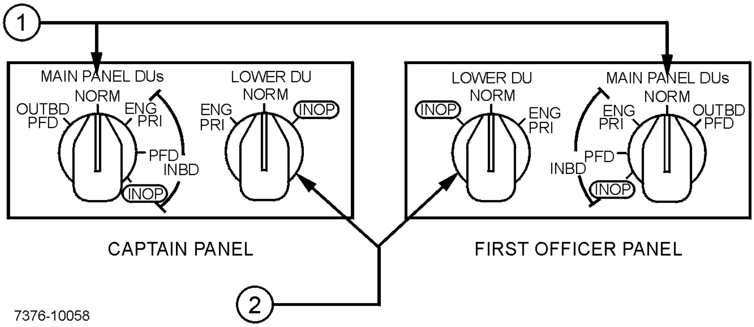
ALL ON 1 / ALL ON 2 – Provides a means of manually switching to a single DEU as the source of information for all six display units.

② Control Panel Select Switch

NORMAL – The left EFIS control panel controls the Captain's displays and the right EFIS control panel controls the First Officer's displays.

BOTH ON 1 / BOTH ON 2 – Provides a means of manually switching control of the Captain's and First Officer's displays to a single EFIS control panel.

7 8 9 DISPLAY SELECT PANELS



① MAIN PANEL DUs Selector

Selects what is displayed on the respective outboard and inboard display units:

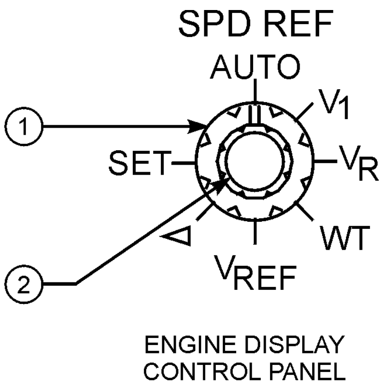
- Outboard Primary Flight Display (OUTBD PFD) – Displays the compact EFIS format on the outboard display unit and blanks the inboard display unit.
- Normal (NORM) – Displays normal EFIS and MAP displays on the outboard and inboard display unit; provides automatic display switching if a display unit fails.
- Inboard Engine Primary (INBD ENG PRI) – Displays the engine and systems display on the inboard display unit and the compact EFIS format on the outboard display unit.
- Inboard Primary Flight Display (INBD PFD) – Displays the compact EFIS format on the inboard display unit and blanks the outboard display unit.

② LOWER DU Selector

Select what is displayed on the lower display unit.

- Engine Primary (ENG PRI) – Displays the engine and systems display on the lower display unit and blanks the upper display unit.
- Normal (NORM) – Displays the normal engine and system displays on the upper display unit and no display on the lower display unit; provides automatic display switching to the lower display unit if the upper display unit fails.

7 8 9 SPEED REFERENCE SELECTOR



7376-10059

① Speed Reference Selector (Outer)

Sets the reference airspeed bugs on the Mach / Airspeed indicator:

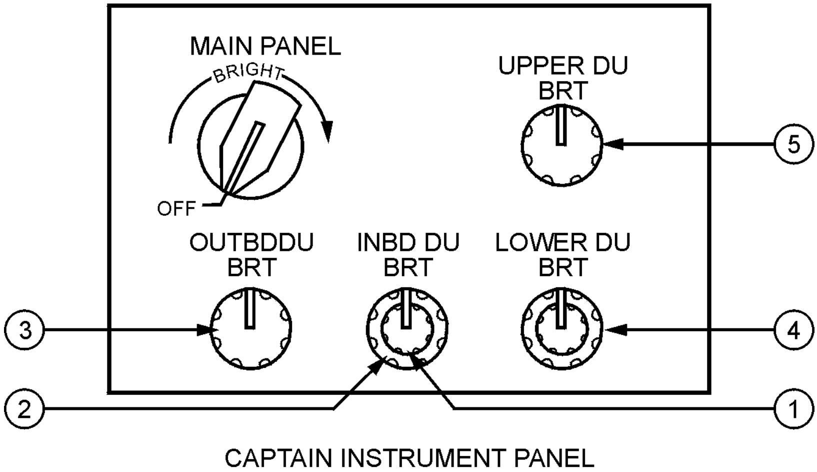
- AUTO – The reference airspeeds and gross weight are provided automatically through the FMC.
- V1 – Used to manually set decision speed on the ground; in flight, displays **V1 INVALID ENTRY**.
- VR – Used to manually set rotation speed on the ground; in flight, displays **VR INVALID ENTRY**.
- WT – Allows manual entry of reference gross weight.
- VREF – Used to manually set the landing reference speed in flight; on the ground, displays **VREF INVALID ENTRY**.
- Bug 5 – Used to manually set the white bug 5 to the desired value.
- SET – Removes the text above the Mach / Airspeed indicator.

② Speed Reference Selector (Inner) (Two Speed Slew)

ROTATE -

- Manually sets the appropriate reference airspeed or gross weight.
- The digital display appears above the Mach / Airspeed Indicator.

7 8 9 CAPTAIN BRIGHTNESS CONTROLS



7376-10060

① Inboard DU Weather Radar Brightness Control (inner) (rotary)

ROTATE – Adjusts weather radar display brightness on the Captain inboard display unit.

② Inboard DU Brightness Control (outer) (rotary)

ROTATE – Adjusts the brightness of the Captain inboard display unit.

③ Outboard DU Brightness Control (rotary)

ROTATE – Adjusts the brightness of the Captain outboard display unit.

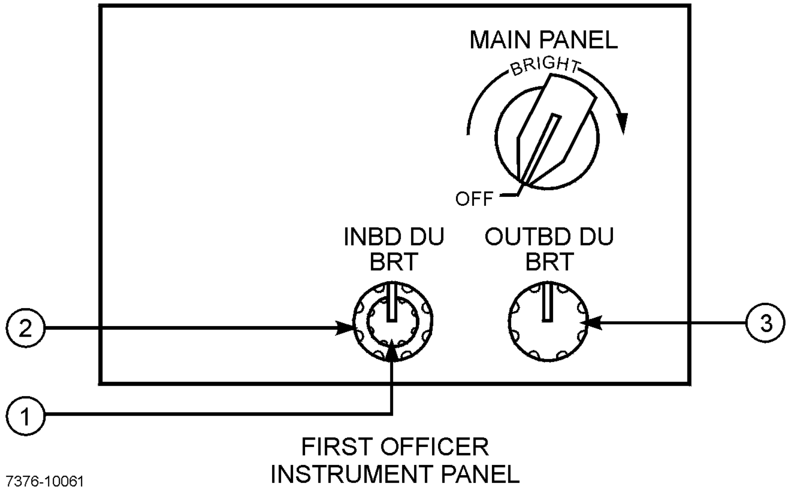
④ Lower DU Brightness Control (outer) (rotary)

ROTATE – Adjusts the brightness of the lower display unit.

⑤ Upper DU Brightness Control (rotary)

ROTATE – Adjusts the brightness of the upper display unit.

7 8 9 FIRST OFFICER BRIGHTNESS CONTROLS



① Inboard DU Weather Radar Brightness Control (inner) (rotary)

ROTATE – Adjusts weather radar display brightness on the First Officer inboard display unit.

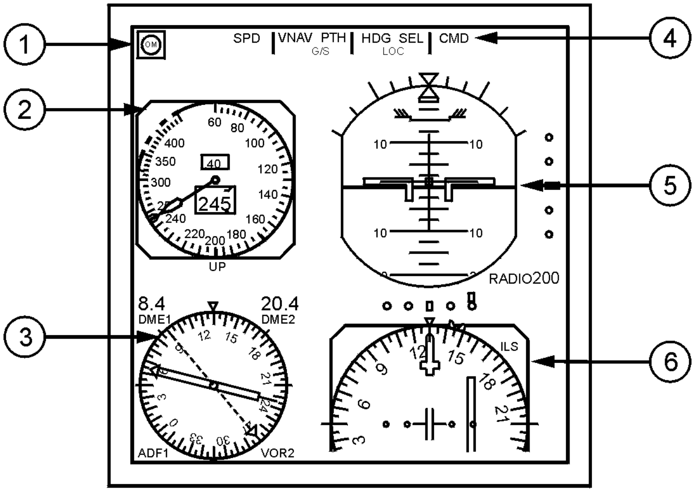
② Inboard DU Brightness Control (outer) (rotary)

ROTATE – Adjusts the brightness of the First Officer inboard display unit.

③ Outboard DU Brightness Control (rotary)

ROTATE – Adjusts the brightness of the First Officer outboard display unit.

CAPTAIN OUTBOARD DISPLAY



LEFT FORWARD PANEL

77371617a

① Marker Beacon

② Mach / Airspeed Indicator

③ Radio Distance Magnetic Indicator

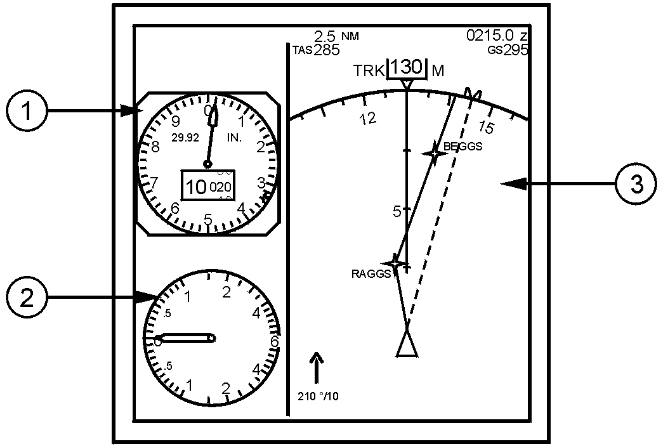
④ Flight Mode Annunciations

- Refer to Section 6.4, Automatic Flight.

⑤ Attitude Indicator

⑥ Horizontal Situation Indicator

CAPTAIN INBOARD DISPLAY



LEFT FORWARD PANEL

77371618b

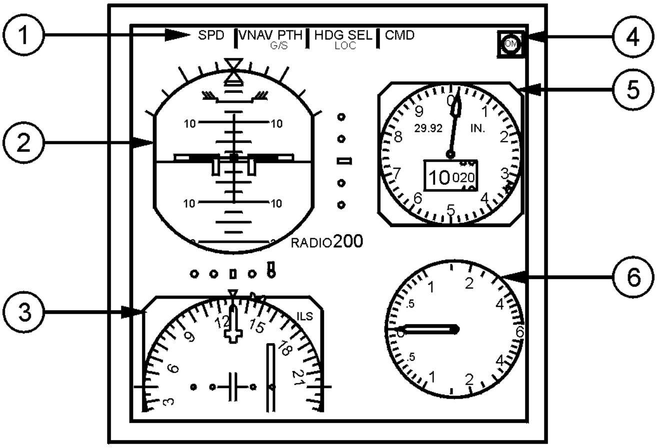
① Altimeter

② Vertical Speed Indicator

③ Navigation Display

- Displays approach, VOR, moving map, or static map as selected on the EFIS control panel.

FIRST OFFICER OUTBOARD DISPLAY



RIGHT FORWARD PANEL

77371619a

① Flight Mode Annunciations

- Refer to Section 6.4, Automatic Flight.

② Attitude Indicator

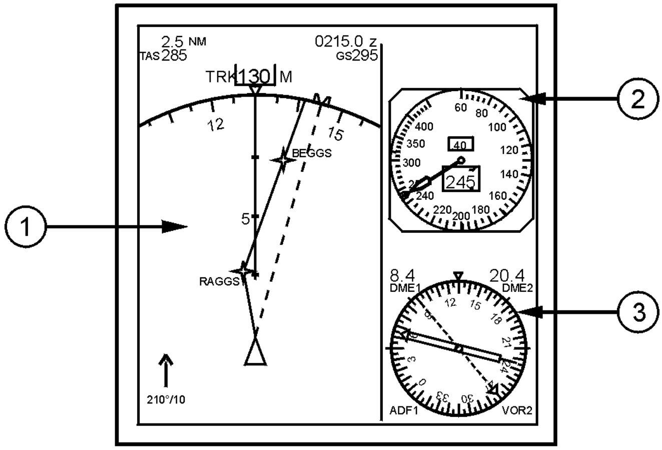
③ Horizontal Situation Indicator

④ Marker Beacon

⑤ Altimeter

⑥ Vertical Speed Indicator

FIRST OFFICER INBOARD DISPLAY



RIGHT FORWARD PANEL

77371620a

① Navigation Display

- Displays approach, VOR, moving map, or static map as selected on the EFIS control panel.

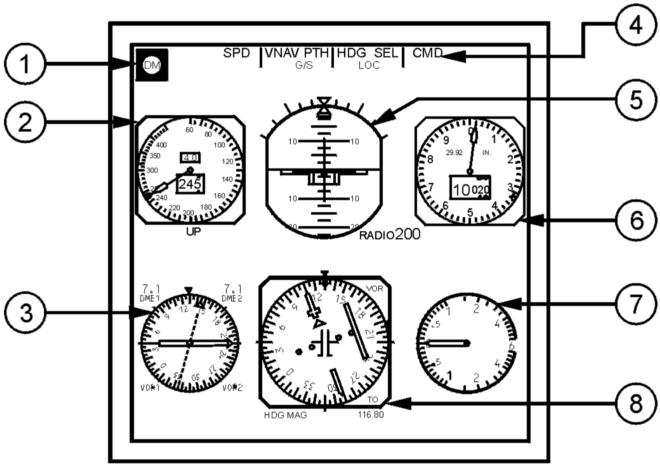
② Mach / Airspeed Indicator

③ Radio Distance Magnetic Indicator

COMPACT EFIS FORMAT

The compact EFIS format is displayed automatically upon failure of either an inboard or an outboard display unit. The compact format can also be selected manually with the MAIN PANEL DUs selectors on the display select panel.

In the compact format, a full rose HSI is displayed. Other displays are about 25% smaller than normal.



LEFT AND RIGHT FORWARD PANELS

77371621a

① Marker Beacon

② Mach / Airspeed Indicator

③ Radio Distance Magnetic Indicator

④ Flight Mode Annunciations

⑤ Attitude Indicator

⑥ Altimeter

⑦ Vertical Speed Indicator

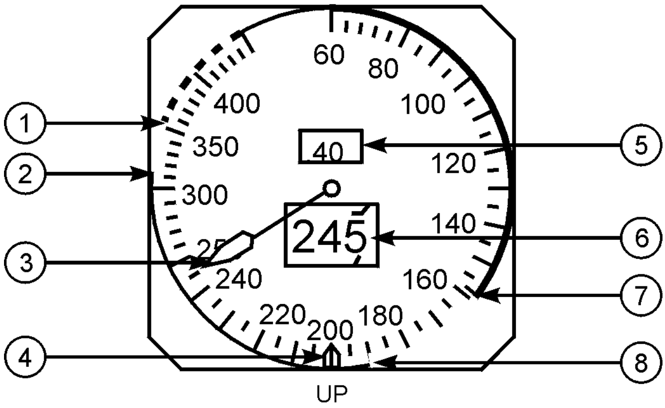
⑧ Horizontal Situation Indicator

INTENTIONALLY LEFT BLANK

7 8 9 ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS) – MACH / AIRSPEED INDICATOR (MASI)

MACH / AIRSPEED INDICATOR – GENERAL

The mach / airspeed indicator displays air data inertial reference system (ADIRS) airspeed and other airspeed related information.



77371622a

① Maximum Operating Speed (red and white)

Start of the arc indicates the maximum speed as limited by the lowest of the following:

- Vmo/Mmo
- Landing gear placard speed
- Flap placard speed.

② High Speed Buffet / Flap Extension Speed (amber)

At high altitudes and flaps up, the start of the arc indicates the airspeed that provides a 0.3 g maneuver margin to high speed buffet.

When flaps are not up, the start of the arc indicates flap extension placard speed for the next normal flap setting. The arc is removed when the flap handle is moved to the landing flap selected on the APPROACH REF page or when the flap lever has been moved to flaps 30 or 40.

③ Airspeed Pointer (white)

Indicates current calibrated airspeed in knots.

④ Airspeed Cursor (magenta)

Displays target airspeed:

- Indicates the airspeed manually selected in the IAS / MACH window.
- Indicates the FMC computed airspeed when the IAS / MACH window is blank.

⑤ Mach Digital Counter (white)

Indicates current Mach number:

- Displays when airspeed increases above 0.40 Mach.
- Blanks when airspeed decreases below 0.38 Mach.

⑥ Airspeed Digital Counter (white)

Indicates current calibrated airspeed in knots.

⑦ Stick Shaker Speed (red)

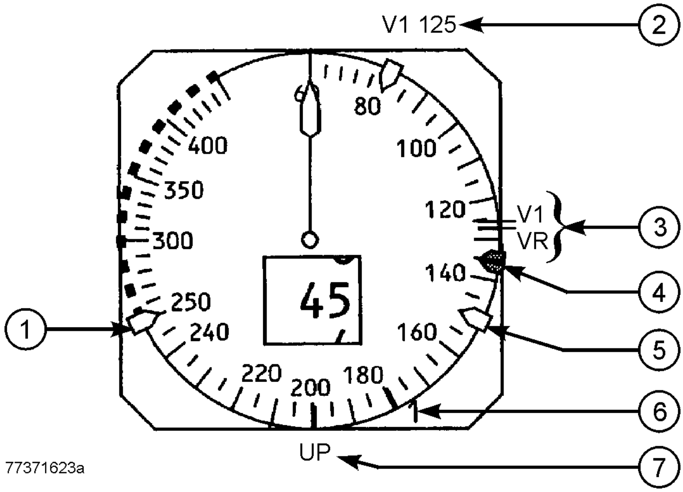
Red index mark indicates the speed at which stick shaker occurs.

⑧ Minimum Maneuver Speed (amber)

Amber index mark indicates minimum maneuver speed.

Inhibited on takeoff until first flap retraction or valid V_{REF} entered.

MACH / AIRSPEED INDICATOR – TAKEOFF



① Bug 5 (white)

Displayed if the speed reference selector on the engine display control panel is in the bug 5 position and a value greater than 60 knots has been selected. Not available if the speed reference selector is in the AUTO position.

② Speed Reference Display (green)

Displayed if the airspeed and/or weight is entered via the speed reference selector on the engine display control panel:

- On the ground, V_1, V_R, and takeoff gross weight may be selected; if V_{REF} is selected, **INVALID ENTRY** is displayed.
- In flight, V_{REF} and landing gross weight may be selected; if V_1 or V_R is selected, **INVALID ENTRY** is displayed
- Removed when the speed reference selector is moved to the SET position.

③ Takeoff Reference Speeds (green)

Indicates V_1 (decision speed) and V_R (rotation speed) as selected on the CDU TAKEOFF REF page or as set with the speed reference selector on the engine display control panel:

- Amber **NO VSPD** flag is displayed on the ground if V_1 or V_R is not selected on the CDU or is not set with the speed reference selector.
- Displayed for takeoff when speed is greater than 80 knots.
- Removed at lift-off.

④ Airspeed Cursor (magenta)

Set with the speed selector on the mode control panel.

⑤ V_2+15 (white)

Displayed for takeoff.

Removed when either of the following occurs:

- At first flap retraction
- When V_{REF} is entered.

⑥ Flap Maneuvering Speed (green)

Indicates flap maneuvering speed for the displayed flap position:

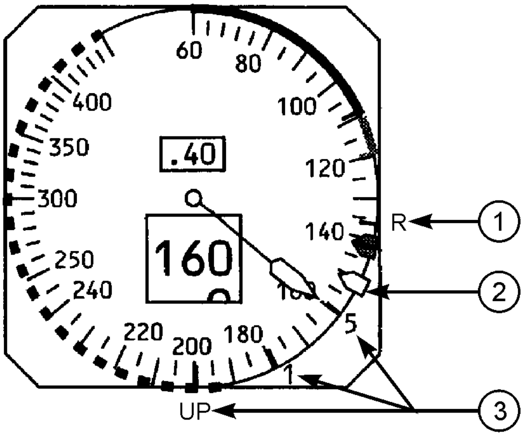
- When the V_2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed except for a flaps 1 takeoff
- Flap bugs inhibited if less than V_{REF} +4.

⑦ Flaps Up Airspeed (green)

Displayed after zero fuel weight is entered in the CDU and takeoff gross weight is calculated, or after takeoff gross weight is set with the speed reference selector.

Not displayed above approximately 20,000 feet altitude.

MACH / AIRSPEED INDICATOR – APPROACH



77371624a

① Landing Reference Speed (green)

Indicates V_{REF} (reference speed) as selected on the CDU APPROACH REF page (refer to Section 6.11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel.

② V_{REF}+15

Displayed after selection of V_{REF}.

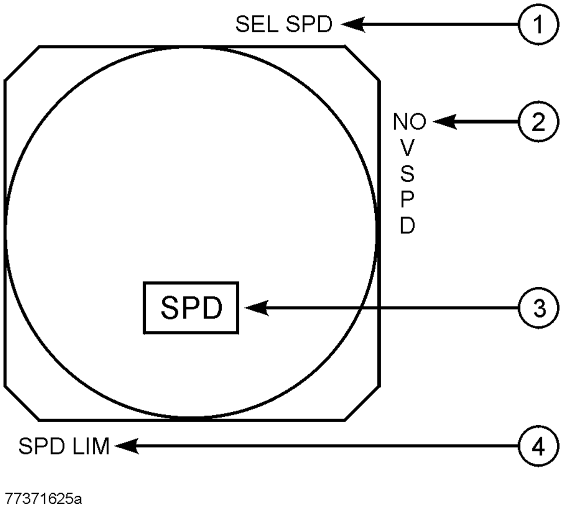
③ Flap Maneuvering Speeds (green)

Indicate flap maneuvering speeds for the displayed flap position:

- Not shown if less than or equal to V_{REF}+4
- Numbered flap maneuvering speed bugs are removed when the flap lever is moved to flaps 30 or 40.

MACH / AIRSPEED INDICATOR FAILURE FLAGS

The flag replaces the appropriate display to indicate source system failure or lack of computed information.



① Selected Speed Flag (amber)

The airspeed cursor is inoperative. The airspeed cursor is removed.

② No **VSPD** Flag (amber)

V_1 (decision speed) or V_R (rotation speed) has not been entered or is invalid.

③ Speed Flag (amber)

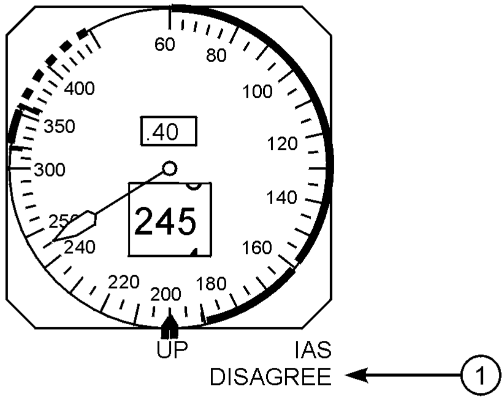
The Mach / airspeed indicator is inoperative. All indicator markings are removed.

④ Speed Limit Flag (amber)

Displays related with stick shaker or maximum operating speed has failed:

- If the stick shaker warning has failed, the red stick shaker speed arc is removed
- If the maximum operating speed has failed, the red and white maximum operating speed arc is removed.

MACH / AIRSPEED INDICATOR – IAS DISAGREE ALERT



773716165

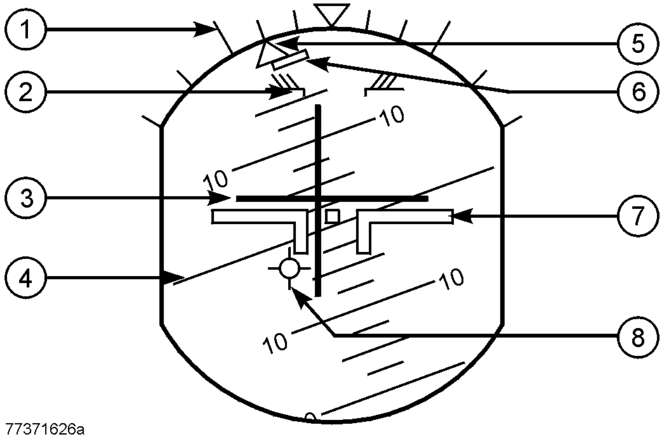
① Airspeed Disagree Alert (amber)

Indicates the captain and first officer airspeed indications disagree by more then 5 knots for 5 continuous seconds.

7 8 9 EFIS – ATTITUDE INDICATOR

Attitude Indicator – General

The attitude indicator displays ADIRS attitude information.



77371626a

① Bank Scale (white)

Provides fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

② Pitch Limit Indicator (amber)

Indicates pitch limit (stick shaker activation for existing flight conditions); displayed when the flaps are not up.

③ Flight Director (magenta)

Indicates flight director steering commands. (Refer to Section 6.4, Automatic Flight.)

④ Horizon Line and Pitch Scale (white)

Indicates the horizon relative to the aircraft symbol; pitch scale is in 2.5 degree increments.

⑤ Bank Pointer

Indicates bank angle; fills and turns amber if bank angle is 35 degrees or more.

⑥ Slip/Skid Indication

Displaces beneath the bank pointer to indicate slip or skid:

- Fills white at full scale deflection
- Turns amber if bank angle is 35 degrees or more; fills amber if the slip / skid indicator is also at full scale deflection.

⑦ Aircraft Symbol

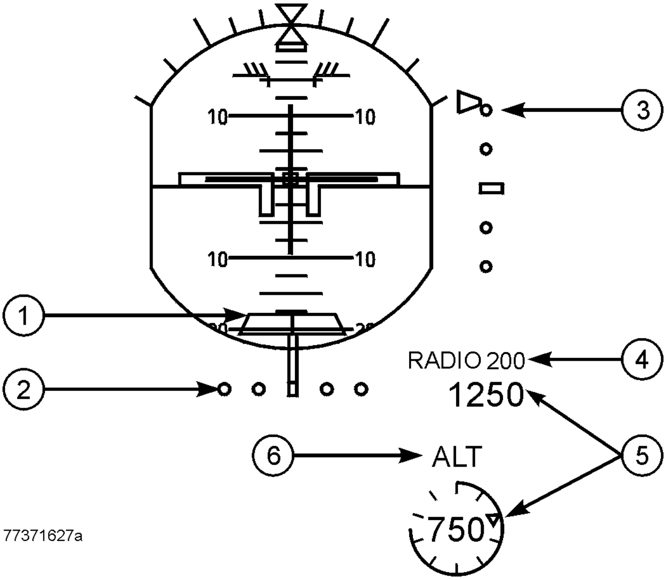
Indicates aircraft attitude relative to the horizon.

⑧ Flight Path Vector (FPV) Indication (white) (As Installed)

Displays flight path angle and drift when selected on the EFIS control panel:

- Flight path angle is displayed relative to the horizon line
- Drift angle is displayed relative to display center.

Attitude Indicator – Instrument Landing System Indications



① Rising Runway (green)

- Displayed when localizer pointer is in view and radio altitude is less than 2500 feet
- Rises towards aircraft symbol when radio altitude is below 200 feet
- Is not displayed when the localizer signal is unusable.

② Localizer Pointer and Deviation Scale

The pointer:

- Indicates localizer position relative to the aircraft
- In view when the localizer signal is received.

The scale:

- Indicates deviation
- Expands when the localizer is engaged and deviation is slightly more than one-half dot
- In view when the localizer signal is tuned.

At low radio altitudes, with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

Each pilot deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC deviation alerting display on each attitude indicator.

③ Glide Slope Pointer and Deviation Scale

The pointer:

- Indicates glide slope position
- In view when the glide slope signal is received
- The pointer is not displayed when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The scale:

- Indicates deviation
- In view when the localizer signal is tuned.

At low radio altitudes, with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive glide slope deviation.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second G/S deviation alerting display on each attitude indicator.

④ Selected Radio Altitude Approach Minimums (green)

- Displays selected minimums as set on the EFIS control panel
- Blank when an altitude less than 0 feet is selected
- "RADIO" legend and readout turn amber and flash for 3 seconds when descending through the selected minimum altitude; the legend and readout become steady amber after 3 seconds
- Changes back to green:
  - When passing the selected minimum altitude plus 75 feet during go-around
  - At touchdown
  - After pressing the RST switch on the EFIS control panel.

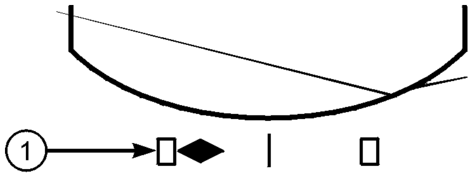
⑤ Radio Altitude (display - white, selected radio altitude pointer - green)

- Displayed below 2500 feet AGL
- Blanked above 2500 feet AGL
- Digital display from 2500 to 1000 feet AGL
- Round dial display below 1000 feet AGL:
  - Pinter replaces digital display of selected radio minimum altitude
  - The circumference of the dial is added to, or taken away from, to depict the aircraft's radio altitude
- Dial and readout turn amber and dial flashes for 3 seconds when descending through the selected minimum altitude; the dial becomes steady amber after 3 seconds
- Changes back to white:
  - When passing through the selected minimum altitude plus 75 feet during go-around
  - At touchdown
  - After pressing the RST switch on the EFIS control panel.

⑥ Radio Altitude Height Alert (white)

Displayed when radio altitude is less than or equal to 1000 feet. Blanked when descent continues below 500 feet AGL, or after pressing the RST switch on the EFIS control panel.

EXPANDED LOCALIZER INDICATIONS



773716166

① Expanded Localizer Scale (As Installed)

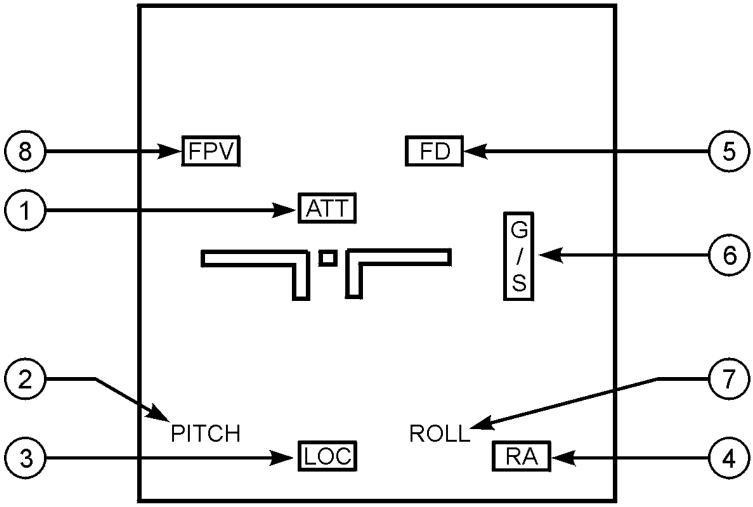
- Displayed when the autopilot or flight director is in LOC mode, deviation is slightly more than one half dot and track is within 5 degrees of the MCP selected course.
- Displayed when the autopilot is in LOC mode, deviation is slightly more than one half dot and track is within 5 degrees of the MCP selected course.

Reverts to standard scale when out of LOC mode, and ground speed is less than 30 knots or radio altitude is greater than 200 feet.

A rectangle equals 1/2 dot deviation.

ATTITUDE INDICATOR FAILURE FLAGS

Flags replace the attitude displays to indicate source system failure or lack of computed information.



77371628a

① Attitude Flag (amber)

The attitude display has failed.

② Pitch Flag (amber)

The Captain and First Officer pitch angle displays differ by more than 5 degrees.

③ Localizer Flag (amber)

An ILS frequency is tuned and the ILS localizer deviation display on the attitude indicator has failed.

④ Radio Altitude Flag (amber)

The radio altitude display has failed.

⑤ Flight Director Flag (amber)

The flight director has failed.

⑥ Glide Slope Flag (amber)

An ILS frequency is tuned and the ILS glide slope deviation display on the attitude indicator has failed.

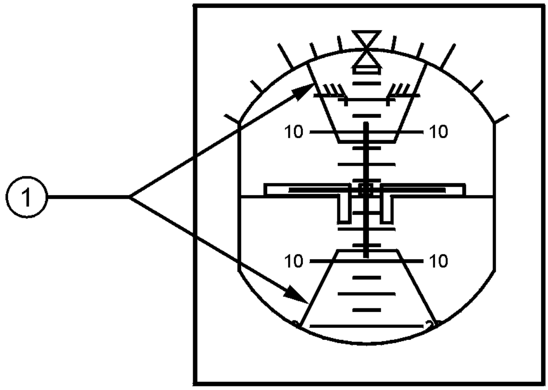
⑦ Roll Flag (amber)

The Captain and First Officer roll displays differ by more than 3 degrees.

⑧ Flight Path Vector Flag (amber)

FPV is selected on the EFIS control panel, but has failed. De-selection of FPV removes the flag.

TRAFFIC ALERT AND COLLISION AVOIDANCE INDICATIONS

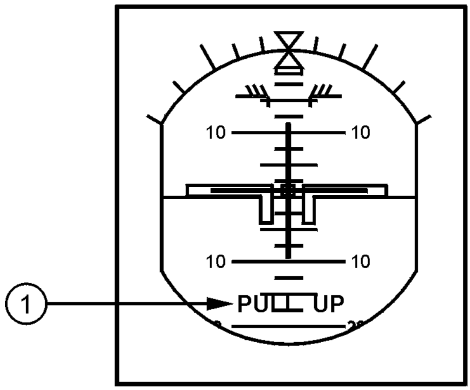


77371629a

① Traffic Alert and Collision Avoidance System Pitch Command (red)

The area(s) inside the red lines indicate(s) the pitch region(s) to avoid in order to resolve the traffic conflict. The aircraft symbol must be outside the TCAS pitch command area(s) to ensure traffic avoidance.

GPWS ANNUNCIATIONS



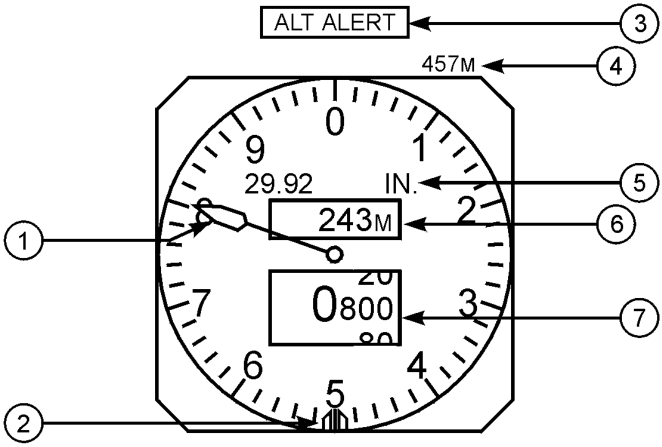
77371630a

① GPWS Annunciations (red)

7 8 9 EFIS – ALTIMETER

Altimeter – General

The altimeter displays ADIRS altitude and other altitude related information.



77371631a

① Altitude Pointer

Makes one revolution each one thousand feet.

② Reference Altitude Marker (green)

Indicates the barometric minimums as set by the minimums selector on the EFIS control panel.

The minimums reference selector must be in the BARO position to adjust the reference altitude marker.

③ Altitude Alert Annunciation (amber)

- Appears steady for altitude acquisition
- Flashes during altitude deviation
- Refer to Section 6.15, Warning Systems.

④ Metric Selected Altitude Readout (readout–magenta, caption–cyan)

Displays MCP altitude in meters when MTRS is selected on the EFIS control panel. Not available in compact mode.

⑤ Barometric Setting (green)

Indicates the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS control panel.

⑥ Metric Digital Readout (readout - white, caption - cyan)

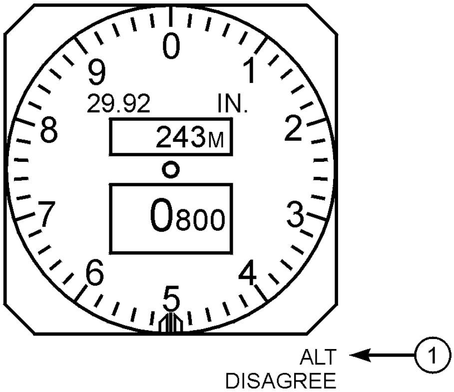
Displays current altitude in meters when MTRS is selected on the EFIS control panel. Not available in compact mode.

⑦ Digital Readout (white)

Displays current altitude in increments of thousands, hundreds and twenty feet:

- For positive values of altitude below 10,000 feet, a green crosshatch symbol is displayed
- A negative sign appears when altitude below zero feet is displayed.

Altimeter – Altitude Disagree Alert



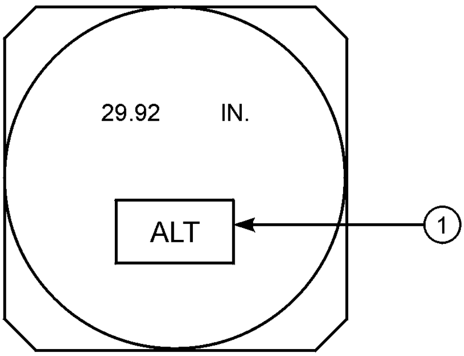
77371631a

① Altitude Disagree Alert (amber)

Indicates the captain and first officer altitude indications disagree by more than 200 feet for more than 5 continuous seconds.

Altimeter Failure Flag

The failure flag replaces the altitude displays to indicate system failure.



77371632a

① Altitude Failure Flag (amber)

The barometric altitude or barometric correction has failed:

- All altimeter symbols are removed except the **ALT ALERT** annunciation and the barometric setting.

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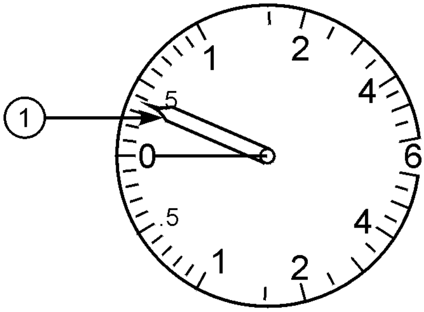
7 8 9 EFIS – VERTICAL SPEED INDICATOR

Vertical Speed Indicator – General

The vertical speed indicator displays ADIRS instantaneous vertical speed.

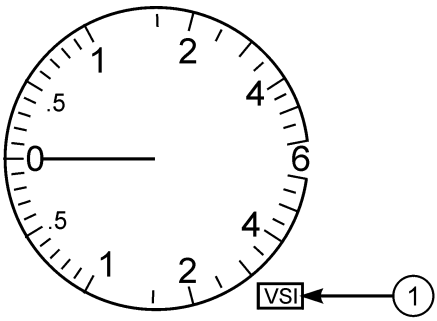


77371633a

① Vertical Speed Pointer (white)

Depicts rate of climb or descent from 0 to 6000 feet per minute.

Vertical Speed Indicator Failure Flag



77371633b

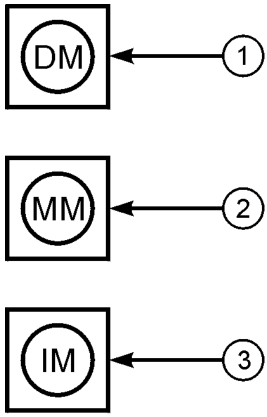
① VSI Failure Flag (amber)

Vertical speed has failed. The pointer is also removed.

7 8 9 EFIS – MARKER BEACON INDICATIONS

Marker Beacons Indications

The marker beacon indication flashes when over one of the marker beacon transmitters.



77371634a

① Outer Marker (cyan)

Flashes when over an outer marker beacon.

② Middle Marker (amber)

Flashes when over a middle marker beacon.

③ Inner Marker (white)

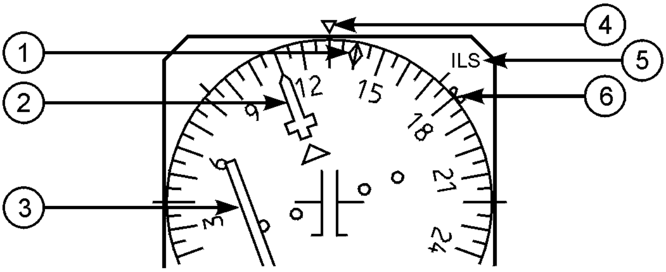
Flashes when over an airway or inner marker beacon.

7 8 9 NAVIGATION DISPLAYS

7 8 9 HORIZONTAL SITUATION INDICATOR (HSI)

Horizontal Situation Indicator - General

The HSI displays current ADIRS heading, track and other information.



77371635a

① Drift Angle Pointer (white)

Indicates current drift angle or track.

② Selected Course Pointer (white)

Indicates the course set on the mode control panel. Set by the related mode control panel course selector.

③ Course Deviation Indicator (magenta)

Indicates deviation from the selected localizer or VOR course.

④ Heading Pointer (white)

Indicates current heading.

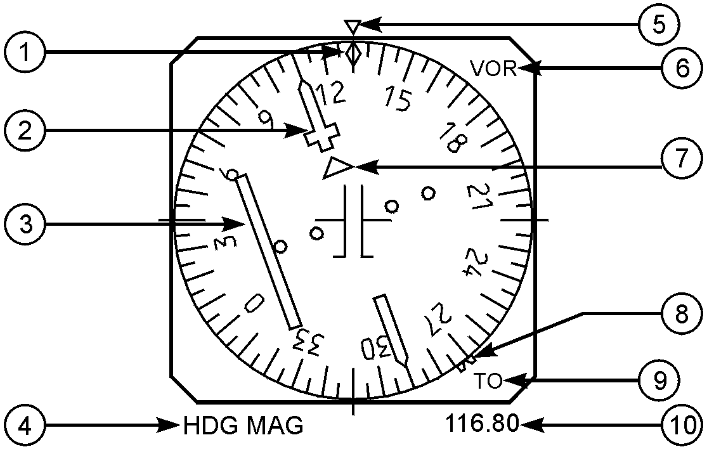
⑤ Lateral Deviation Source Annunciation (green)

Identifies the selected navigation source as VOR or ILS.

⑥ Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel. If the selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

Horizontal Situation Indicator – Compact Display



77371636a

① Drift Angle Pointer (white)

Indicates current drift angle or track.

② Selected Course Pointer (white)

Indicates the course set on the mode control panel. Set by the related mode control panel course selector.

③ Course Deviation Indicator (magenta)

Indicates deviation from the selected localizer or VOR course.

④ Magnetic / True Heading Annunciation (green)

Indicates the HSI reference:

- **HDG MAG** (green) indicates display is oriented relative to magnetic north
- **TRU HDG** (green) indicates display is oriented relative to true north; a white box is displayed continuously around **TRU HDG**
- Transition from **TRU HDG** to **HDG MAG** results in a green box around **HDG MAG** for 10 seconds
- When **TRU HDG** is displayed and the aircraft descends more than 2000 feet at a descent rate greater than -800 feet per minute, an amber box is drawn around **TRU HDG**; the box flashes for 10 seconds, then turns steady amber.

⑤ Heading Pointer (white)

Indicates current heading.

⑥ Lateral Deviation Source Annunciation (green)

Identifies the selected navigation source as VOR or ILS.

⑦ TO / FROM Pointer (white)

⑧ Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel.

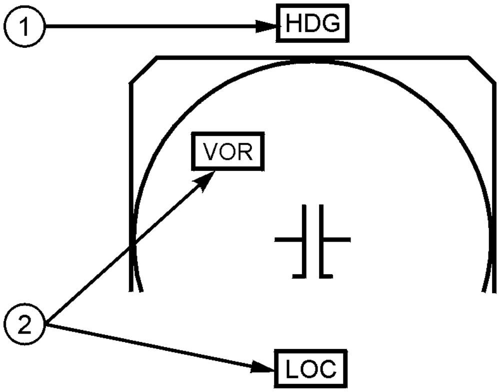
⑨ TO / FROM Annunciation (white)

⑩ Frequency Display (green)

Indicates selected navigation radio frequency.

Horizontal Situation Indicator Failure Flags

The flags replace the horizontal situation indicator displays to indicate source system failure or lack of computed data.



77371637

① Heading Failure Flag (amber)

The heading source has failed. The compass rose is removed.

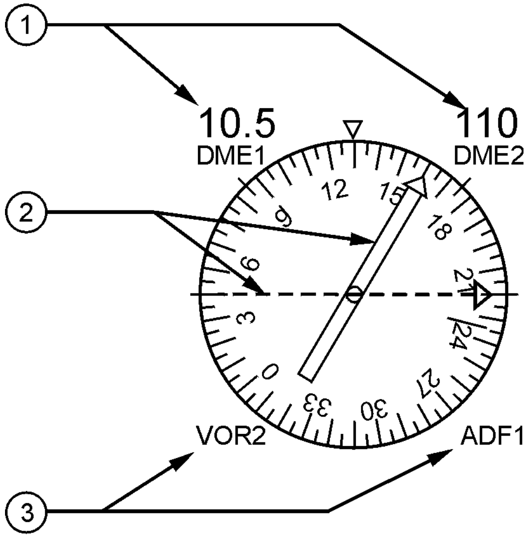
② **VOR / LOC** Failure Flag (amber)

The aircraft navigation data source has failed.

7 8 9 RADIO DISTANCE MAGNETIC INDICATOR (RDMI)

Radio Distance Magnetic Indicator – General

The RDMI provides the same information as a conventional RDMI.



77371638a

① DME Indications (white)

Displayed if DME information is available from the navigation aid tuned in the VHF navigation control panel.

② Bearing Pointers (VOR source - green)

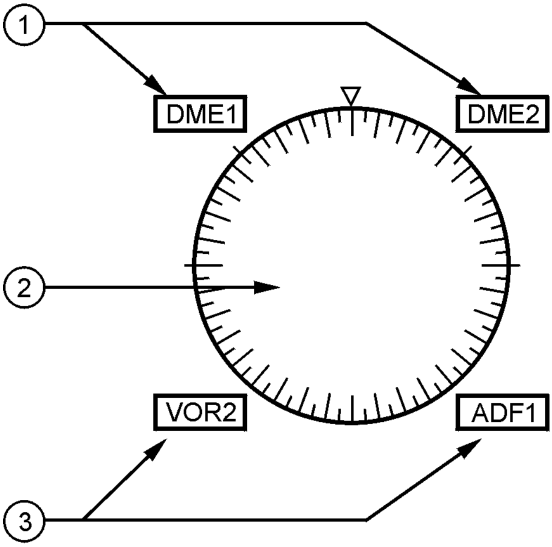
- Narrow pointer uses signals from the VHF NAV receiver No. 1
- Wide pointer uses signals from the VHF NAV receiver No. 2.

③ Bearing Source Indications (VOR source - green)

- Indicates **OFF** (white) if related VOR / ADF switch on the EFIS control panel is in the OFF position
- Displays **INOP** (white) if the VOR / ADF switch is in the ADF position and ADF receivers are not installed.

Radio Distance Magnetic Indicator Failure Flags

The flags replace the RDMI displays to indicate source system failure.



77371639a

① DME Failure Flags (amber)

The DME system has failed.

② Heading Failure

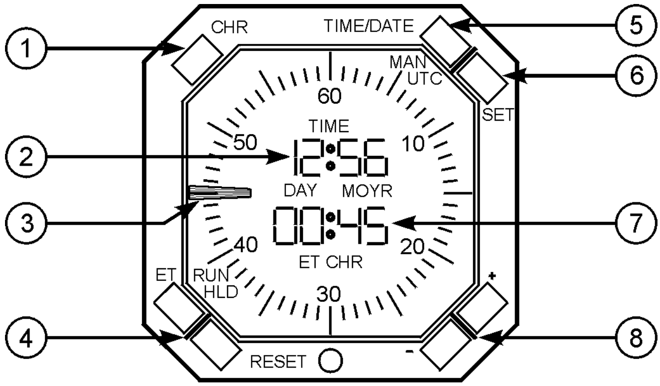
The heading display is removed if heading information has failed.

③ VOR Failure Flags (amber)

The selected VOR information is invalid.

7 8 9 CLOCK

(As Installed)



LEFT and RIGHT FORWARD
PANELS

773716167

① Chronograph (CHR) Control

PUSH –

- Controls the start, stop and reset functions of the CHR display and second hand with successive pushing
- Overrides any existing ET display.

② Time / Date Indicator

- Displays UTC or manual time (hours, minutes) when time is selected with the time/date pushbutton
- Alternately displays day-month and year when date is selected with the time / date pushbutton.

③ Chronograph Second Hand

- Indicates chronograph seconds
- Controlled by the CHR control

④ Elapsed Time (ET) and RESET Pushbutton

Controls the elapsed time function.

- Select the ET pushbutton once to run the elapsed time
- Select the ET pushbutton again to hold the elapsed time
- Select the RESET pushbutton to set the elapsed time to 0.

The **RUN** or **HLD** symbol is displayed on the lower left part of the LCD display.

⑤ TIME/DATE Pushbutton

Controls the time / date function.

- Select the TIME/DATE pushbutton once to see UTC time
- Select the TIME/DATE pushbutton again to see UTC date
- Select the TIME/DATE pushbutton again to see manual time
- Select the TIME/DATE pushbutton again to see manual date.

The **UTC** or **MAN** symbol is displayed on the upper right part of the LCD display.

In MAN mode, clock time and date come from the clock. In UTC mode, clock time and date come from the global positioning system.

⑥ SET Pushbutton

Controls the setting of manual time and date.

With manual time displayed:

- Select the SET pushbutton once and the hours flash, use the plus or minus pushbutton to adjust the hours
- Select the SET pushbutton again and the minutes flash, use the plus or minus pushbutton to adjust the minutes
- Select the SET pushbutton again to run the time.

With manual date displayed:

- Select the SET pushbutton once and the day flashes, use the plus or minus pushbutton to adjust the day
- Select the SET pushbutton again and the month flashes, use the plus or minus pushbutton to adjust the month
- Select the SET pushbutton again and the year flashes, use the plus or minus pushbutton to adjust the year
- Select the SET pushbutton again to run the date.

Note: A delay greater than one minute while setting the time or date results in the clock reverting to the previous time / date setting.

⑦ Elapsed Time (ET)/ Chronograph Indicator

- Displays elapsed time (hours, minutes) or chronograph minutes
- The chronograph display replaces the elapsed time display
- Elapsed time continues to run in the background and displays after the chronograph is reset.

⑧ Plus (+) and Minus (-) Pushbuttons

Used to set the manual time and date

- Select the **+** pushbutton to increase the value
- Select the **-** pushbutton to decrease the value.

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7 8 9 STANDBY FLIGHT INSTRUMENTS

STANDBY MAGNETIC COMPASS

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

STANDBY HORIZON INDICATOR

The standby horizon indicator provides attitude information that is independent of the primary attitude displays. The indicator is powered by the battery bus and remains powered after the loss of all normal AC power as long as battery power is available. The gyro reaches operational speed approximately 60 seconds after power is applied. The indicator requires three minutes to achieve accuracy requirements.

STANDBY ALTIMETER / AIRSPEED INDICATOR

Standby altitude and airspeed are displayed on a single indicator.

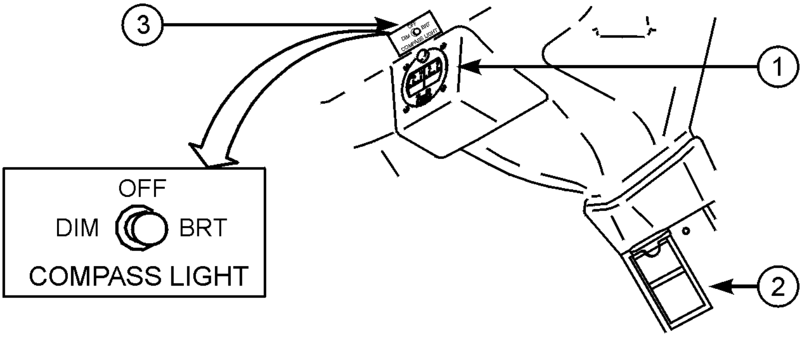
The standby altimeter receives static pressure from the alternate static ports. Current altitude is displayed digitally. A pointer indicates altitude in hundreds of feet. Barometric setting windows display the barometric setting in both millibars and inches of mercury as set by the barometric setting control. The altimeter has a range of -1000 to 50,000 feet.

The standby airspeed indicator receives ram pressure from the auxiliary pitot probe and static pressure from the alternate static ports. It provides current airspeed in knots.

STANDBY RADIO MAGNETIC INDICATOR

The standby radio magnetic indicator (RMI) displays magnetic heading and VOR/ADF bearing to the station. The RMI is powered by the AC standby bus and remains powered after the loss of all normal AC power as long as battery power is available.

7 8 9 Standby Magnetic Compass



CENTER POST ABOVE GLARESHIELD

773716168

① Standby Magnetic Compass

Displays magnetic heading.

② Standby Magnetic Compass Correction Card

Provides appropriate heading corrections.

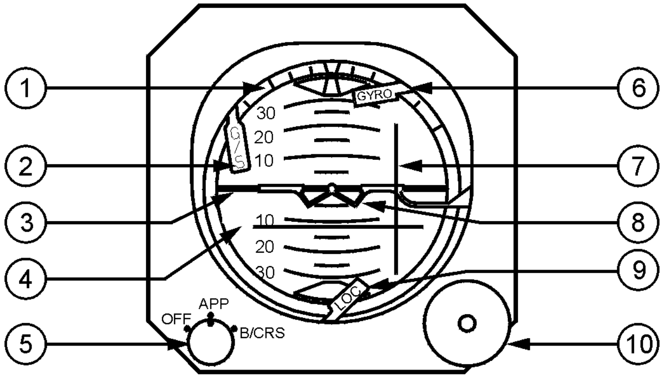
③ Compass Light Switch

OFF – Compass light is extinguished.

BRT – Sets compass light to full brightness.

DIM – Sets compass light to low brightness.

7 8 9 Standby Attitude Indicator



CENTER INSTRUMENT PANEL

77371643a

① Bank Indicator And Scale

Scale marks are at 0, 10, 20, 30, 45 and 60 degrees.

② Glideslope Flag

- Glideslope receiver has failed
- Glideslope pointer is removed.

③ Horizon Line and Pitch Angle Scale

Pitch scale is in 5 degree increments.

④ Glideslope Pointer and Deviation Scale

- Pointer indicates glideslope position
- Pointer is not displayed when
  - Approach selector is off or in B/CRS
  - No computed data exists
  - Glideslope receiver has failed
- Scale indicates deviation.

⑤ Approach Mode Selector

OFF – Glideslope and localizer pointers retracted from view.

APP – Glideslope and localizer pointers in view; ILS signals provided by the No. 1 ILS receiver.

B/CRS – Reverses sensing for localizer pointer during back course approaches; glideslope pointer not displayed.

⑥ GYRO Flag

Attitude is unreliable.

⑦ Localizer Pointer and Deviation Scale

- Pointer indicates localizer position
- Pointer is not displayed when
  - Approach selector is off
  - No computed data exists
  - Localizer receiver has failed
- Scale indicates deviation.

⑧ Aircraft Symbol

⑨ Localizer Flag

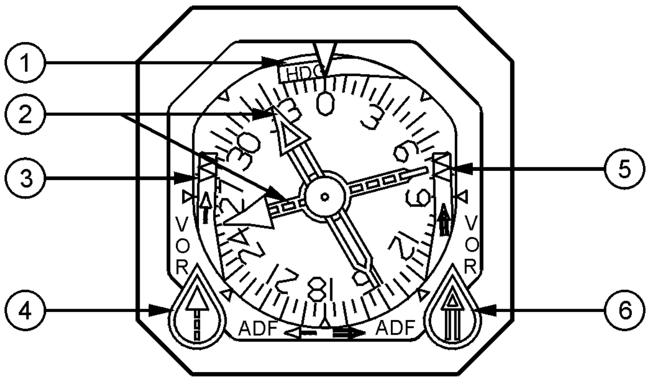
- Localizer receiver has failed
- Localizer pointer is removed.

⑩ Caging Control

PULL – Aligns horizon line with the aircraft symbol.

RELEASE – The control contracts.

7 8 9 Standby Radio Magnetic Indicator



CENTER INSTRUMENT PANEL

77371645a

① Heading Warning Flag

The compass signal from the air data inertial reference system is lost.

② Bearing Pointers

- Narrow pointer uses signals from the VHF NAV receiver No. 1.
- Wide pointer uses signals from the VHF NAV receiver No. 2.

③ Bearing Pointer No. 1 Warning Flag

VOR mode:

- RMI power failure
- VHF NAV signal unreliable.

④ VOR Bearing Pointer No. 1 Switch

ROTATE – Selects VOR for the bearing pointer.

⑤ Bearing Pointer No. 2 Warning Flag

VOR mode

- RMI power failure
- VHF NAV signal unreliable.

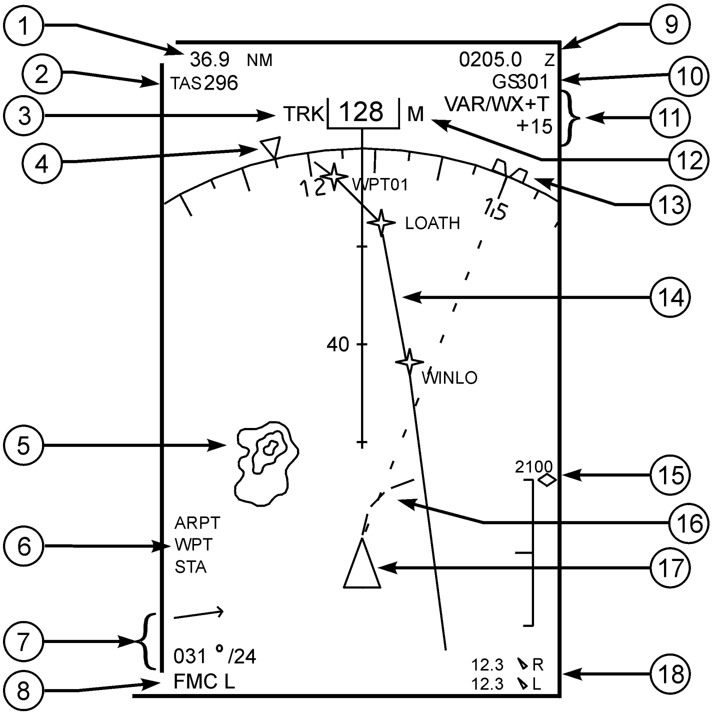
⑥ VOR Bearing Pointer No. 2 Switch

ROTATE – Selects VOR for the bearing pointer.

7 8 9 NAVIGATION DISPLAYS

MAP MODE

Expanded MAP Mode



77371647a

① Distance to Next Active Waypoint

② True Airspeed

③ Current Track

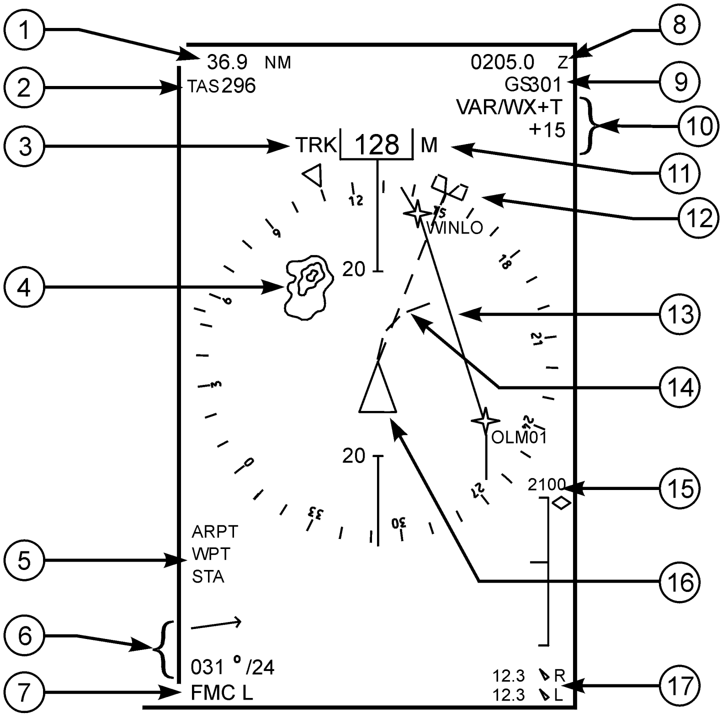
④ Heading Pointer

⑤ Weather Radar Returns

⑥ MAP Options

7. Wind Direction and Speed
8. MAP Source Annunciation
9. Estimated Time of Arrival at Next Active Waypoint
10. Groundspeed
11. Weather Radar Annunciations
12. Magnetic/True Reference
13. Selected Heading Bug
14. Active LNAV Route
15. Vertical Deviation Scale and Pointer
16. Position Trend Vector
17. Aircraft Symbol
18. Position Difference Display

7 8 9 Center MAP Mode



77371648a

1. Distance to Next Required Waypoint
2. True Airspeed
3. Current Track
4. Weather Radar Returns
5. MAP Options
6. Wind Direction and Speed
7. MAP Source Annunciation
8. Estimated Time of Arrival at Next Active Waypoint

9 Groundspeed

10 Weather Radar Annunciations

11 Magnetic/True Reference

12 Selected Heading Bug

13 Active Route

14 Position Trend Vector

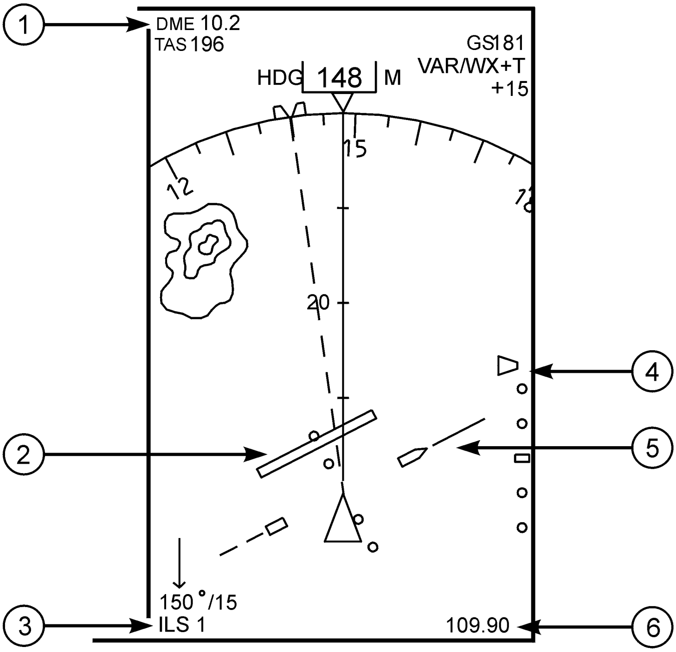
15 Vertical Deviation Scale and Pointer

16 Aircraft Symbol

17 Position Difference Display

7 8 9 APPROACH MODE

Expanded Approach Mode



77371649a

① Reference ILS DME

② Localizer Deviation Indication and Scale

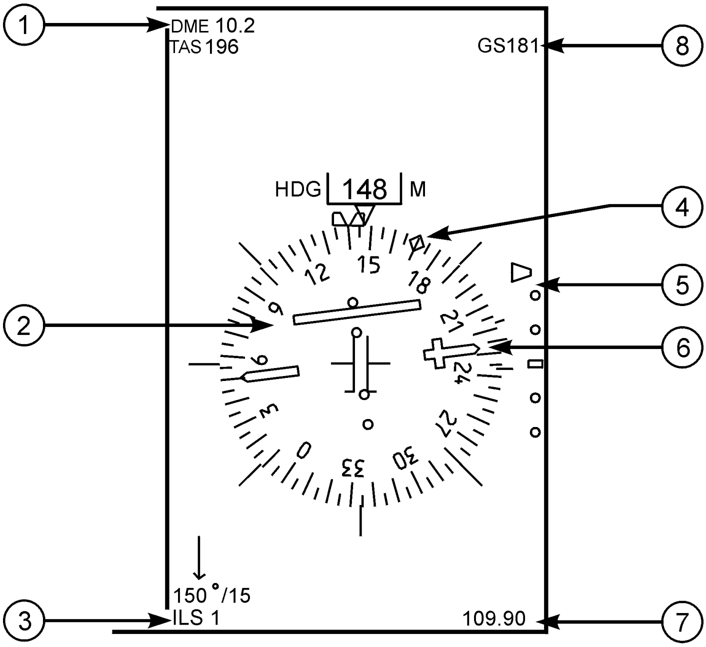
③ Reference ILS Receiver

④ Glide Slope Pointer and Scale

⑤ Selected Course Pointer

⑥ Reference ILS Frequency

Center Approach Mode



77371650a

① Reference ILS DME

② Localizer Deviation Indication and Scale

③ Reference ILS Receiver

④ Drift Angle Pointer

⑤ Glide Slope Pointer and Scale

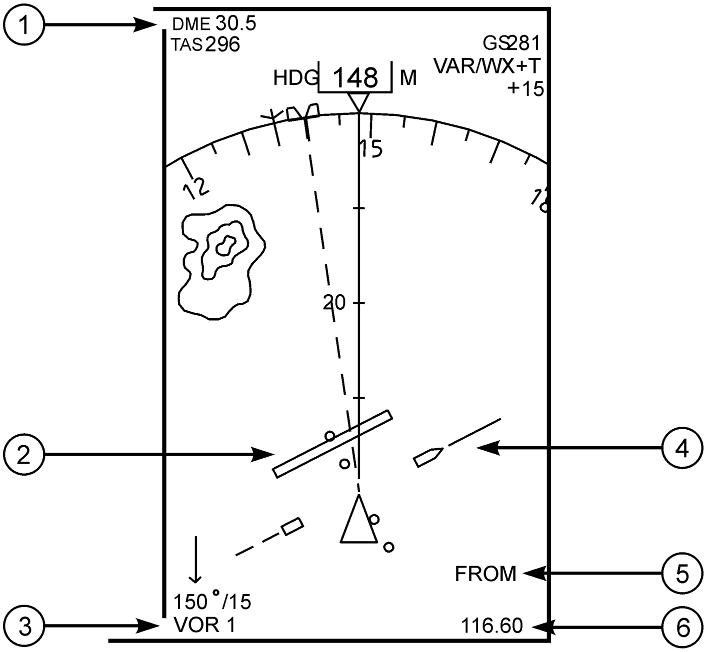
⑥ Selected Course Pointer

⑦ Reference ILS Frequency

⑧ Groundspeed

7 8 9 VOR MODE

Expanded VOR Mode



77371651a

① Reference VOR DME

② Lateral Deviation Indication and Scale

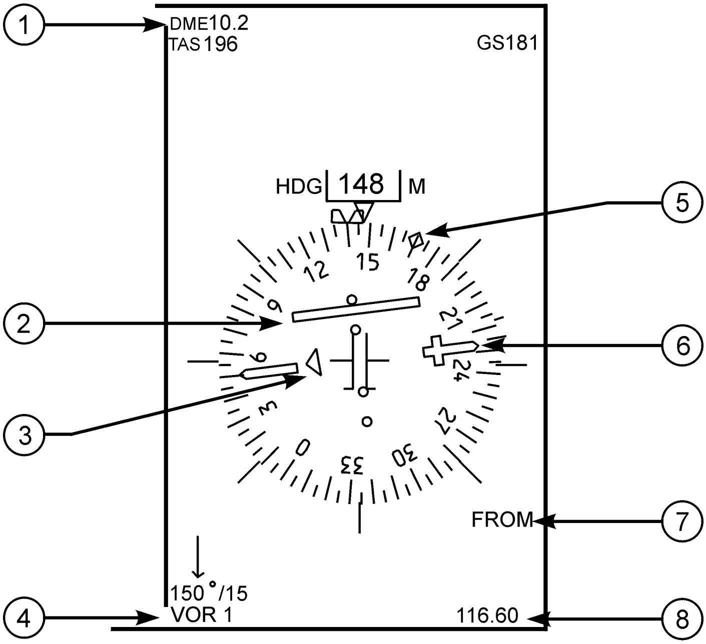
③ Reference VOR Receiver

④ Selected Course Pointer

⑤ **TO** / **FROM** Indication

⑥ Reference VOR Frequency

Center VOR Mode



77371652a

① Reference VOR DME

② Lateral Deviation Indication and Scale

③ TO / FROM Pointer

④ Reference VOR Receiver

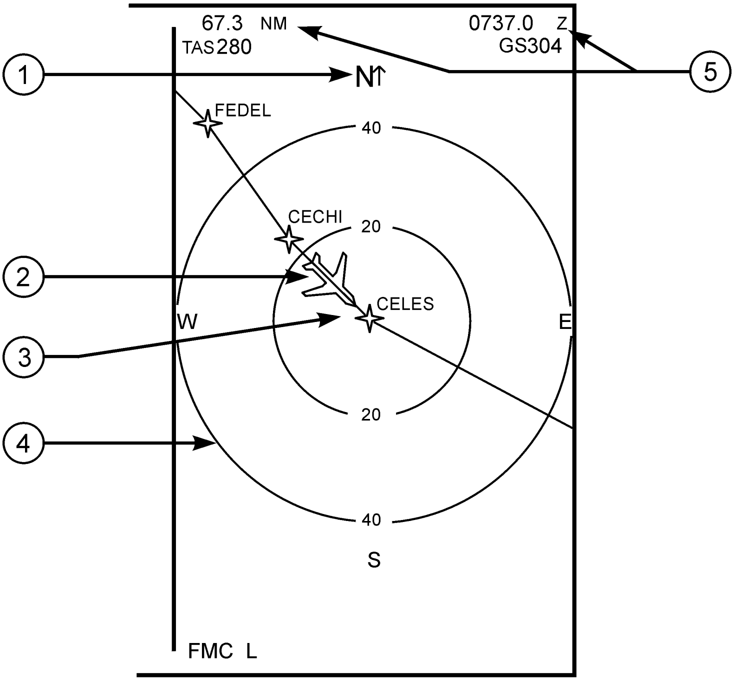
⑤ Drift Angle Pointer

⑥ Selected Course Pointer

⑦ TO / FROM Indication

⑧ Reference VOR Frequency

Plan Mode



77371653a

① True North Up Arrow

② Aircraft Symbol

Denotes current position and true heading. Symbol does not display north of 82N latitude or south of 82S latitude.

③ Center Waypoint

The waypoint located at the display center is identified as CTR on the CDU RTE LEGS page.

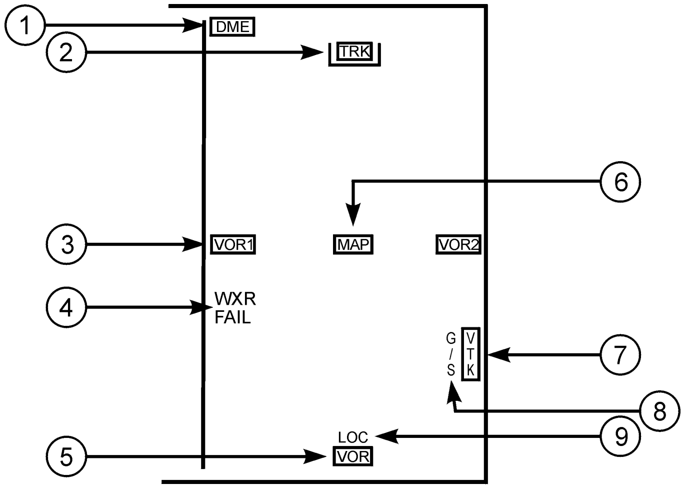
④ Range Circle

⑤ Active Waypoint Information

7 8 9 FAILURE INDICATIONS AND FLAGS

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.

Failure Flags – Expanded MAP, Center MAP, Expanded APP, Expanded VOR Modes



77371657a

① DME Failure Flag (APP and VOR modes)

DME display has failed.

② Track Failure Flag (MAP modes)

Track data have failed.

③ VOR Failure Flag (MAP modes)

EFIS control panel POS switch selected and VOR display failed.

④ Weather Radar Annunciations (MAP, APP and VOR modes)

WXR FAIL – Weather radar has failed. No weather data are displayed.

WXR WEAK – Weather radar calibration fault.

WXR ATT – Attitude stabilization for antenna has been lost.

WXR STAB – Antenna stabilization is off.

WXR DSP – Display unit cooling has been lost or an overheat condition has occurred. Weather radar display is blanked.

⑤ VOR Failure Flag (VOR modes)

VOR display has failed.

⑥ MAP Failure Flag (MAP modes)

The related FMC generated map display has failed.

⑦ Vertical Track Failure Flag (MAP modes)

FMC vertical track data are invalid.

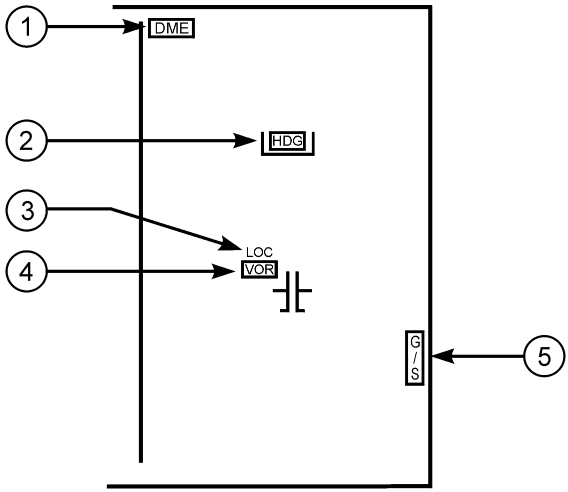
⑧ ILS Glide Slope Failure Flag (APP modes)

ILS glide slope display has failed.

⑨ ILS Localizer Failure Flag (APP modes)

ILS localizer display has failed.

Failure Flags – Center APP And Center VOR Modes



77371658a

① DME Failure Flag (APP and VOR modes)

DME display has failed.

② Heading Failure Flag (APP and VOR modes)

Heading display has failed.

③ ILS Localizer Failure Flag (APP modes)

ILS localizer display has failed.

④ VOR Failure Flag (VOR modes)

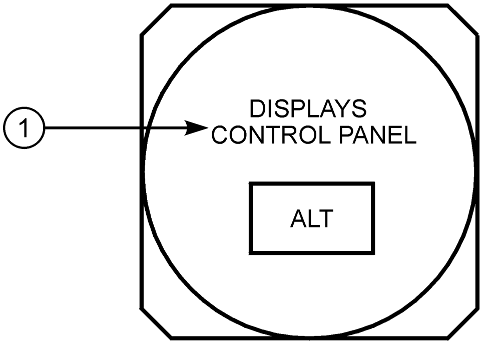
VOR display has failed.

⑤ ILS Glide Slope Failure Flag (APP modes)

ILS glide slope display has failed.

7 8 9 ADDITIONAL FLAGS AND ANNUNCIATIONS

Displays Control Panel Annunciation



773716169

① Displays Control Panel Annunciation (amber)

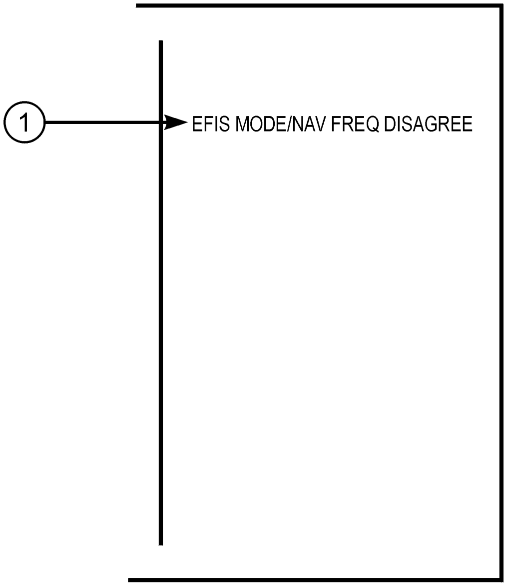
With the CONTROL PANEL select switch on the overhead panel in:

- BOTH ON 1 - Left (Capt) EFIS control panel has failed
- NORMAL - Corresponding EFIS control panel has failed
- BOTH ON 2 - Right (F/O) EFIS control panel has failed.

Altitude information is removed.

7 8 9 ADVISORY MESSAGES

Mode / Frequency Disagree Annunciation



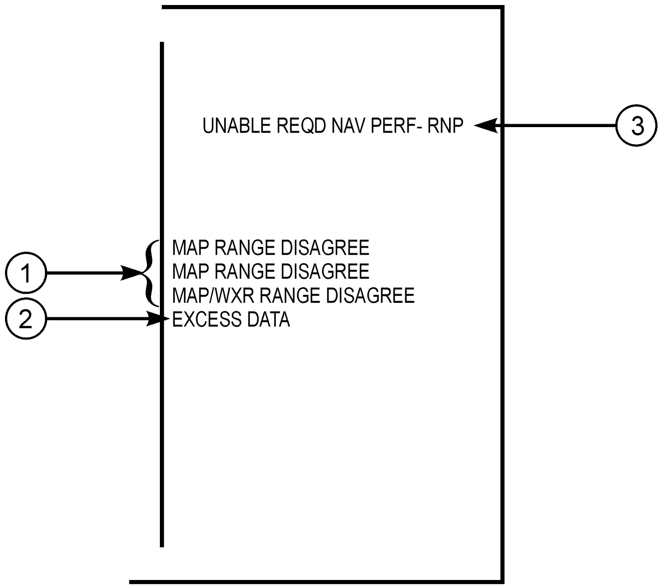
77371654a

① Mode / Frequency Disagree Annunciation (amber)

Indicates APP is selected with a VOR frequency tuned, or VOR is selected with an ILS frequency tuned.

- The annunciation only applies to an on-side comparison of the EFIS control panel mode and tuned VOR/ILS frequency
- Applicable to expanded and center APP and VOR modes
- Dashes displayed on DME display and ILS/VOR frequency display
- Localizer deviation bar, VOR course deviation bar, and glide slope pointer (for APP mode) are not displayed.

Navigation Advisory Messages



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① Range Disagreement Annunciations (amber)

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP display range.

WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the WXR display range.

MAP/WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and WXR display ranges.

② EXCESS DATA Annunciation (amber)

The amount of data sent to the navigation display exceeds the display capability.

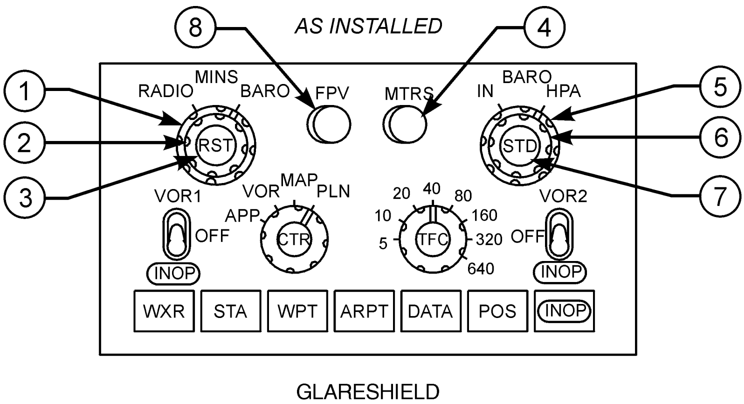
③ Nav Advisory Message (amber)

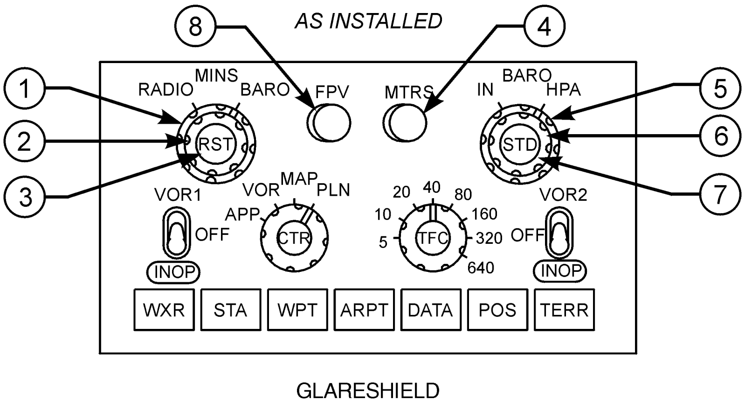
UNABLE REQD NAV PERF-RNP – Displayed in MAP or Center MAP during approach.

7 8 9 EFIS CONTROL PANEL (EFIS / MAP DISPLAY)

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

EFIS Control Panel Controls – Flight Instrument Displays





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① Minimums (MINS) Reference Selector (outer) (two position)

RADIO – Selects radio altitude as the minimums reference.

BARO – Selects barometric altitude as the minimums reference.

② Minimums (MINS) Selector (middle) (slew)

ROTATE – Adjusts the radio or baro minimums altitude.

③ Minimums (MINS) Reset (RST) Switch (inner) (momentary action)

PUSH –

- Blanks radio height ALT alert
- Resets the radio altitude minimums alert display on the attitude indicator
- Blanks the reference altitude marker on the altimeter if displayed; sets the reference altitude marker to zero if not previously displayed.

④ Meters (MTRS) Switch (momentary action)

PUSH – Displays altitude indications in meters. Not available in compact display format.

⑤ Barometric (BARO) Reference Selector (outer) (two position)

IN – Selects inches of mercury as the barometric altitude reference.

HPA – Selects hectopascals as the barometric altitude reference.

⑥ Barometric (BARO) Selector (middle) (slew)

ROTATE – Adjusts the barometric altitude setting on the altimeter.

⑦ Barometric (BARO) Standard (STD) Switch (inner) (momentary action)

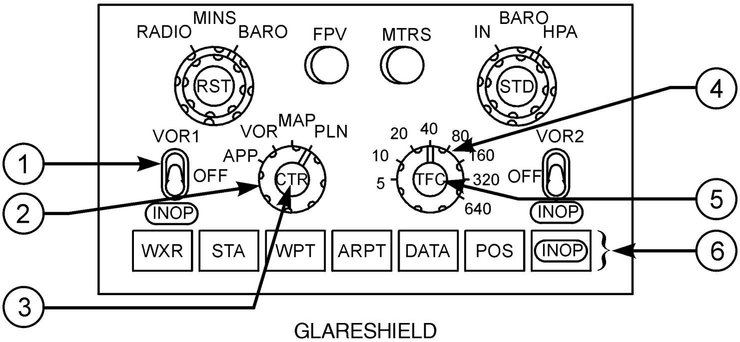
PUSH – Selects the standard barometric setting (29.92 inches Hg/1013 HPA) for barometric altitude reference.

⑧ Flight Path Vector (FPV) Switch (momentary action)

PUSH – Displays flight path vector on the attitude indicator.

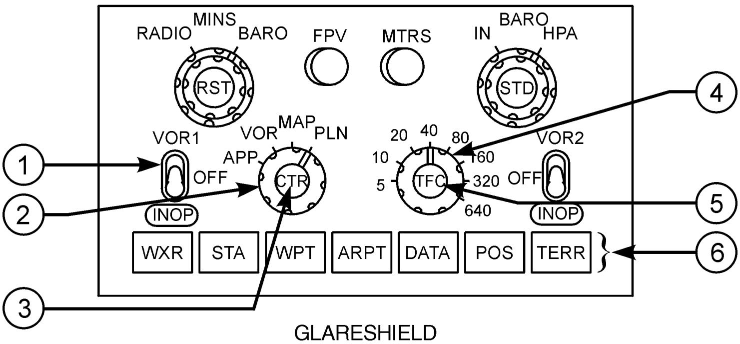
EFIS Control Panel Controls – Navigation Displays

AS INSTALLED



GLARESHIELD

AS INSTALLED



GLARESHIELD

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① VOR/ADF Switch (three position)

Displays VOR information on the respective RDMI.

VOR – Displays the selected VOR bearing pointer and VOR bearing pointer source indicator.

OFF – Removes the **VOR** displays and displays **OFF** in place of the bearing pointer source indicators.

ADF – Inoperative.

② Mode Selector (outer)

Selects the desired display.

APP –

- Displays localizer and glideslope information in heading-up format
- Displays reference ILS receiver, ILS frequency, course and DME
- Weather radar and TCAS are not displayed in center APP mode.

VOR –

- Displays VOR navigation information in heading-up format
- Displays reference VOR receiver, VOR frequency, course, DME and TO/FROM information
- Weather radar and TCAS are not displayed in center VOR mode.

MAP –

- Displays FMC generated route and MAP information, aircraft position, heading and track, in a track-up format
- Displays waypoints, including the active waypoint, within the selected range
- Displays VNAV path deviation.

PLN –

- Displays a non-moving, true north up, route depiction
- The aircraft symbol represents actual aircraft position
- Allows route step-through using the CDU LEGS page
- Weather radar and TCAS are not displayed.

③ Center (CTR) Switch (inner)

PUSH –

- Displays the full compass rose (center) for APP, VOR and MAP modes
- Subsequent pushes alternate between expanded and center displays.

④ Range Selector (outer)

Selects desired display range in nautical miles for APP, VOR, MAP or PLN mode.

⑤ Traffic (TFC) Switch (inner)

PUSH – Displays TCAS information

⑥ MAP Switches (momentary action)

The MAP switches:

- Add background data / symbols to MAP and center MAP modes
- Displays can be selected simultaneously
- Second push removes the information.

WXR (weather radar) – Energizes weather radar transmitter and displays weather radar returns in MAP, center MAP, expanded VOR and expanded APP modes. When the 640 nm range is selected, weather radar returns are limited to 320 nm.

STA (station) –

- Displays all FMC data base navigation aids if on map scales 5, 10, 20 or 40 nm.
- Displays FMC data base high altitude navigation aids on map scales 80, 160, 320 or 640 nm.

WPT (waypoint) – Displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 nm or less.

ARPT (airport) – Displays all airports which are stored in the FMC data base and which are within the viewable map area.

DATA – Displays altitude constraint, if applicable, and estimated time of arrival for each active route waypoint.

POS (position) – Displays VOR bearing vectors extended from the nose of the aircraft symbol to the stations.

(As Installed) TERR (terrain) – Displays GPWS generated terrain data in MAP, center MAP, VOR, and APP modes.

INTENTIONALLY LEFT BLANK

3 5 7 8 9 EFIS Symbology Descriptions

The following symbols can be displayed, depending on EFIS control panel switch selections. Colors indicate the following:

- W (White) - Present status, range scales
- G (Green) - Active or selected mode and/or dynamic conditions
- M (Magenta) - Command information, pointers, symbols, fly-to condition, weather radar turbulence
- C (Cyan) - Non-active or background information
- A (Amber) - Cautions, faults, flags
- R (Red) - Warnings
- B (Black) - Blank area, off condition

SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
TRK 0 6 2 M TRK 0 6 2 TRU	HDG (G) - Displayed data is referenced to APL HEADING. TRK (G) - Displayed data is referenced to APL TRACK. (W) - TRACK/HDG index pointer. 062 (W) - Numeric value of HDG or TRK. M (G) - Indicates display is oriented relative to MAGNETIC North. TRU TRU (G) BOX (W) - Indicates display is oriented relative to TRUE North.	TRK Full Nav Exp Nav Map Map CTR Plan	3 5	Indicates number under index pointer is the current track.
HDG 0 6 2 M HDG 0 6 2 TRU		HDG Full VOR/ILS Exp. VOR/ILS		Indicates number under index pointer is the current heading.
TRK 0 6 2 M	Track orientation (G). current track (W), and track reference (G)	MAP, CTR MAP	7 8 9	Displays TRK as the orientation, the current track, and M or TRU as the reference, and points to the heading on the compass rose.
HDG 2 6 3 M	Heading orientation (G). current heading (W), heading reference (G), and heading pointer (W)	APP, APP CTR, VOR, VOR CTR	7 8 9	Displays HDG as the display orientation, the current track, and M or TRU as the reference, and points to the heading on the compass rose.
	Selected heading bug (M)	Full VOR/ILS Full NAV Exp. VOR/ILS Exp. Nav Map CTR Map Plan	3 5	Displays the MCP-selected heading. A dashed line (M) extends from the marker to the airplane symbol (VOR CTR and APP CTR do not display dashed line).
		MAP, MAP CTR APP, APP CTR, VOR, VOR CTR	7 8 9	

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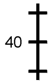
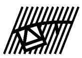
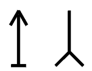
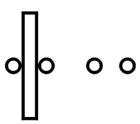
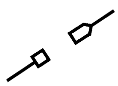
SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	Track line and range scale (W)	EXP VOR/ILS EXP NAV MAP, CTR MAP - - - - - MAP, CTR MAP, APP VOR	3 5 - - - - - 7 8 9	Indicates current track.
M OR TRU	Heading/track reference (G), box (W) in TRU, box (A) if TRU displayed in descent.	MAP, MAP CTR APP, APP CTR, VOR, VOR CTR	7 8 9	Indicates heading/track is referenced to magnetic north or true north. On transition from TRU to M, a highlight box is displayed around M for 10 seconds. When TRU is the reference, the highlight box is displayed full time (white)
	Expanded compass (W)	EXP VOR/ILS EXP NAV MAP, PLAN - - - - - MAP, APP, VOR	3 5 - - - - - 7 8 9	An arc of approximately 70° is displayed. - - - - - Displays 60 degrees of compass rose.
 - - - - - 	Current heading pointer (W)	FULL NAV EXP NAV MAP, CTR MAP, PLAN - - - - - MAP, MAP CTR , APP, APP CTR, VOR, VOR CTR	3 5 - - - - - 7 8 9	Points to current heading on the compass rose.
	Wind direction/ speed and wind arrow (W)	FULL VOR/ILS FULL NAV EXP VOR/ILS EXP NAV MAP, CTR MAP - - - - - MAP, MAP CTR, APP, APP CTR, VOR, VOR CTR	3 5 - - - - - 7 8 9	Indicates wind speed and direction, with respect to display orientation and heading/ track reference. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots. Dashes are displayed until TAS is greater than 101 knots.

SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
GS310	Groundspeed (W)	All	7 8 9	Current ground speed.
TAS312	True airspeed (W)	All	7 8 9	Current true airspeed displayed above 100 knots.
VOR 1, 2 ILS 1, 2	System source annunciation (G)	FULL VOR/ILS FULL NAV EXP VOR/ILS EXP NAV	3 5	Indicates the selected receiver as the display reference.
		APP, APP CTR, VOR, VOR CTR	7 8 9	
116.80	ILS/VOR frequency display (G)	FULL VOR/ILS EXP VOR/ILS	3 5	Displays frequency of manually tuned navaid.
		APP, APP CTR, VOR, VOR CTR	7 8 9	
		ALL	3 5	
DME 24.6	DME distance (W)	APP, APP CTR, VOR, VOR CTR	7 8 9	Indicates DME distance to the reference navaid.
	ADF 1 pointer head and tail (C)	All	3 5	Indicates bearing to (head) or from (tail) the tuned station. Not displayed if POS selected on the EFIS control panel.
	ILS localizer or VOR course deviation indication (M) and scale (W)	FULL VOR/ILS FULL NAV EXP VOR/ILS EXP NAV	3 5	Displays LOC or VOR course deviation.
		APP, APP CTR, VOR, VOR CTR	7 8 9	
	Selected course pointer (W) and line (M)	EXP VOR/ILS EXP NAV	3 5	Displays selected course as set by related MCP course selector.
		APP, VOR,	7 8 9	

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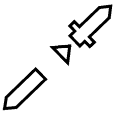
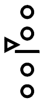
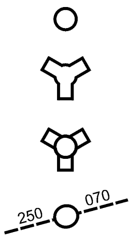
SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	Selected course pointer (W) TO/FROM pointer (W)	FULL VOR/ILS FULL NAV - - - - - APP CTR, VOR CTR	3 5 - - - - - 7 8 9	Displays selected course as set by the related MCP course selector. TO/FROM pointer is displayed when VOR navigation is being used.
	Glideslope pointer (M) and scale (W)	FULL VOR/ILS EXP VOR/ILS - - - - - APP, APP CTR	3 5 - - - - - 7 8 9	Displays glideslope position and deviation. Displays VOR TO/FROM indication.
TO FROM	To/from indication (W)	FULL VOR/ILS EXP VOR/ILS - - - - - VOR, VOR CTR	3 5 - - - - - 7 8 9	Displays VOR TO/FROM indication.
	VOR (C, G). DME/TACAN (C, G) VORTAC (C, G) Manually tuned VOR radials	MAP, CTR MAP, PLAN - - - - - MAP, MAP CTR, PLAN	3 5 - - - - - 7 8 9	When the EFIS control panel STA map switch is off, tuned naviads, excluding NDBs, are displayed (G). When the EFIS control panel STA map switch is selected on, appropriate naviads are displayed. All navaids contained in the FMC data base and within the MAP area displayed when the selected range is 3 5 10, 20, 40nm 7 8 9 5, 10, 20, 40nm. Only high altitude navaids are displayed when the selected range 3 5 80, 160, 320nm; 7 8 9 80, 160, 320, 640nm. Navaids not being used are displayed in cyan. Tuned VHF navaids are displayed in green, regardless of switch selection. When a navaid is manually tuned, the selected course and reciprocal are displayed.

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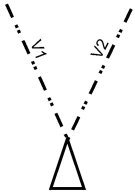
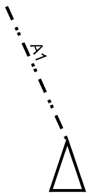
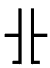
SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	VOR radials (G)	MAP, CTR MAP	3 5	The VOR/ADF switch on the EFIS Control Panel must be ON and a valid VOR signal must be received Dis-plays relative bearing to the tuned VOR station(s).
		MAP, CTR MAP	7 8 9	When the POS map switch is selected on and a valid VOR signal is received, the station radial is displayed.
	ADF bearings (C). 7 8 9 Have no ADF Radio Receivers	MAP, CTR MAP		The VOR/ADF switch on the EFIS Control Panel must be ON and a valid ADF signal must be received. Displays relative bear-ing to the tuned ADF station(s)
	Airplane symbol (W)	EXP VOR/ILS EXP NAV MAP, CTR MAP, PLAN	3 5	Current airplane position is at the apex of the triangle.
		MAP, CTR MAP, APP, VOR	7 8 9	
	Airplane symbol (W)	FULL VOR/ILS FULL NAV	3 5	Current airplane position is at the center of the symbol.
		APP CTR, VOR CTR,	7 8 9	

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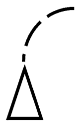
SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	Position trend vector (W) (dashed line))	MAP, CTR MAP	3 5	Predicts position at the end of 30, 60,and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range dettermines the number of segments displayed. For range: – greater than 20 NM, 3 segments – = 20 NM, 2 segments – <= 10 NM, 1 segment.
		MAP, MAP CTR	7 8 9	
	Airplane symbol (W)	PLN	7 8 9	Indicates actual position and track along the flight plan route in plan mode only. Inhibited north of 82N latitude and south of 82S latitude.
	Airplane symbol (W)	PLN	7 8 9	Represents current FMC position. Only displayed when north of 82N latitude and south of 82S latitude.
124 NM	Active waypoint distancel (W)	ALL	3 5	Distance to the active waypoint.
		MAP, CTR MAP, PLN	7 8 9	
0835.4z	Active waypoint ETA (W)	FULL NAV EXP NAV MAP, CTR MAP, PLAN	3 5	Indicates FMS-calculated ETA at the active waypoint.
		MAP, MAP CTR, PLN	7 8 9	

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SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
 AMBOY (Conditional WPT) 3 5 	Waypoint: active (M) inactive (W)	MAP, CTR MAP, PLAN - - - - MAP, CTR MAP, PLN	3 5 - - - - 7 8 9	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route. Data with parenthesis for conditional waypoints indicates type of conditional waypoint (altitude, "VECTORS" "INTC",
 MLF	Off route waypoint (C)	MAP, CTR MAP, PLAN - - - - MAP, MAP CTR, PLN	3 5 - - - - 7 8 9	When the WPT switch is ON, waypoints not on the selected route are displayed for ranges 3 5 10, 20, or 40 NM; 7 8 9 5, 10, 20, or 40.
	Flight plan route: active (M), modified (W), inactive (C), offset (M) (6 7 8 9)	MAP, CTR MAP, PLAN - - - - MAP, MAP CTR, PLN	3 5 - - - - 7 8 9	The active route is displayed with a contin-uous line (M) between waypoints.Active route modifications are dis-played with short dashes (W) between waypoints. Inactive routes are displayed with long dashes (C) between an offset route, select-ed through the FMC, is displayed with a dot - dash line (M) parallel to the active route.
 KILMR 12000 0835Z	Route data: active waypoint (M), inactive waypoint (W).	MAP, CTR MAP, PLAN - - - - MAP, CTR MAP, PLN	3 5 - - - - 7 8 9	When the RTE DATA switch 3 5 or DATA map switch on 7 8 9 entered or proce-dural altitude and ETA's for route waypoints will be displayed.

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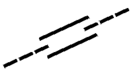
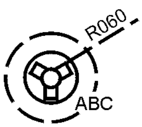
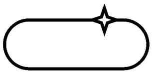
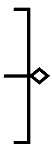
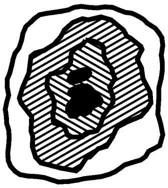
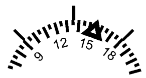
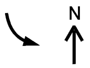
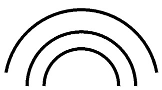
SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	Procedure turn: active route (M), modified route (W), inactive route (C)	MAP, MAP CTR, PLN	ALL	A procedure turn appears when in the flight plan. The procedure turn appears as a fixed sized if the selected range is greater than 80 NM. A scaled representation of procedure turn is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the procedure turn.
	Airport and runway (W)	MAP, CTR MAP, PLAN MAP, MAP CTR, PLN	3 5 7 8 9	Displayed when selected as the origin or destination and selected range is 3 5 80, 160, 320 7 8 9 80, 160, 320, 640.
	Airport (C) In CAL Ops specs	MAP, CTR MAP, PLAN MAP, MAP CTR, PLN	3 5 7 8 9	Displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway (W)	MAP, CTR MAP, PLAN MAP, MAP CTR, PLN	3 5 7 8 9	Displayed when selected as the origin or destination and selected range is 3 5 10, 20, 40 NM 7 8 9 10, 20, 40 NM. Dashed runway centerlines extend 14.2NM
	Selected reference point and bearing distance information (G)	MAP, CTR MAP, PLAN MAP, MAP CTR, PLN	3 5 7 8 9	Displayed the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).

SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	Holding pattern: active route (M), modified route (W), inactive route (C)	MAP, CTR MAP, PLAN MAP, MAP CTR, PLN	3 5 7 8 9	A holding pattern appears when in the flight plan. The holding pattern appears as a fixed size if the selected range is greater than 80 NM. A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the holding fix.
	Altitude range arc (G)	MAP, CTR MAP MAP, MAP CTR	3 5 7 8 9	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude is reached.
 T/C T/D S/C E/D	Altitude profile point and identifier (G)	MAP, CTR MAP, PLAN MAP, MAP CTR, PLN	3 5 7 8 9	Indicates the approximate map position of the FMC-calculated T/C (top-of-climb), T/D (top-of-descent), S/C (step climb), and E/D (end of descent) points. Deceleration points have no identifier.
	VNAV path pointer (M) and deviation scale (W)	FULL NAV EXP NAV MAP, CTR MAP MAP, MAP CTR, PLN	3 5 7 8 9	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates +/- 400 feet deviation. Digital display is provided when the pointer indicates more than +/- 400 feet.

SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	WEATHER RADAR RETURNS (G, Y, R, M)	EXP VOR/ILS EXP NAV MAP, CTR MAP - - - - - MAP, MAP CTR, APP, VOR	3 5 - - - - - 7 8 9	When either WXR switch is selected to the ON position, multi-colored weather radar returns are displayed. The most intense precipitation areas are displayed in red; less intensities, yellow, and lowest intensities, green. Areas of turbulence associated with precipitation are displayed in magenta.
STA WPT ARPT	Selected map options (C)	MAP, CTR MAP, PLN	7 8 9	Displays EFIS control panel selected map options.
FMC L or R	MAP source annunciation (G)	MAP, MAP CTR, PLN	7 8 9	Displays source of FMC data used by CDS for data presentation.
4.5 ▷L 4.5 △R	Position difference display (W)	FULL NAV EXP NAV MAP, CTR MAP - - - - - MAP, MAP CTR	3 5 - - - - - 7 8 9	Numbers – Indicate the position difference in NM between the present FMC position and the L IRS and R ILS present position. The selected IRS source is displayed on the first line. Arrows – Indicate the relative bearing to the related IRS present position. L or R – Indicates which IRS present position difference corresponds to. Displayed when the position difference of the L IRS and/or R IRS exceeds the position difference limits.

SYMBOL(S)	DATA NAME/(COLOR)	APPLICABLE MODE(S)	APPLICABLE A/C	REMARKS
	Drift angle pointer (W)	FULL VOR/ILS FULL NAV	3 5	Indicates airplane's present track. Replaces track line in the center APP and VOR modes.
		APP CTR, VOR CTR	7 8 9	Indicates airplane's present track. Replaces track line when a Full Rose mode is selected.
	North up arrow (G)	PLAN	3 5	Indicates map background is oriented and referenced to true north.
		PLN	6 8 9	
	Range arcs (W)	MAP, APP, VOR	7 8 9	Displayed in APP and VOR modes when the EFIS WXR map switch is selected or TCAS TFC switch is selected. Range arcs are displayed in MAP mode with or without WXR or TFC selected.

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FIRE PROTECTION

TABLE OF CONTENTS

SYSTEM DESCRIPTION

INTRODUCTION

There are fire detection and extinguishing systems for:

- engines
- APU
- lavatories
- cargo compartments.

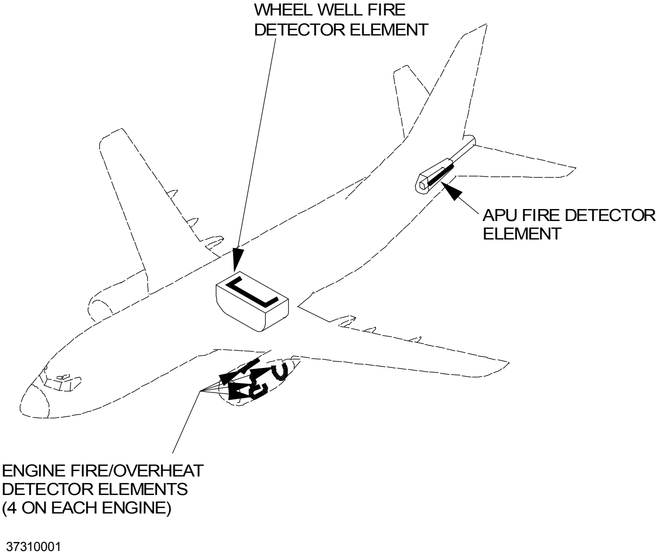
The engines also have overheat detection.

The main gear wheel well has a fire detection system, but no fire extinguishing capability.

ENGINE FIRE PROTECTION

Engine fire protection consists of these systems:

- engine overheat and fire detection powered by the battery bus
- engine fire extinguishing powered by the hot battery bus.



FIRE AND OVERHEAT DETECTOR ELEMENT LOCATIONS

ENGINE OVERHEAT AND FIRE DETECTION

Each engine contains two overheat / fire detector loops. Each of these loops consists of four detector elements. Each loop provides both fire and overheat detection. As the temperature of a detector increases to a predetermined limit, the detector senses an overheat condition. At higher temperatures, the detector senses a fire condition. Normally, both detector loops must sense an overheat or fire condition to cause an engine overheat or fire alert. The **ENG OVERHEAT** light or engine fire warning switch remains illuminated until the temperature drops below the onset temperature.

An OVHT DET switch for each engine, labeled A, B, and NORMAL, permits selection of either loop A or B, or both A and B (NORMAL), as the active detecting loops.

The system contains a fault monitoring circuit. If one loop fails with the OVHT DET switch in NORMAL, that loop is automatically deactivated and the remaining loop functions as a single loop detector. There is no flight deck indication of single loop failure. If both loops fail on an engine, the **FAULT** light illuminates and the system is inoperative.

If the OVHT DET switch is positioned to A or B, the system operates as a single loop system. The non-selected loop is not monitored. If the selected loop fails, the **FAULT** light illuminates and the system is inoperative.

The indications of an engine overheat are:

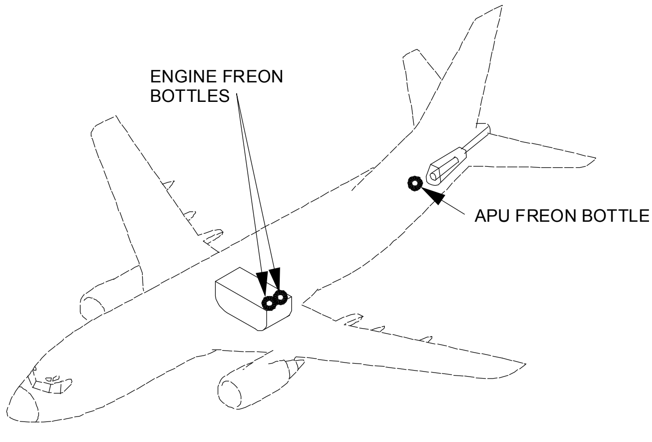
- both **MASTER CAUTION** lights illuminate
- the **OVHT/DET** system annunciator light illuminates
- the related **ENG OVERHEAT** light illuminates.

The indications of an engine fire are:

- the fire warning bell sounds
- both master **FIRE WARN** lights illuminate
- the related engine fire warning switch illuminates
- all related engine overheat alert indications illuminate
- engine overheat occurs before engine fire warning.

Note: The **FAULT** light is not connected to the Master Caution light system.

ENGINE FIRE EXTINGUISHING



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EXTINGUISHER BOTTLE LOCATIONS

The engine fire extinguisher system has two engine fire extinguisher bottles, two engine fire warning switches, two **BOTTLE DISCHARGE** lights, and an EXT TEST switch. Either or both bottles can be discharged into either engine.

The engine fire warning switches are normally locked down to prevent inadvertent shutdown of an engine. Illumination of an engine fire warning switch or **ENG OVERHEAT** light unlocks the engine fire warning switch. The switches may also be unlocked manually.

Pulling the engine fire warning switch up:

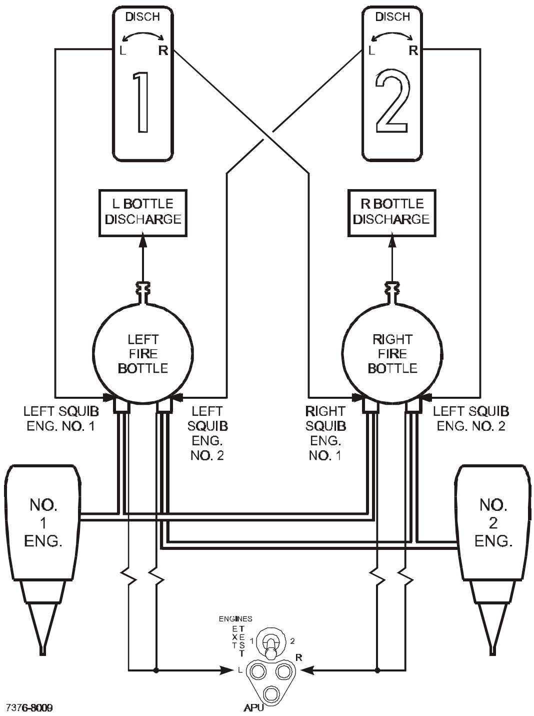
- ③ ❸ ❺ closes the main engine fuel shutoff valve
- ❼ ❽ ❾ closes both the engine fuel shutoff valve at the HMU and the spar fuel shutoff valve
- closes the engine bleed air valve resulting in loss of wing anti-ice to the affected wing and closure of bleed air operated pack valve as long as the pneumatic isolation valve remains closed
- trips the generator control relay and breaker
- closes the hydraulic fluid shutoff valve and deactivates the engine driven hydraulic pump **LOW PRESSURE** light

- disables respective thrust reverser
- allows the engine fire warning switch to be rotated for discharge
- arms one discharge squib on each engine fire extinguisher bottle.

Rotating the engine fire warning switch electrically "fires" a squib, discharging the extinguishing agent into the related engine. Rotating the switch the other way discharges the remaining bottle.

The **L** or **R BOTTLE DISCHARGE** light illuminates a few seconds after the engine fire warning switch is rotated, indicating the bottle has discharged.

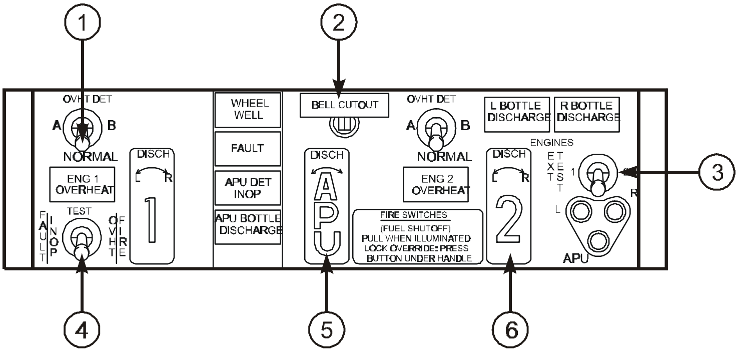
The **ENG OVERHEAT** light remains illuminated until the temperature drops below the onset temperature.



ENGINE FIRE EXTINGUISHER SCHEMATIC

CONTROLS AND INDICATORS

OVERHEAT / FIRE PROTECTION PANEL SWITCHES



AFT ELECTRONIC PANEL

7376-8003

① Overheat Detector (OVHT DET) Switch

NORMAL – detection loop A and loop B are active.

A – detection loop A is active.

B – detection loop B is active.

② Fire Warning BELL CUTOUT Switch

Push –

- extinguishes both master **FIRE WARN** lights
- silences the fire warning bell
- silences the remote APU fire warning horn (on the ground only)
- resets the system for additional warnings.

③ Extinguisher (EXT) TEST Switch

(spring-loaded to center)

1 or 2 – tests bottle discharge circuits for all three extinguisher bottles.

④ Fault / Inoperative (FAULT/INOP) and Overheat / Fire (OVHT/FIRE) TEST Switch

(spring-loaded to center)

FAULT/INOP – tests fault detection circuits for both engines and the APU.

OVHT/FIRE – tests overheat and fire detection loops on both engines and APU, and wheel well fire detector.

⑤ APU Fire Warning Switch

Illuminated (red) –

- indicates fire in APU
- unlocks APU fire warning switch.

Flight Deck

- Master **FIRE WARN** lights illuminate, fire warning bell sounds.

Main Wheel Well

- APU fire warning horn sounds (on ground only), and APU fire warning light flashes.

Down – normal position, mechanically locked if no fire signal.

Up –

- arms APU extinguisher circuit
- closes fuel shutoff valve, APU bleed air valve, and APU inlet door
- trips generator control relay and breaker
- allows APU fire warning switch to rotate.

Rotate (left or right) –

- discharges APU fire bottle.

Rotating the APU fire warning switch in either direction electrically "fires" the squib discharging the extinguishing agent into the APU. The APU **BOTTLE DISCHARGE** light illuminates after a few seconds, indicating the bottle has discharged.

⑥ Engine Fire Warning Switch

Illuminated (red) –

- indicates fire in related engine
- unlocks related engine fire warning switch
- Master **FIRE WARN** lights illuminate and fire warning bell sounds.

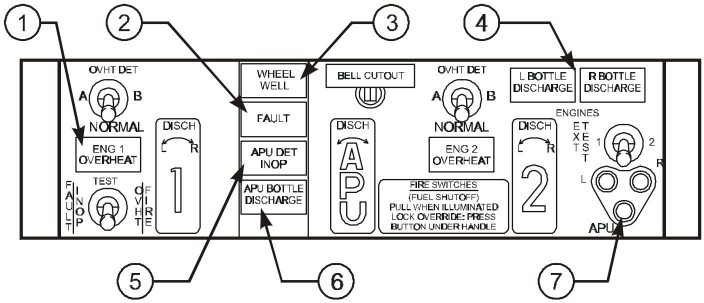
Down – normal position, mechanically locked if no fire signal.

Up –

- arms one discharge squib on each engine fire extinguisher
- closes fuel, hydraulic shutoff and engine bleed air valves
- disables thrust reverser
- trips generator control relay and breaker
- deactivates engine driven hydraulic pump **LOW PRESSURE** light
- allows engine fire warning switch to rotate.

Rotate (left or right) – discharges related fire bottle.

OVERHEAT / FIRE PROTECTION PANEL LIGHTS



AFT ELECTRONIC PANEL

7376-8004

① Engine (**ENG**) **OVERHEAT** Light

Illuminated (amber) – indicates overheat in related engine.

- **MASTER CAUTION** and **OVHT/DET** system annunciator lights illuminate.

② **FAULT** Light

Illuminated (amber) – with the overheat detector switch in NORMAL - indicates both detector loops for an engine have failed.

Illuminated (amber) – with the overheat detector switch in A or B – indicates the selected loop for an engine has failed.

- **MASTER CAUTION** and **OVHT/DET** system annunciator lights do not illuminate.

③ **WHEEL WELL** Fire Warning Light

Illuminated (red) – indicates fire in main gear wheel well

- Master **FIRE WARN** lights illuminate and fire warning bell sounds.

④ Engine **BOTTLE DISCHARGE** Light

Illuminated (amber) – indicates related fire extinguisher bottle has discharged.

⑤ APU Detector Inoperative (**DET INOP**) Light

Illuminated (amber) – indicates APU detector loop has failed.

- **MASTER CAUTION** and **OVHT/DET** system annunciator lights illuminate.

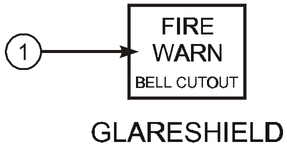
⑥ APU **BOTTLE DISCHARGE** Light

Illuminated (amber) – indicates APU extinguisher bottle has discharged.

⑦ Extinguisher Test (**EXT TEST**) Lights

Illuminated (green) – EXT TEST switch is positioned to 1 or 2 and circuit continuity is normal.

MASTER FIRE WARNING LIGHT



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① Master Fire Warning (**FIRE WARN**) Lights

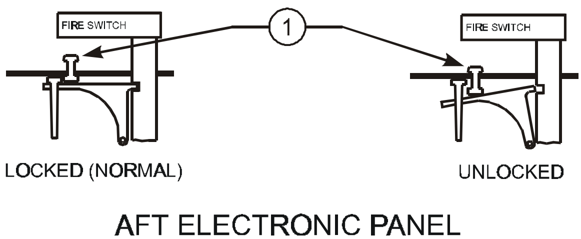
Illuminated (red) – indicates a fire warning (or system test) in engine, APU, main gear wheel well or cargo compartment

- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

Push –

- extinguishes both master **FIRE WARN** lights
- silences fire warning bell
- silences remote APU fire warning horn
- resets system for additional warnings
- pushing fire warning bell cutout switch on overheat / fire protection panel results in same actions.

FIRE WARNING SWITCH OVERRIDE



7376-8006

① Fire Warning Switch Override

Push – unlocks fire warning switch.

FIRE AND OVERHEAT SYSTEM TESTS

The fire and overheat detection systems can be tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch. Extinguisher continuity can be tested by pushing and holding the EXT TEST switch. All test indications clear when switches are released.

FAULT/INOP Test Detection

The fault detection (Overheat and Fire Monitor) circuits for both the engines and the (Fire Monitor) for the APU are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the FAULT/INOP position.

The indications for the FAULT/INOP test are:

- both **MASTER CAUTION** lights illuminate
- the **OVHT/DET** system annunciator light illuminates
- the **FAULT** light illuminates
- the **APU DET INOP** light illuminates.

OVERHEAT/FIRE Test Detection

The overheat and fire detection loops (continuity test) on both engines, the APU, and the fire detector in the wheel well are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the OVHT/FIRE position.

The indications for the OVHT/FIRE test are:

- the fire warning bell sounds
- both master **FIRE WARN** lights illuminate
- both **MASTER CAUTION** lights illuminate
- the **OVHT/DET** system annunciator light illuminates
- both engine fire warning switches illuminate
- the APU fire warning switch illuminates
- both **ENG OVERHEAT** lights illuminate
- the **WHEEL WELL** fire warning light illuminates if AC power is available
- on the ground, the wheel well APU fire warning horn sounds and the wheel well APU fire warning light flashes.

Extinguisher Test

When the EXT TEST switch is positioned to 1 or 2, the green **EXT TEST** lights illuminate, verifying circuit continuity from the squib to the engine fire warning switch.

APU FIRE PROTECTION

APU fire protection consists of these systems:

- APU fire detection powered by the battery bus.
- APU fire extinguishing powered by the hot battery bus.

APU Fire Detection

A single fire detection loop is installed on the APU. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The APU fire warning switch remains illuminated until the temperature of the detector has decreased below the onset temperature.

The system contains a fault monitoring circuit. If the loop fails, the **APU DET INOP** light illuminates indicating the APU fire detection system is inoperative.

The indications of an APU fire are:

- the fire warning bell sounds
- both master **FIRE WARN** lights illuminate
- the APU fire warning switch illuminates
- the APU automatically shuts down
- the wheel well APU fire warning horn sounds, (on the ground only), and the wheel well APU fire warning light flashes.

APU Fire Extinguishing

The APU fire extinguisher system consists of one APU fire extinguisher bottle, an APU fire warning switch, an **APU BOTTLE DISCHARGE** light, and an EXT TEST switch. The APU ground control panel located in the right main wheel well also contains an APU fire warning light, an APU BOTTLE DISCHARGE switch, an APU fire control handle and APU HORN CUTOUT switch.

The APU fire warning switch is normally locked down to prevent inadvertent shutdown of the APU. Illumination of the APU fire warning switch unlocks the switch. The switch may also be unlocked manually.

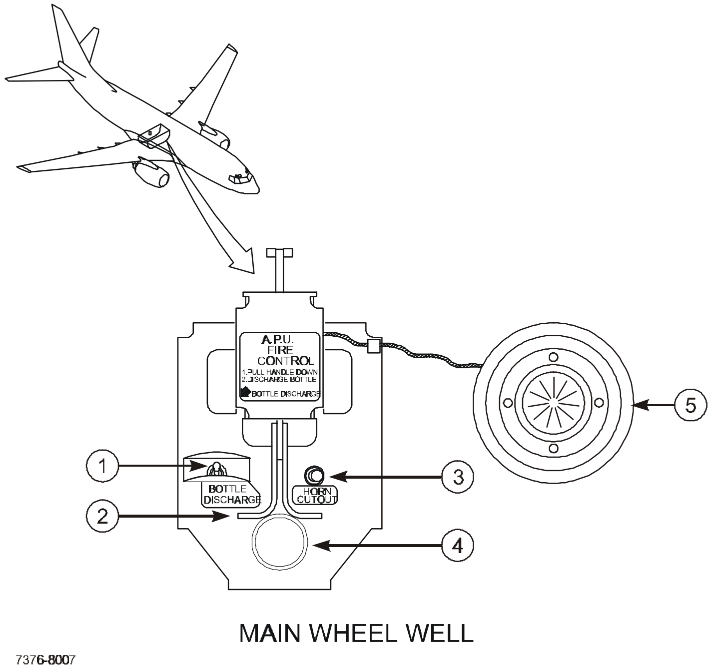
Pulling the APU fire warning switch up:

- provides backup for the automatic shutdown feature
- closes the fuel solenoid and closes the APU fuel shutoff valve
- closes the APU bleed air valve
- closes the APU air inlet door
- trips the APU generator control relay and breaker
- allows the APU fire warning switch to be rotated for discharge
- arms the APU fire extinguisher bottle squib.

Rotating the APU fire warning switch in either direction electrically “fires” the squib discharging the extinguishing agent into the APU. The **APU BOTTLE DISCHARGE** light illuminates after a few seconds, indicating the bottle has discharged.

The APU fire warning switch and fire **WARNING** light (wheel well) remain illuminated until the temperature surrounding the sensor / responder has decreased below the alarm temperature.

APU GROUND CONTROL PANEL



① APU BOTTLE DISCHARGE Switch

(spring-loaded to center)

Left or right – discharges APU extinguisher.

Note: Armed only if APU fire control handle is pulled at this panel.

② APU Fire Control Handle

Up – normal position.

Down –

- closes APU fuel shutoff and solenoid valves, bleed air valve and APU inlet door
- trips generator control relay and breaker
- arms APU BOTTLE DISCHARGE switch (on this panel only).

③ APU Fire Warning HORN CUTOUT Switch

Push –

- silences fire alarm bell
- silences APU fire warning horn
- causes APU fire warning light to stop flashing but remain illuminated.

④ APU Fire Warning Light

Illuminated (red flashing) – indicates fire in APU.

Flight Deck

- Flight deck fire warning bell sounds.

Main Wheel Well

- APU fire warning horn sounds.

Illuminated (red steady) – indicates APU fire warning HORN CUTOUT switch has been pushed following an APU fire indication.

⑤ APU Fire Warning Horn

Compartment Fire Classification

The forward and aft cargo compartments are now classified as Class C compartments. The classification changed from D to C with the installation of the fire detection and suppression system.

CARGO COMPARTMENT SMOKE DETECTION AND SUPPRESSION

③ 3 5 Cargo compartment smoke detection and extinguishing is powered by the hot battery bus.

7 8 9 Cargo compartment smoke detection is powered by DC bus 1 and DC bus 2.

7 8 9 Cargo compartment fire extinguishing is powered by the hot battery bus.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors in a dual loop configuration. Normally, both detection loops must sense smoke to cause an alert. These loops function in the same manner as the engine overheat / fire detection loops.

③ 3 5 Cargo Compartment Fire Warning

A cargo fire warning is indicated by:

- fire warning bell
- **FIRE WARN** lights
- **MASTER CAUTION** lights
- Annunciator Panel:
  - **OVHT/DET**
- Cargo Fire Control Panel:
  - **FIRE** light
  - **A** and **B DET** lights for affected cargo compartment
- **FWD** or **AFT** squib light for affected compartment
- **BTL-1** and **BTL-2** squib lights.

7 8 9 Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:

- fire warning bell
- **FIRE WARN** lights
- the **FWD/AFT** cargo fire warning light(s) illuminates.

③ 3 5 Cargo Compartment Fire Suppression

The forward and aft cargo compartments contain discharge nozzles in the ceiling. Two extinguisher bottles (1 ST and 2 ND) are connected to the forward and aft compartment nozzles through a diverter valve. Each bottle has one squib.

The diverter valve has two squibs, forward and aft. Only one can be fired. This determines the compartment to which the (1 ST and 2 ND) bottles are discharged.

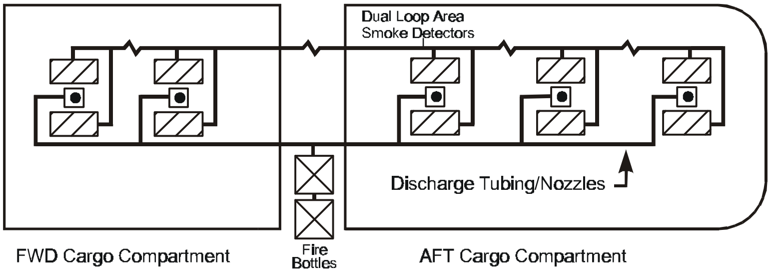
When a fire is indicated with the ARM switch on the cargo fire control panel selected to AUTO, the respective forward or aft diverter valve squib light and both bottle squib lights illuminate. These lights indicate the respective squib is armed.

When the bottle one DSCH 1 ST BTL switch is pushed, agent is quickly discharged into the compartment determined by the diverter valve to put out "knock down" the fire. When the bottle two DSCH 2 ND BTL switch is pushed, 15 minutes after discharging the first bottle, agent is discharged through a metering valve, then through the diverter. The metering valve sustains discharge from bottle two for approximately 45 minutes, which provides fire suppression for 60 minutes.

7 8 9 Cargo Compartment Fire Suppression

Two fire extinguisher bottles are installed. Detection of a fire in either forward or aft compartment causes the **FWD** or **AFT** cargo fire warning light to illuminate. The extinguishers are armed by pushing the appropriate cargo fire ARMED switch. Once armed, the first bottle is discharged by pushing the cargo fire DISCH switch. This discharges the first bottle total contents into the selected compartment. The second bottle discharges 60 minutes later at a reduced flow into the selected compartment automatically. Discharge of the second bottle may be disabled if the system is disarmed. The cargo fire **DISCH** light illuminates when a bottle is discharged. It may take up to 30 seconds for the light to illuminate. On landing, if the first bottle was discharged and the system remains armed, the second bottle discharge is inhibited.

7 8 9 CARGO FIRE EXTINGUISHER SCHEMATIC



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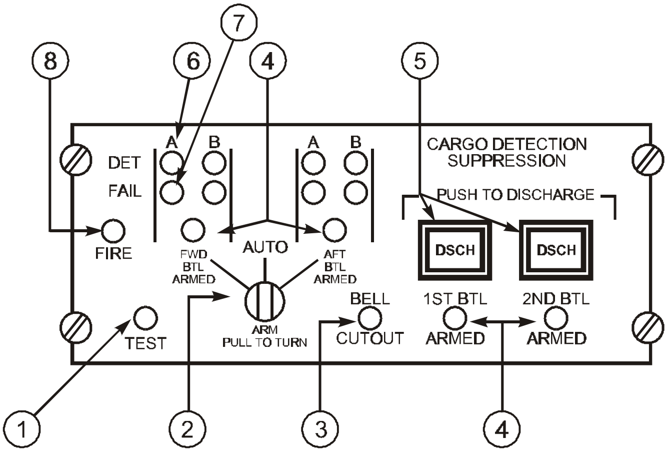
③ 3 5 CARGO FIRE SYSTEM TESTS

The cargo fire detection and extinguishing system can be tested by pushing and holding the cargo fire TEST switch. This sends a test signal to the forward and aft cargo fire detector loops and continuity of bottle and deverter valve squibs circuits. All test indications clear when the TEST switch is released.

7 8 9 CARGO FIRE SYSTEM TESTS

The cargo fire detection and suppression system can be tested by pushing and holding the cargo fire TEST switch. This sends a test signal to the forward and aft cargo fire detector loops and verifies continuity of the extinguisher bottle squib circuits. All test indications clear when the TEST switch is released.

③ 3 5 CARGO FIRE PANEL



7376-8008

① TEST Switch – Push – Tests detection and suppression systems.

Fire bell – sounds
FIRE WARN – 2 (red) lights illuminate
MASTER CAUTION – 2 (amber) lights illuminate
OVHT/DET annunciator illuminates

CARGO FIRE CONTROL PANEL (forward center pedestal)

DET – 4 (amber) lights, respective detector loop operational
FAIL – 4 (amber) lights, respective loop fail monitor system operational
FWD BLT ARMED / AFT BLT ARMED – 2 (green) lights – diverter squibs operational
1 ST BTL ARMED / 2 ND BTL ARMED – 2 (green) lights – each bottle squib operational
FIRE – one (red) light

DSCH annunciators switch lights – 2 (amber) lights do not illuminate when TEST switch is pushed.
DSCH annunciators switch lights are tested when lights test switch on the center instrument panel is placed to TEST.

② ARM Switch – Controls arming of squibs.

AUTO – With a cargo fire warning indication:

- Diverter valve squib automatically armed for compartment with fire.
- Extinguisher squibs automatically armed for bottle 1 and bottle 2.
- Respective squib lights illuminate.
- Permits automatic switching from dual to single loop mode if a single loop fails.

FWD or AFT – Cargo fire warning indication not required:

- Forward or aft compartment diverter valve squib armed for selected compartment.
- Respective diverter squib light illuminates.
- Bottle 1 squib light and bottle 2 squib light illuminate.

③ BELL CUTOUT Switch

- Resets fire warning system, extinguishes **FIRE WARN** lights and silences fire bell.

④ Squib lights – 4 (green) – Illuminated, respective squib armed or TEST switch pushed.

- **FWD/AFT** squib lights illuminated
  Forward or aft squibs on diverter valve armed.

- **BTL 1** or **BTL 2** squib lights illuminated
  Bottle 1 and 2 squibs armed.

⑤ DSCH – Push to discharge – 2 switches

- Automatically armed with fire indication when ARM switch selected to AUTO

- Manually armed when ARM switch selected to FWD or AFT.

- DSCH (1 ST BTL) push to discharge switch – Push
  Fire two squibs – Either the forward or aft cargo compartment squib on diverter valve and number 1 bottle squib. Agent flows through diverter valve to appropriate compartment.

- DSCH (2 ND BTL) push to discharge switch – Push
  Fires number 2 bottle squib. Agent flows through metering and diverter valves to appropriate compartment.

- **DSCH** annunciators 2 (amber)

  Illuminated when respective bottle pressure is low.

⑥ **DET** lights 4 (amber)

Illuminated when respective detector senses smoke or TEST switch pushed.

⑦ **FAIL** lights 4 (amber)

Illuminated when respective loop has failed or TEST switch pushed.

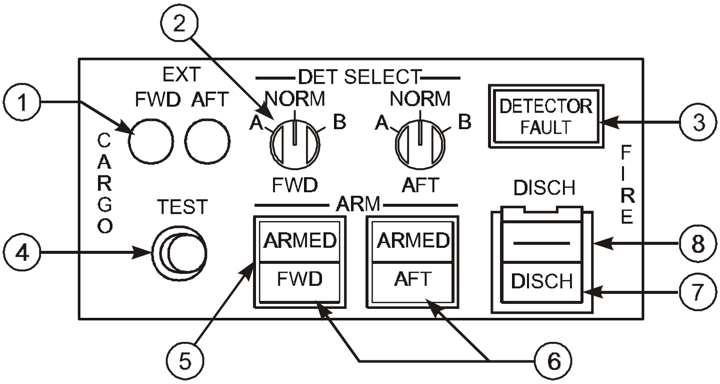
⑧ **FIRE** light (red)

Illuminated when forward or aft cargo compartment smoke (fire) detected or TEST switch pushed.

③ 3 5 Cargo Fire Light Test

To test the Cargo Suppression Detection Control Panel lights, the aircraft's Master Dim and Test switch must be moved to TEST. This will test all the lights on the Cargo Suppression Detection Control Panel including the **DSCH** indicators not tested by the system test.

7 8 9 Cargo Fire Panel



AFT ELECTRONIC PANEL

7376-8010

① Extinguisher (**EXT**) Test Lights

Illuminated (green) - Cargo Fire TEST switch is pushed and fire bottle discharge squib circuit continuity is normal.

② Detector Select (DET SELECT) Switches

NORM - detection loop A and B are active.

A - detection loop A is active.

B - detection loop B is active.

③ **DETECTOR FAULT** Light

Illuminated (amber) -

- Both loops in one or both cargo compartments have failed

④ Cargo Fire TEST Switch

PUSH - tests circuits for both forward and aft cargo fire detector loops and suppression system.

7 8 9 Cargo Fire Test

The indications for the Cargo Fire test are:

- the fire warning bell sounds
- both master **FIRE WARN** lights illuminate
- the extinguisher test lights illuminate
- the **FWD** and **AFT** cargo fire warning lights illuminate when all detectors in selected loop(s) respond to the fire test
- the cargo fire bottle **DISCH** light illuminates.

During a cargo fire test, the **DETECTOR** fault light illuminates if one or more detectors in the loop(s) has failed.

Individual detector faults can only be detected by a manually initiated test. The **MASTER CAUTION** light does not illuminate.

At the end of cargo fire testing, up to a four second delay may occur to allow all applicable indications to extinguish at the same time.

⑤ Cargo Fire ARM Switches

PUSH -

- FWD ARMED - extinguisher armed for the forward cargo compartment
- AFT ARMED - extinguisher armed for the aft cargo compartment.
- If the first bottle has discharged and the system remains armed, the second bottle discharge is inhibited upon landing.
- The second bottle discharge timer is disabled when the system is disarmed.

⑥ Cargo Fire (**FWD/AFT**) Warning Lights

Illuminated (red) -

- at least one detector in each loop detects smoke
- with power failed in one loop, at least one detector on the remaining loop detects smoke
- master **FIRE WARN** lights illuminate and fire warning bell sounds.

⑦ Cargo Fire Bottle Discharge (**DISCH**) Light

Illuminated (amber) - indicates that either extinguisher bottle has discharged

⑧ Cargo Fire Discharge (DISCH) Switch

PUSH - if system is armed, discharges the first extinguisher bottle. Timer is set for 60 minutes to discharge the second extinguisher bottle.

MAIN WHEEL WELL FIRE DETECTION

Main wheel well fire detection is powered by the No. 1 AC transfer bus.

The main wheel well has no fire extinguishing system. The nose wheel well does not have a fire detection system.

A single fire detector loop is installed in the main wheel well. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The **WHEEL WELL** fire warning light remains illuminated until the temperature of the detector has decreased below the onset temperature.

The indications for a main wheel well fire are:

- the fire warning bell sounds
- both master **FIRE WARN** lights illuminate
- the **WHEEL WELL** fire warning light illuminates.

LAVATORY FIRE PROTECTION

Lavatory fire protection consists of these systems:

- lavatory smoke detection
- lavatory fire extinguishing (heat activated).

Lavatory Smoke Detection

The lavatory smoke detection system monitors for the presence of smoke. When smoke is detected:

- an aural warning sounds
- the red alarm indicator light on the lavatory smoke detector panel illuminates.

There is no flight deck indication. When smoke is no longer present the system automatically resets.

Lavatory Fire Extinguisher System

Heat activated fire extinguishers for each disposal receptacle located within the lavatory have been installed. The built-in fire extinguisher will discharge automatically into each disposal receptacle upon occurrence of a fire in the receptacle.

A fire extinguisher system is located beneath the sink area in each lavatory. When a fire is detected:

- fire extinguisher operation is automatic
- flight deck has no indication of extinguisher discharge.

Lavatory Smoke Detector

A smoke detector in each lavatory monitors the air for presence of smoke or equivalent contaminants. The detector sounds an aural warning and illuminates a light.

There are two types of smoke detectors. On early aircraft, the smoke detector is below the sink behind the access door. On later aircraft the smoke detector is in the ceiling of the lavatory.

Early Type

The detector uses a photocell device to detect the smoke. Only a 4-7% smoke concentration is necessary to activate the aural and visual alarms, depending on the efficiency of the lav ventilation system. Based on an average ventilation system, a cigarette smoker will probably activate the alarm system.

The aural alarm sounds the cabin chime every 4 seconds. The visual alarm is the amber call light for the respective lavatory. Aural and visual alarms remain active until the smoke concentration is reduced below alarm level.

The smoke detector is powered by 28V DC bus 1 through a circuit breaker on P18-4 panel labeled **PASS & CREW CALL**.

Circuit breaker deactivation shuts down all detectors and **PASS & CREW** call system.

Later Type

The smoke detector uses an ionization sensor to detect smoke. A very small amount of radioactive material ionizes the air between two electrodes, allowing current to flow through the air between the electrodes. Any smoke particles present interfere with this current flow. The change in current flow is sensed by a current amplifier, which outputs a signal to turn on the alarm horn and alarm indicator light.

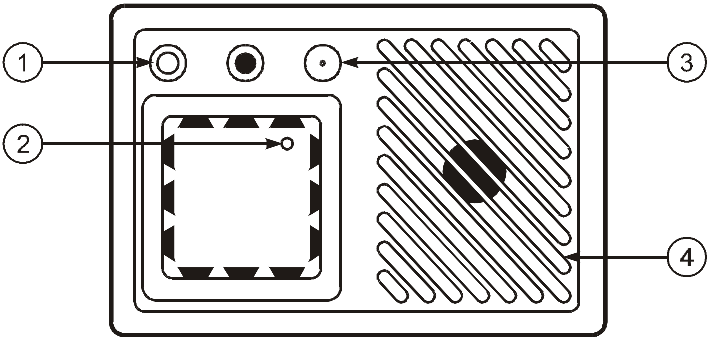
The smoke detector is powered by the 28V DC bus 1 through a circuit breaker on P18-4 panel labeled **PASS & CREW CALL/LAV SMOKE DETECTOR**.

Once activated, the smoke detector continues to sound an aural alarm and light remains illuminated until reset.

Reset can be made by pulling the **LAV SMOKE** detector circuit breaker on P18-4 for 5 seconds and then closing the circuit breaker. If the circuit breaker is not closed, smoke detectors and call system are deactivated.

789 Smoke detector deactivation is via circuit breaker P18-3 (lavatory smoke).

3 5 7 8 9 Lavatory Smoke Detector – Later Type



LAVATORY SMOKE DETECTOR

7376-8001

① POWER-ON Indicator Light (green) – Illuminated when power is applied to the smoke detector.

② ALARM Indicator Light (red) – Illuminated when smoke is detected.

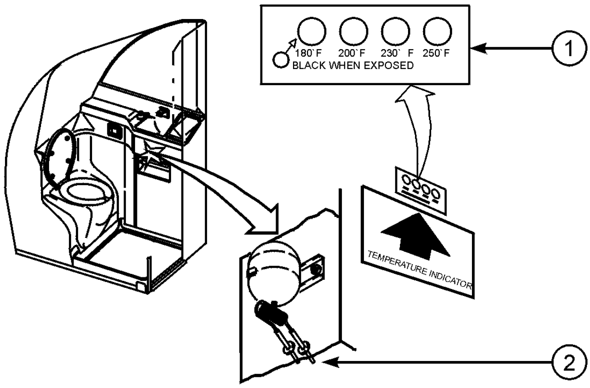
③ TEST Switch – INOP

④ Speaker – Alarm horn, activates with continuous tone when smoke is detected.

Horn sounds until reset.

LAVATORY FIRE

Lavatory Fire Extinguisher



BELOW LAVATORY SINK

7376-8002

① TEMPERATURE INDICATOR Placard

White – normal condition.

Black – exposed to high temperatures.

② Heat Activated Nozzles

Flat black – normal condition.

Aluminum – indicates extinguisher has discharged.

Note: Some bottles only have one nozzle.

LIST OF EFFECTIVE PAGES

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ELECTRICAL

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ELECTRICAL SYSTEM DESCRIPTION

GENERAL

Primary electrical power is provided by two engine driven generators or integrated drive generators (IDGs) as installed. The generators / IDGs produce 115 volt, 400 cycle, three-phase alternating current. Each generator / IDG supplies its own bus system in normal operation and can also supply power to the opposite bus system when one engine generator / IDG is inoperative. Step-down transformers provide low voltage AC power for lighting, instruments and other low voltage AC circuits. Transformer rectifier (TR) units and a battery / battery charger supply DC power and backup power for the standby system. There are two basic principles of operation for the electrical system:

- There is no paralleling of the AC power.
- The source of power being connected to a bus system automatically disconnects an existing source.

The electrical power system may be categorized into three main divisions: the AC system, the DC system, and the standby power system.

Engine Generators / IDGs

③ 3 5 Two 45 KVA three-phase brushless generators provide primary AC power. Each generator is driven through a constant speed drive (CSD) which maintains a constant generator speed throughout the normal operating range of the engine. The CSD is coupled directly to the engine and provides for complete mechanical isolation of the generator.

7 8 9 Two 90 KVA integrated drive generators (IDGs) provide primary AC power. The IDGs contain the generator and drive in a common housing which maintains a constant generator speed throughout the normal operating range of the engine. The IDG eliminates the need for a separate drive (CSD) unit. An integral electro-mechanical disconnect provides for complete isolation of the IDG.

APU Generator

The APU generator may be used to supply primary power on the ground and will serve, inflight, as backup for the engine generators. APU operation is monitored on the overhead panel, which includes an ammeter for generator load monitoring.

③ 3 5 The APU generator can supply both generator busses on the ground but only one generator bus inflight.

7 8 9 The APU generator can supply power to both transfer busses on the ground and inflight.

External Ground Power

An external AC power receptacle located near the nose gear wheel well, on the lower right side of the fuselage, allows the use of an external power source. Status lights on a panel adjacent to the receptacle permit the ground crew to determine if the external power is being used. A **GRD POWER AVAILABLE** light provides flight deck indication that AC ground power is connected to the aircraft. A GRD PWR switch allows transmission of external power to both bus systems.

The Battery Switch must be ON for the GRD PWR switch to be able to power the aircraft's AC systems. ③ 3 5 Positioning the Battery Switch to OFF will automatically disconnect GRD PWR.

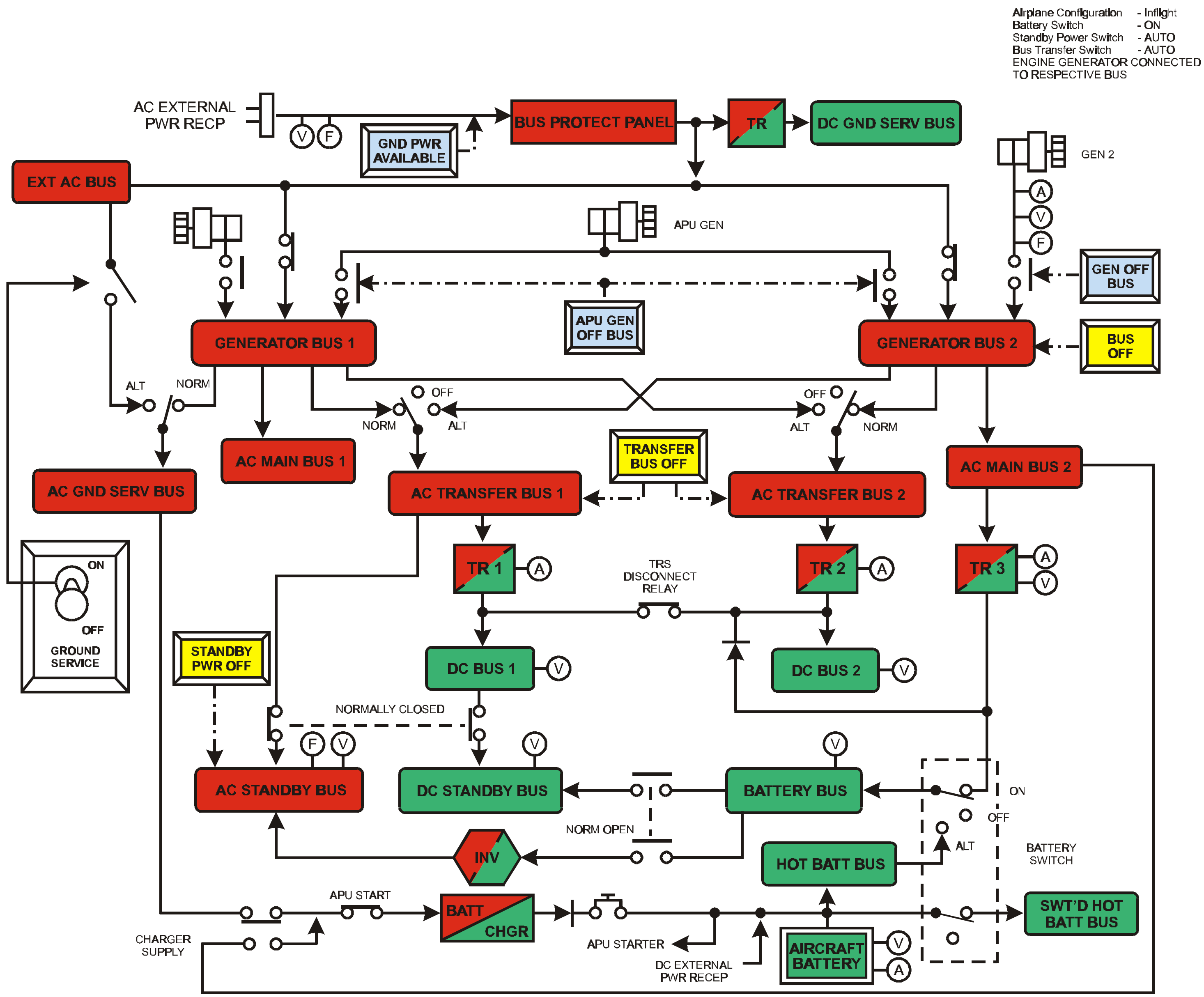
Ground Service

For ground servicing, a solenoid-held Ground Service Switch is on the forward attendant's panel. This switch provides power from ground power directly to the AC ground service bus(ses) for utility outlets, cabin lighting and the battery charger without powering all aircraft electrical busses.

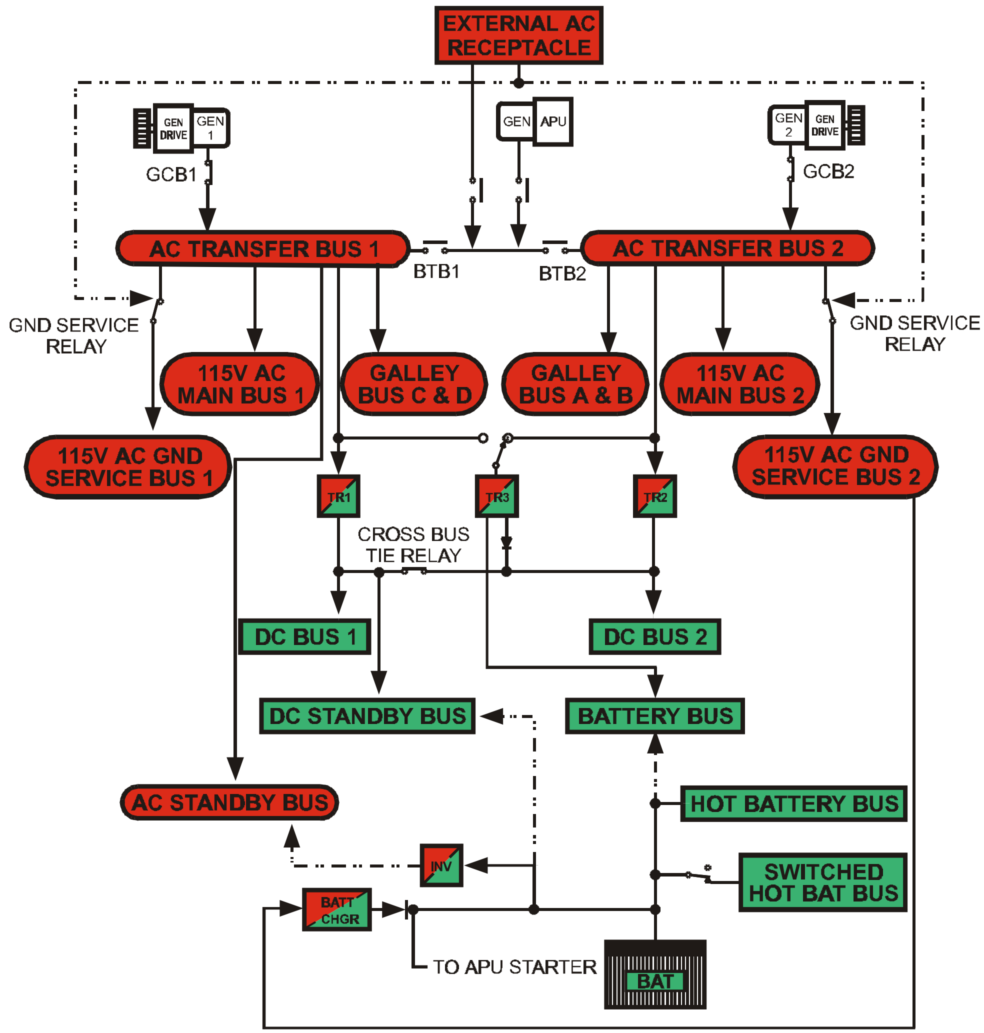
③ 3 5 The Ground Service Switch is magnetically held in the ON position and is overridden when the GRD PWR switch is positioned to ON.

7 8 9 A second AC ground service bus has been added. Ground service busses continue to operate identical to and power the same components as in prior models. The ground service switch is a momentary push button and is overridden when both AC transfer busses are powered.

③ 3 5 ELECTRICAL POWER SCHEMATIC



7 8 9 ELECTRICAL POWER SCHEMATIC



Airplane Configuration - In Flight
Battery Switch - ON
Standby Power Switch - AUTO
Bus Transfer Switch - AUTO
ENGINE GENERATOR CONNECTED TO RELATED BUS

7376-6002

③ 3 5 AC Power System

Each AC power system consists of a generator bus, a main load bus and a transfer bus. If there is a failure of a generator bus, the associated transfer bus can be supplied automatically from the powered generator bus. Each transfer bus has an associated transfer relay which automatically selects the opposite generator bus as a power supply if its normal generator bus fails and the Bus Transfer Switch is in AUTO.

With the aircraft on the ground and external power connected, momentarily positioning the Ground Power Switch to ON trips both engine generators or APU generator and connects external power to both generator busses. When the APU is operating, electrical power output of the APU generator can be connected to either or both generator busses through the respective APU Generator Switches.

Whenever ground power is on both generator busses, and APU or engine generator power is applied to one generator bus, ground power continues to supply power to the remaining generator bus.

In flight, each engine generator normally powers its own generator bus. If a generator is inoperative, the APU generator may be used to power one inoperative generator's bus. Since the entire electrical system is powered from the two generator busses, all electrical components can be powered with any two operating generators.

The electrical system monitors itself, through bus protection panels, for correct voltage, frequency, and ground faults in the generator, or excessive current draw from any generator.

③ 3 5 Bus Transfer System

The generator busses and main busses supply the heavy and nonessential electrical loads respectively. The transfer busses supply the essential loads. If a generator trips off the line inflight due to a fault, the generator bus and main bus will be de-energized, but the transfer bus automatically transfers to the operating generator.

7 8 9 AC POWER SYSTEM

Each AC power system consists of a transfer bus, a main bus, two galley busses, and a ground service bus. Transfer bus 1 also supplies power to the AC standby bus. If the AC source powering either transfer bus fails or is disconnected, the transfer bus can be powered by any available source through the BTBs with the bus transfer switch in AUTO.

With the aircraft on the ground and both generator control switches OFF, or with APU power applied, selecting the GRD PWR switch ON connects external power to both transfer busses. Likewise, selecting either APU GEN switch ON connects APU power to both transfer busses. Whichever source is selected last powers both busses. It is not possible to power one transfer bus with external power and one transfer bus with APU power.

The transfer busses can be powered from the IDG by momentarily positioning the related generator switch to ON. This closes the related generator circuit breaker (GCB) and connects the generator to the transfer bus. Whenever external power or APU is powering both transfer busses, and IDG power is applied to its related transfer bus, external power or APU continues to supply power to the remaining transfer bus.

In flight, each IDG normally powers its own transfer bus. If an IDG is no longer supplying power, the BTBs automatically close to allow the other IDG to supply both transfer busses through the tie bus and BTBs. The APU can power either or both busses through the BTBs.

The system also incorporates an automatic generator on-line feature in case the aircraft takes off with the APU powering both transfer busses. If the APU is either shut down or fails, the IDGs are automatically connected to their related transfer busses. This action occurs only once in flight and only under the circumstances described above.

7 8 9 Bus Tie System

Either generator or the APU can supply power to both transfer busses. If the BUS TRANS switch is in the AUTO position and the source powering the transfer bus is disconnected or fails, the source powering the opposite transfer bus automatically picks up the unpowered transfer bus through the BTBs.

③ 3 5 Automatic Galley Load Shedding

Inflight electrical load shedding provides the capability to reduce power demands automatically when operating on one generator. A protective circuit will turn off all galley power. This feature ensures that the remaining generator will not be overloaded.

7 8 9 Automatic Load Shedding

For single generator operation, the system is designed to shed electrical load incrementally based on actual load sensing. The galley busses A and B on transfer bus 2 are shed first; if an overload is still sensed, the galley busses C and D on transfer bus 1 are shed; if overload still exists, main bus 1 and main bus 2 will be shed. When configuration changes to more source capacity (two generator operation), automatic load restoration of the main busses and galley busses occurs; manual restoration of galley power can be attempted by reset of the Galley Power Switch to OFF, then back ON.

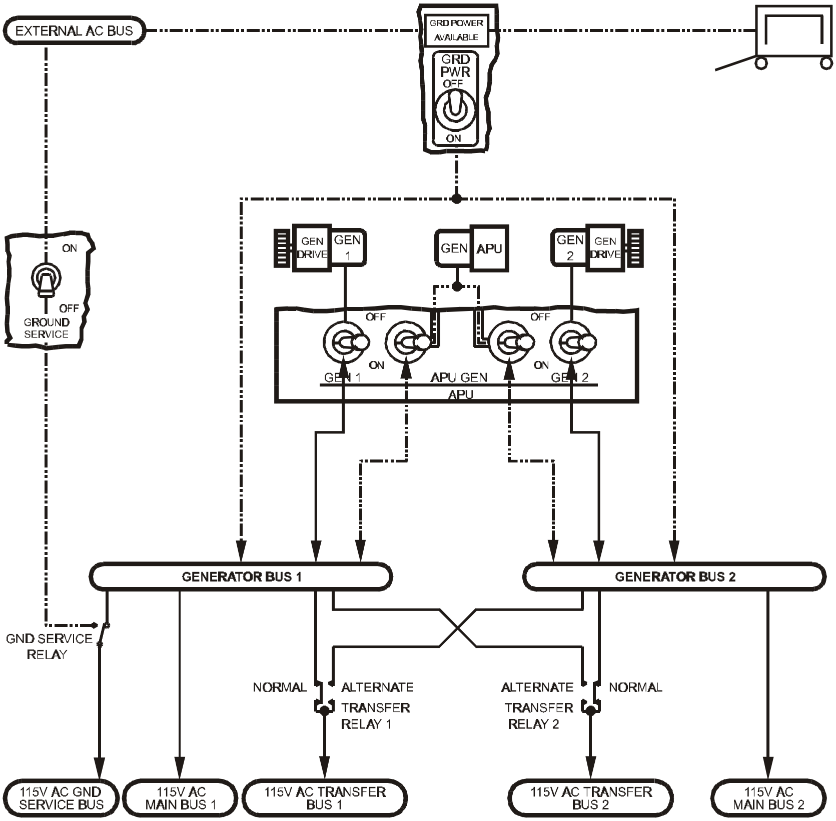
3 5 APU Automatic Galley Load Shedding

With the APU providing electrical power, galley electrical loads will automatically be shed should the total aircraft electrical power requirements exceed design limits.

7 8 9 APU Automatic Load Shedding

In flight, if the APU is the only source of electrical power, all galley busses are automatically shed. If electrical load still exceeds design limits, both main busses are also automatically shed. On the ground, the APU attempts to carry a full electrical load. If an overload condition is sensed, the APU sheds galley busses first and then main busses until the load is within limits. Manual restoration of galley power can be attempted by moving the Galley Power Switch to OFF, then back ON.

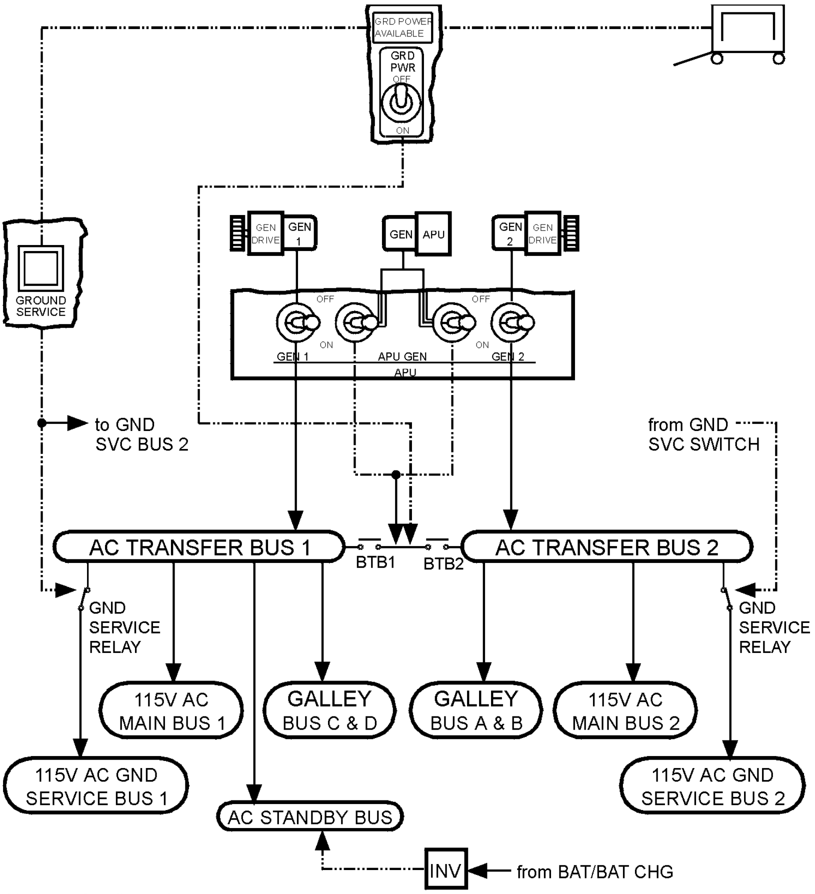
③ 3 5 AC POWER SYSTEM SCHEMATIC



Airplane Configuration:
- Battery Switch - ON
- Standby Power Switch - AUTO
- Bus Transfer Switch - AUTO
- ENGINE GENERATOR CONNECTED TO RESPECTIVE BUS

7376-6003

7 8 9 AC POWER SYSTEM SCHEMATIC



Airplane Configuration:
- Battery Switch - ON
- Standby Power Switch - AUTO
- Bus Transfer Switch - AUTO
- ENGINE GENERATOR CONNECTED TO RELATED BUS

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ELECTRICAL POWER CONTROLS AND MONITORING

③ 3 5 Generator Drive

Each engine-driven generator is connected to its engine through a generator drive unit, which provides a constant generator frequency output of 400 cps. Each generator drive is a self-contained unit consisting of oil supply, cooler, instrumentation, and disconnect device, which provides for complete isolation of the generator drive from the engine in the event of a malfunction.

Operating conditions of the generator drive can be observed on the Generator Drive Oil Temperature Indicator. Oil temperature is measured as it enters and leaves the generator drive. Temperature of oil entering the generator drive is indicated on the IN scale. Temperature differential between outlet and inlet is indicated as RISE (out temperature minus in temperature). During normal operations, the oil temperature rise should be less that 20 deg C. Readings above 20 deg C indicate excessive generator load or poor condition of the drive or low oil quantity.

Two amber caution lights indicate generator drive malfunctions of excessive oil temperature in the internal oil tank or low oil pressure. When the generator drive has been disconnected, the **LOW OIL PRESSURE** light will be on. The **HIGH OIL TEMPERATURE** light remains on until the oil is cooled.

A Generator Drive Disconnect switch is installed. This switch disconnects the generator drive from the engine in the event of a generator drive malfunction. Reactivating of the generator may be accomplished only on the ground by maintenance personnel.

7 8 9 Generator Drive

The IDGs contain the generator and drive in a common housing, and are lubricated and cooled by a self-contained oil system. An integral electro-mechanical disconnect device provides for complete mechanical isolation of the IDG from the engine.

The **DRIVE** amber caution light comes on when:

- Low oil pressure is sensed in the IDG
- The IDG is disconnected automatically due to high oil temperature
- The IDG is disconnected manually with the drive disconnect switch
- The engine is not running.

An IDG disconnect switch is installed. This switch disconnects the IDG from the engine in the event of IDG malfunction. Reactivation of the IDG may be accomplished only on the ground by maintenance personnel.

AC AND DC METERS

AC Voltmeter And Frequency Meter

AC voltage and frequency may be read on the AC voltmeter and frequency meter for standby power, ground power, generator No. 1, APU generator, generator No. 2 and static inverter. Frequency will be indicated only when the generator is electrically excited. The voltage regulator automatically controls the generator output voltage.

③ 3 5 Current readings for the two engine generators and the APU generator may be read only on the ammeters on the overhead panel.

7 8 9 Current readings for the two engine IDGs and the APU generator may be read on the AC ammeter.

The TEST position is used by maintenance and connects the voltmeter and frequency meter to the power systems test module for selection of additional reading points.

Normal indications are:

- AC Voltmeter 115 ± 5 volts
- Frequency Meter 400 CPS ± 10 CPS.

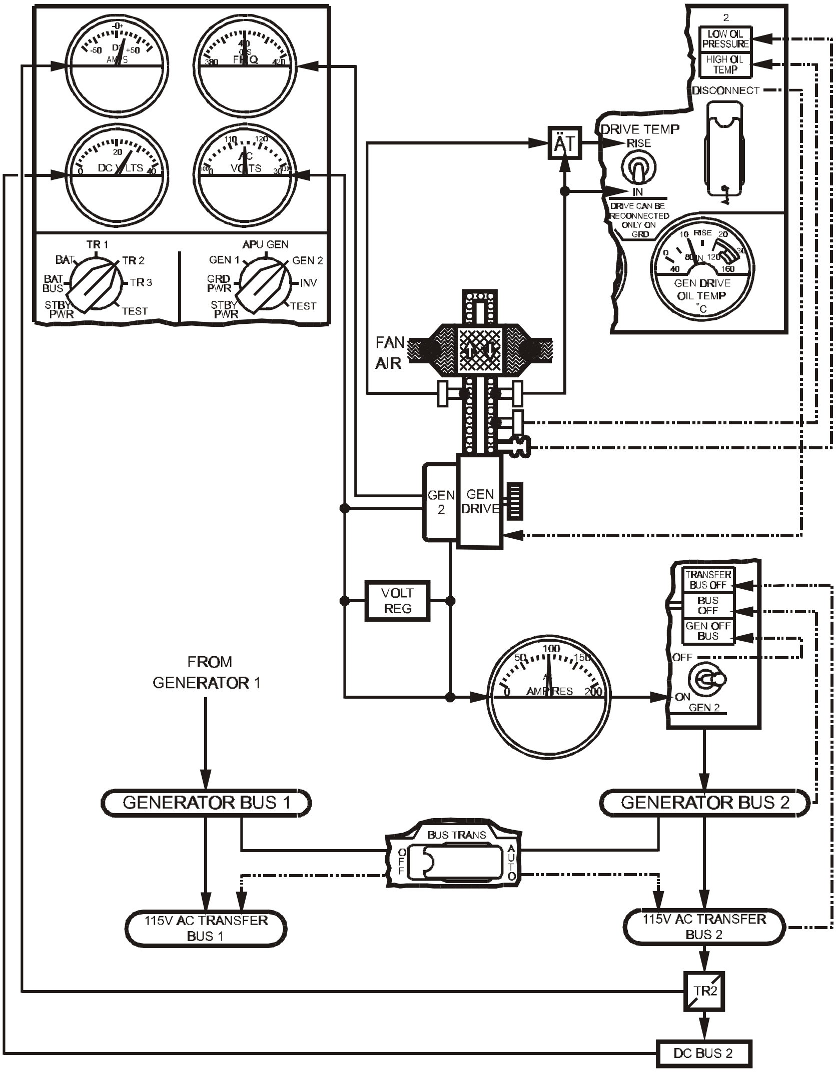
DC Voltmeter And Ammeter

DC voltage and amperage may be read on the DC voltmeter and ammeter for the battery and each of the three transformer-rectifiers. The standby power and battery bus will display only DC voltage.

Normal indication is 28 volts.

The TEST position is used by maintenance.

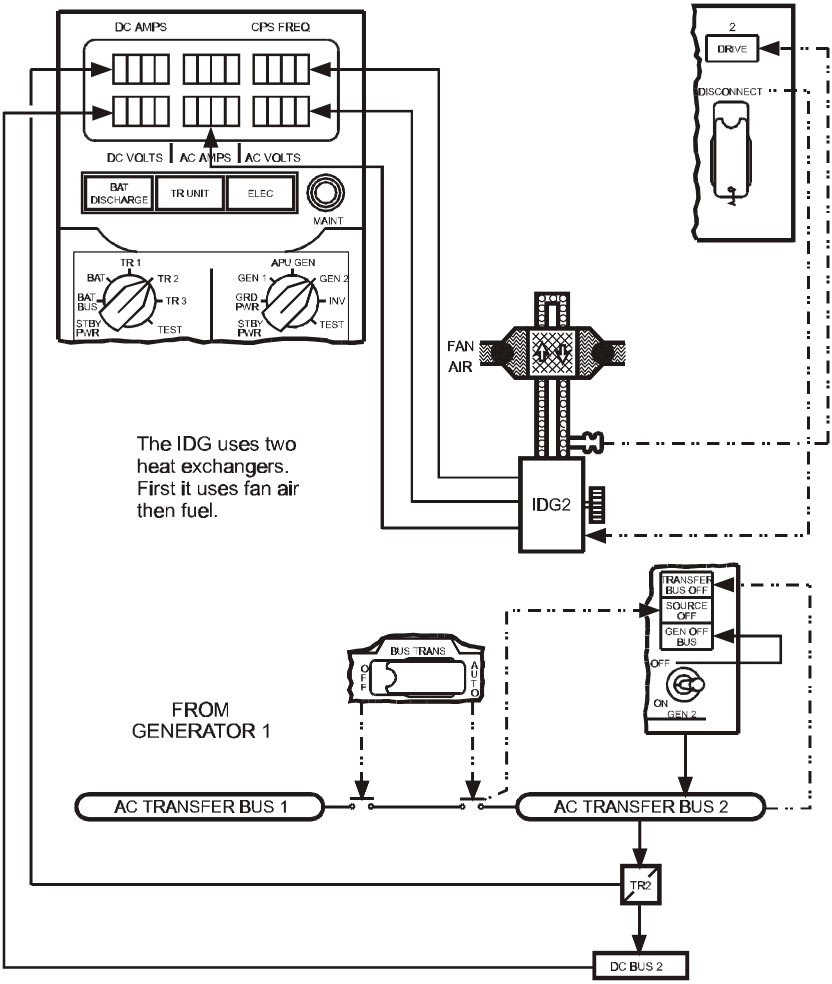
③③⑤ ELECTRICAL POWER CONTROLS AND MONITORING SCHEMATIC



CONDITION: ENGINE DRIVEN GENERATORS ON AC BUSSES

7376-6004

7 8 9 ELECTRICAL POWER CONTROLS AND MONITORING SCHEMATIC



CONDITION: ENGINE DRIVEN GENERATORS ON AC BUSSES

7376-6005

DC POWER SYSTEM

The 28V DC power system supplies electrical loads requiring DC power. Three transformer rectifier (TR) units are the primary source of DC power. The battery provides 28V DC to loads required to be operative when no other source is available.

7 8 9 On the ground, an amber ELEC light illuminates to indicate that DC system or standby system equipment has failed. The ELEC light is inhibited in flight.

Transformer Rectifier Units

The TR units convert 115-volt AC to 28-volt DC, and are identified as TR1, TR2, and TR3. TR voltage range is 24-30V.

TR1 and TR2 receive AC power from the transfer busses and power DC busses 1 and 2. With the Bus Transfer Switch in the AUTO position, TR1 and TR 2 are operated in parallel.

③ 3 5 TR3, supplied by main AC bus No. 2, normally powers the battery bus and backs up TR1 and TR2.

7 8 9 TR3 normally receives AC power from transfer bus 2 and has a backup source of AC power from transfer bus 1. Any two TRs are capable of supplying the total connected load.

③ 3 5 The TR3 disconnect relay automatically opens at glideslope capture during a flight director or autopilot ILS approach.

This isolates the DC busses during approach to prevent a single failure from affecting both navigation receivers and flight control computers.

7 8 9 Under normal conditions, DC bus 1, DC bus 2, and the DC standby bus are connected via the cross bus tie relay. In this condition, TR1 and TR2 are each powering DC bus1, DC bus 2, and the DC standby bus. TR3 powers the battery bus and serves as a backup power source for TR1 and TR2.

The cross bus tie relay automatically opens, isolating DC bus 1 from DC bus 2, under the following conditions:

- At glideslope capture during a flight director or autopilot ILS approach. This isolates the DC busses during approach to prevent a single failure from affecting both navigation receivers and flight control computers.
- Bus transfer switch positioned OFF.

Inflight, an amber **TR UNIT** light illuminates if TR1 or TR2 and TR3 has failed. On the ground, any TR fault causes the light to illuminate.

Battery Power

A 24-volt nickel-cadmium battery is located in the electronics compartment. The battery can supply part of the DC system. Battery charging is automatically controlled. A fully charged battery has sufficient capacity to provide power for a minimum of 30 minutes. Battery voltage range is 22-30V.

The busses powered from the battery following a loss of both generators are:

- Battery bus
- DC standby bus
- Hot battery bus
- Switched hot battery bus
- AC standby bus, from the battery bus, through an inverter.

The switched hot battery bus is powered whenever the Battery Switch is ON.

The hot battery bus is always connected to the battery. There is no switch in this circuit. The battery must be above minimum voltage to operate units supplied by this bus.

7 8 9 An amber **BAT DISCHARGE** light illuminates when excessive battery discharge is detected.

Battery Charger

The purpose of the battery charger is to restore and maintain the battery at full electrical power.

③ 3 5 The normal source of power for the battery charger is the AC ground service bus with provisions for automatic switching to the No. 2 main bus.

7 8 9 The battery charger is powered through AC ground service bus 2.

The battery charger provides a voltage output tailored to maximize the battery charge at all times with AC power on the aircraft. With the ground cart plugged in, the ground service bus powered, the Battery Switch ON and the DC Meters Selector in the BAT position, the voltage will read 28 volts, indicating the hot battery bus is being powered from the battery charger. The limited pulse type battery charger converts 115V AC to 28V DC.

Following completion of the primary charge cycle, the battery charger reverts to a constant voltage TR mode. In the TR mode, it powers loads connected to the hot battery bus and the switched hot battery bus. The battery charger TR also powers the battery bus if TR3 fails. With loss of AC transfer bus 1 or the source of power to DC bus 1, the AC and DC standby busses are powered by the battery / battery charger.

DC Power Receptacle

③ 3 5 An auxiliary 28V DC power receptacle is provided near the battery in the electronic compartment. A placard located adjacent to the receptacle gives complete instructions for connecting external DC power. With external DC power connected, the battery is paralleled with the DC external power source and the external power cart will power all circuits normally supplied by the battery. In the event that the aircraft battery is depleted, the APU can be started using DC external power.

7 8 9 No DC power receptacle provided.

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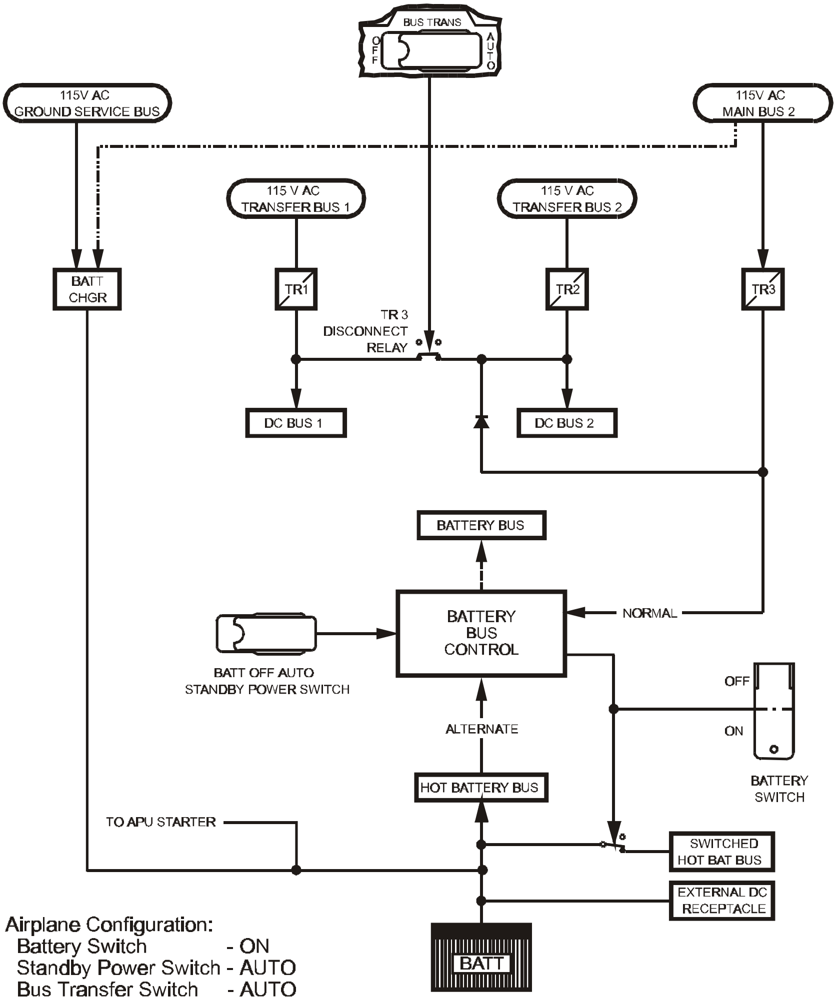
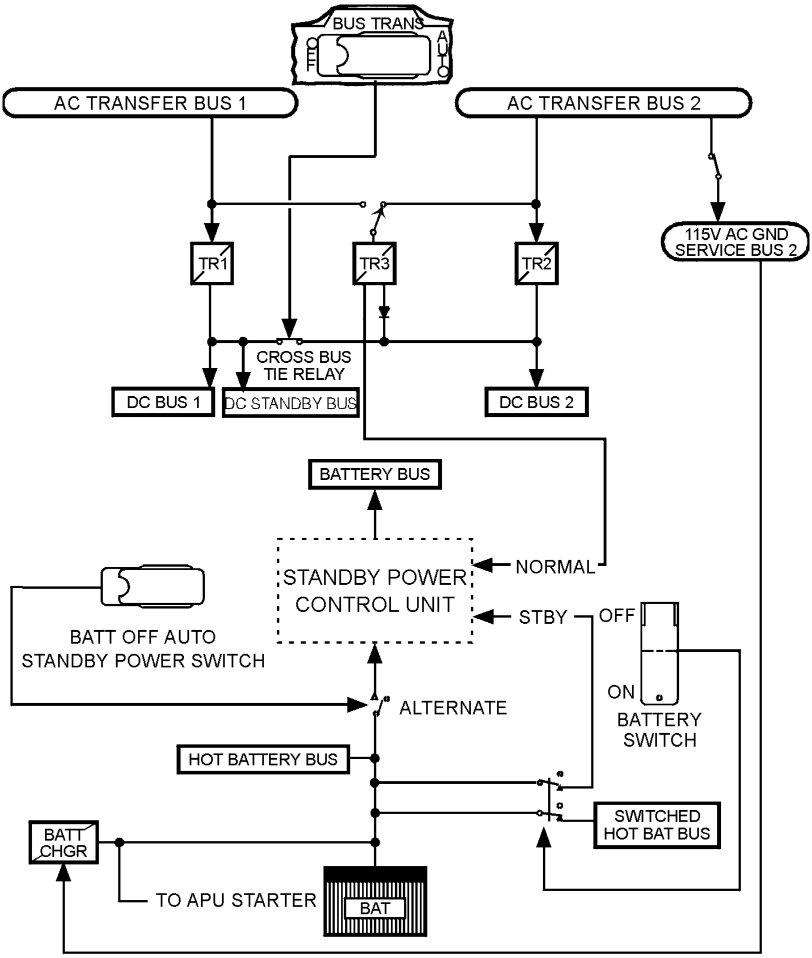
③ 3 5 DC POWER SYSTEM SCHEMATIC



Airplane Configuration:
- Battery Switch - ON
- Standby Power Switch - AUTO
- Bus Transfer Switch - AUTO
- Generator Busses - POWERED

7376-6005

7 8 9 DC POWER SYSTEM SCHEMATIC



Airplane Configuration - In Flight
Battery Switch - ON
Standby Power Switch - AUTO
Bus Transfer Switch - AUTO
ENGINE GENERATOR CONNECTED TO RELATED BUS

7737904

STANDBY POWER SYSTEM

Normal Operation

The standby system is used to supply power to essential AC and DC systems. During normal operation the guarded Standby Power Switch will be in AUTO and the battery switch will be ON.

③ 3 5 Under normal conditions the standby AC bus is energized from the 115-volt transfer bus No. 1 and the standby DC bus is energized from DC bus No. 1.

7 8 9 Under normal conditions the AC standby bus is powered from AC transfer bus No. 1. The DC standby bus is powered by TR1, TR2, and TR3.

Alternate Operation

Alternate or standby power source for the standby busses is the battery. With a complete generator power failure, the 115-volt AC standby bus is powered by the battery bus through the static inverter.

③ 3 5 The 28-volt DC standby bus is powered by the battery bus.

7 8 9 The 28-volt DC standby bus is powered by the battery.

A fully charged battery has sufficient capacity to provide power to essential flight instruments, communication, and navigation equipment for a minimum of 30 minutes.

Automatic switching is provided from the normal power sources to the alternate power source when the Standby Power Switch is in the AUTO position. If either the No. 1 DC bus or the No. 1 transfer bus loses power, both standby busses automatically switch to the battery bus / battery.

③ 3 5 The automatic transfer of power is an inflight feature only. The air / ground safety sensor prevents the battery bus from powering the standby busses when the aircraft is on the ground. This prevents discharging the battery.

7 8 9 With the standby power switch in the AUTO position, the loss of all engine or APU electrical power causes the battery to power the standby loads, both in the air and on the ground.

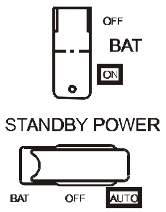
Positioning the switch to BAT overrides automatic switching and places the AC standby bus, DC standby bus, and battery bus on battery power. The battery switch may be ON or OFF. If the battery switch is OFF, the switched hot battery bus is not powered.

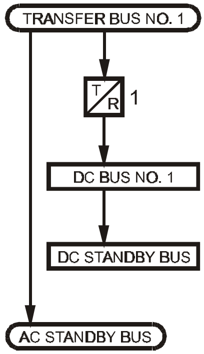
Positioning the standby power switch to OFF de-energizes both the AC standby bus and the DC standby bus and illuminates the **STANDBY PWR OFF** light.

Static Inverter

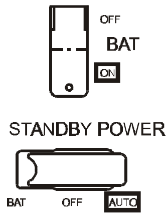
The static inverter converts 28 volt DC power from the battery / battery bus to single-phase 115 volt, 400 Hertz AC power to supply the AC standby bus during the loss of normal electrical power. The power supply to the inverter is controlled by the Standby Power Switch on the overhead panel.

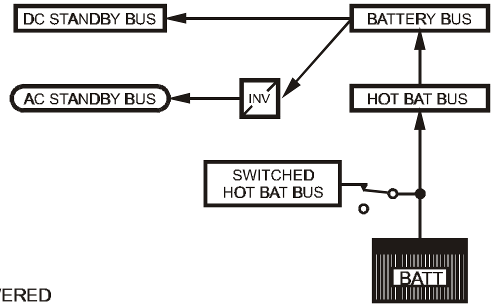
③ 3 5 STANDBY POWER SCHEMATIC



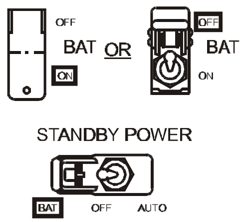


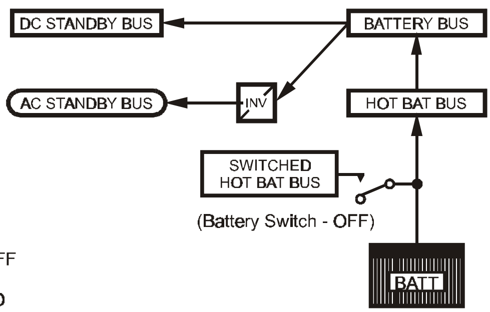
Airplane configuration - Inflight or On The Ground
Battery Switch - ON
Standby Power Switch - AUTO
ENGINE GENERATORS CONNECTED TO RESPECTIVE BUS





Airplane configuration - Inflight
Battery Switch - ON
Standby Power Switch - AUTO
GENERATOR BUSSES NOT POWERED

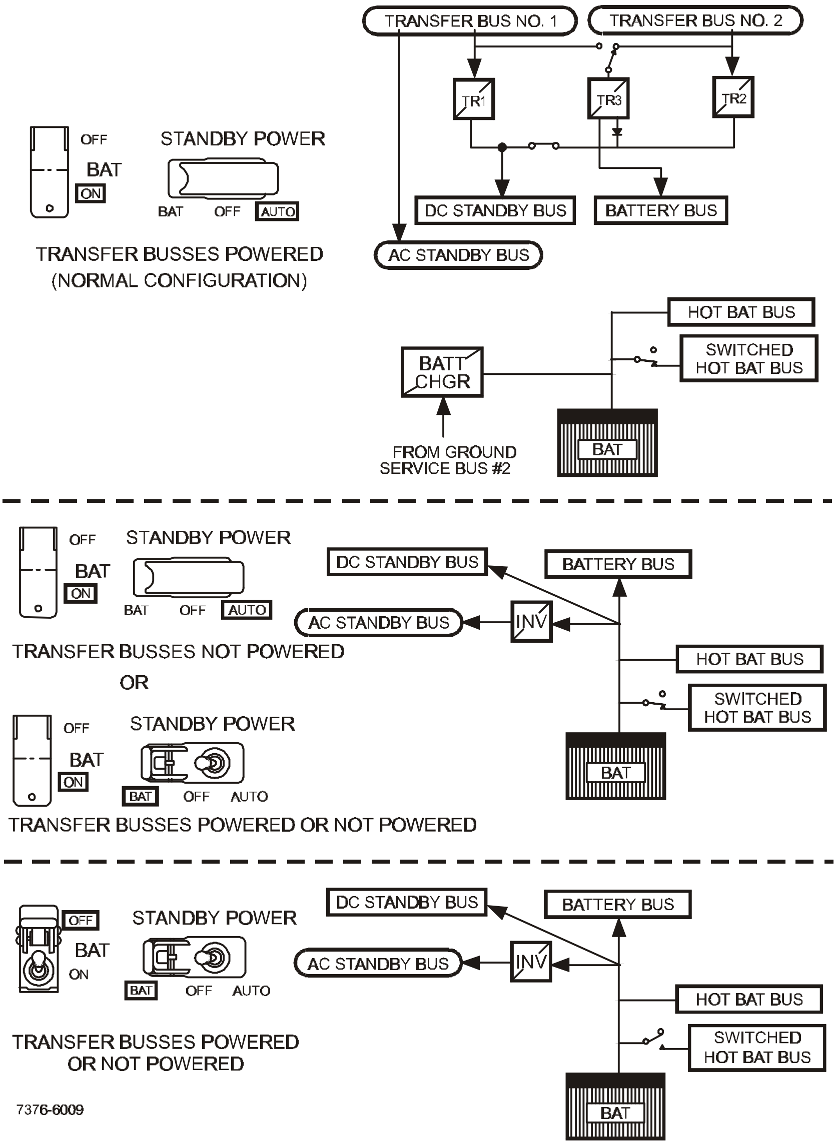




Airplane configuration - Inflight or On The Ground
Battery Switch - ON or OFF
Standby Power Switch - BAT
GENERATOR BUSSES POWERED OR NOT POWERED

7376-6008

7 8 9 STANDBY POWER SCHEMATIC



ELECTRICAL SYSTEM POWER DISTRIBUTION

NO. 1 GENERATOR INOPERATIVE

③ 3 5 Failure In Flight, Transfer Buses Normal

INOPERATIVE COMPONENTS	INDICATION
No. 1 tank forward fuel pump Center tank right fuel pump	Low pressure light Low pressure light
Galley(s)	Inoperative
No. 1 generator Generator bus no. 1	Gen off bus light Bus off light
Left forward window heat Right side window heat Left No. 4 & No. 5 window heat	On light - extinguished On light - extinguished Inoperative
Left elevator pitot heat	L elev pitot light
System B electric pump	Low pressure light
Left outboard landing light Right inboard landing light Left runway turnoff light Nose gear taxi light	Inoperative Inoperative Inoperative Inoperative
Equipment cooling normal	Off light

NO. 2 GENERATOR INOPERATIVE

③ 3 5 Failure In Flight, Transfer Buses Normal

INOPERATIVE COMPONENTS	INDICATION
No. 2 tank forward fuel pump Center tank left fuel pump Fuel temperature indicator	Low pressure light Low pressure light Inoperative
Galley(s)	Inoperative
No. 2 generator Generator bus No. 2 TR unit No. 3	Gen off bus light Bus off light TR No. 3 voltage - zero
Equipment cooling - alternate	If switch is to alternate, off light
Left side window heat Right forward window heat Right No. 4 & No. 5 window heat	On light - extinguished On light - extinguished Inoperative
Right elevator pitot heat Temp probe heat	R elev pitot light Temp probe light
System A electric pump	Low pressure light
Recirculation fan	Inoperative
Right outboard landing light Left inboard landing light Right runway turnoff light	Inoperative Inoperative Inoperative
Engine vibration amplifier	Inoperative

ALL GENERATORS INOPERATIVE

The following list identifies the significant equipment that operates when the battery is the only source of electrical power.

Aircraft General

- Position Lights
- Standby Compass Light
- White Dome Lights
- Emergency Instrument Flood Lights
- Flight Crew Oxygen Qty. Indicator
- Passenger Oxygen – **PASS OXY ON** Light

A/C And Pressurization

- A/C Pack Valves
- **PACK TRIP OFF** Lights
- Manual Pressurization Control
- Altitude Warning Horn

7 8 9

  - Bleed Trip Off Lights

APU / Engines

- APU Operation (start attempts not recommended above 25,000 ft.)

7 8 9

  - Upper display unit
    N1, N2, Fuel Flow, EGT,
    Fuel Quantity, Oil Pressure
    Oil Temperature, Oil Quantity
    Hydraulic Pressure
    Hydraulic Quantity
  - Thrust Reversers
  - Starter Valves
  - Right Igniters

Communications

- Flight Interphone System
- Passenger Address System
- VHF No.1

Electrical

- STANDBY POWER OFF Light

Emergency Equipment

- Passenger Oxygen

Flight Instruments

③

- Captains ADI and HSI

③ 3 5

- Standby Airspeed / Altimeter
- Clocks
- Standby Horizon Indicator
- Captains RDMI

7 8 9

- Captains Inboard Display Unit
  Altimeter, Vertical Speed
  Indicator, Navigation Display
- Captain's Outboard Display Unit Mach / Airspeed Indicator,
  Attitude Indicator, Altimeter, Vertical Velocity Indicator, RDMI, HSI
- Standby Instruments
  RMI, Standby Airspeed Indicator / Altimeter
  Standby Horizon Indicator,
  Standby Magnetic Compass
- Clocks
- Left EFIS Control Panel

Fire Protection

- APU & Engine Fire Ext. Bottles
- APU & Engine Fire Detection System

Fuel

- Crossfeed Valve
- Fuel Quantity Indicators

③ 3 5

  - Engine Fuel SOVs
  - FUEL VALVE CLOSED Lights

7 8 9

  - Spar fuel shutoff valve
  - ENGINE VALVE CLOSED Light
  - SPAR VALVE CLOSED Light

Hydraulic Power

- Engine Hydraulic SOVs
- Standby Rudder SOVs

Landing Gear

- Inboard Antiskid System
- ANTISKID INOP Light
- Parking Brake

Navigation / Flight Management

- VHF No.1
- Left IRS

③ 3 5

- Captain's RDMI
- ADF No.1

7 8 9

  - Left GPS (As Installed)
  - Marker Beacon
  - Left FMC
  - Left CDU
  - Heading / Track Indications
  - DME No.1

Pneumatics

- BLEED TRIP OFF Lights

Power Plant

- Thrust Reversers
- Starter Valves
- Right Igniters

③ $\boxed{3}$ $\boxed{5}$

- N_1 RPM Indications
- EGT Indications

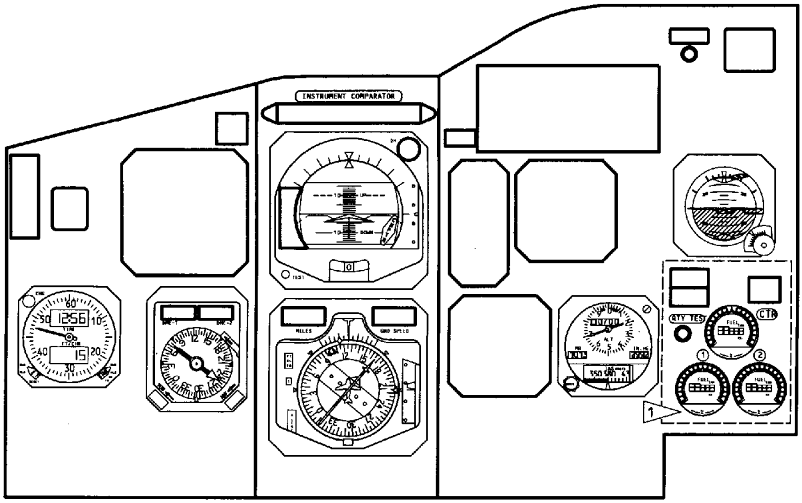
$\boxed{7}$ $\boxed{8}$ $\boxed{9}$

- Upper display unit
- N_1, N_2, fuel flow, EGT, fuel quantity, oil pressure, oil temperature, oil quantity, hydraulic pressure, hydraulic quantity

Warnings

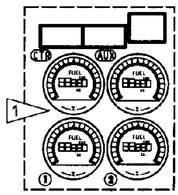
- Stall Warning System
- Aural Warnings
- Master Caution Light Recall

③ Basic Equipment Operating – Captain Instrument Panel



The standby power system utilizes the battery as a source of power to supply the above depicted flight instruments and the below listed systems and engine instruments.

- Left IRS
- No. 1 RDMI
- No. 1 VHF Navigation System (VOR, GS, and LOC)
- No. 1 ADF Navigation System
- No. 1 VHF Communication System
- N1, EGT



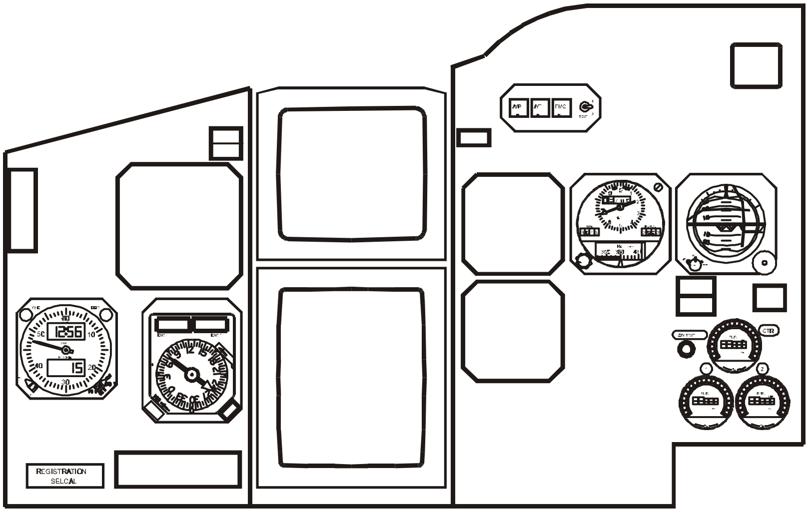
1 As installed

CAUTION: PRIOR TO LANDING, THE STANDBY POWER SWITCH SHOULD BE POSITIONED TO "BAT" TO ENERGIZE THE ABOVE ELECTRONICS AND FOR VHF-1 COMMUNICATIONS.

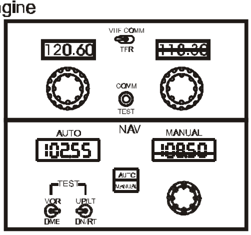
NOTE: All of the Captain's instruments including the engine and fuel quantity indicators, that are powered by standby power are also integrally lighted by standby power.

Airplane Configuration - Inflight Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are useable with only the battery and standby busses powered.	▯ Indicates Inoperative Instruments

3 5 Basic Equipment Operating – Captain Instrument Panel



The standby power system utilizes the battery as a source of power to supply the above depicted flight instruments and the below listed systems and engine instruments.



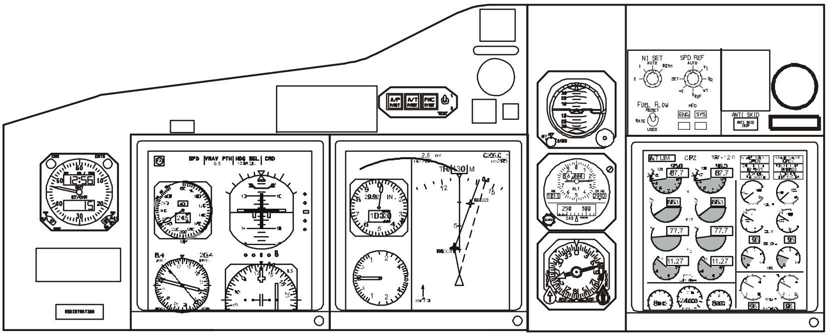
- Left IRS
- No. 1 VHF Navigation System (VOR, GS, and LOC)
- No. 1 ADF Navigation System
- No. 1 VHF Communication System
- N1, EGT

CAUTION: PRIOR TO LANDING, THE STANDBY POWER SWITCH SHOULD BE POSITIONED TO "BAT" TO ENERGIZE THE ABOVE ELECTRONICS AND FOR VHF-1 COMMUNICATIONS.

NOTE: All of the Captain's instruments including the engine and fuel quantity indicators, that are powered by standby power are also integrally lighted by standby power.

Airplane Configuration - Inflight Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are useable with only the battery and standby busses powered.	Indicates Inoperative Instruments

7 8 9 Basic Equipment Operating – Captain Instrument Panel



The standby power system utilizes the battery as a source of power to supply the above depicted flight instruments and the below listed systems and engine instruments.

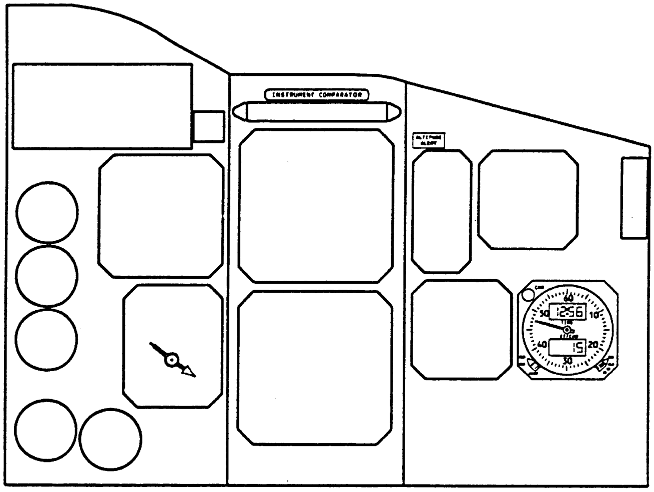
- Left IRS
- Left GPS
- Left FMC
- Left CDU
- No. 1 VHF Navigation System (VOR, GS, LOC, Marker Beacon)
- No. 1 VHF Communication System
- Captain Outboard Display Unit
    - Airspeed, RDMI, Attitude, HSI
- Captain Inboard Display Unit
    - Altimeter, Vertical Speed, Navigation Display
- Upper Display Unit
    - N1, N2, EGT, Fuel Flow, Fuel Quantity, Oil Pressure, Oil Temperature, Oil Quantity, Hydraulic Pressure, Hydraulic Quantity
- Left EFIS Control Panel

NOTE: All of the Captain`s instruments that are powered by standby power are integrally lighted on standby power.

Airplane Configuration - IN FLIGHT Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are usable with only the battery and standby busses powered.	▯	Indicates Inoperative Instruments

7737907

③ Basic Equipment Operating – First Officer Panel



COCKPIT COMMUNICATION

Audio Selector Panels
Flight Interphone
Passenger Address System

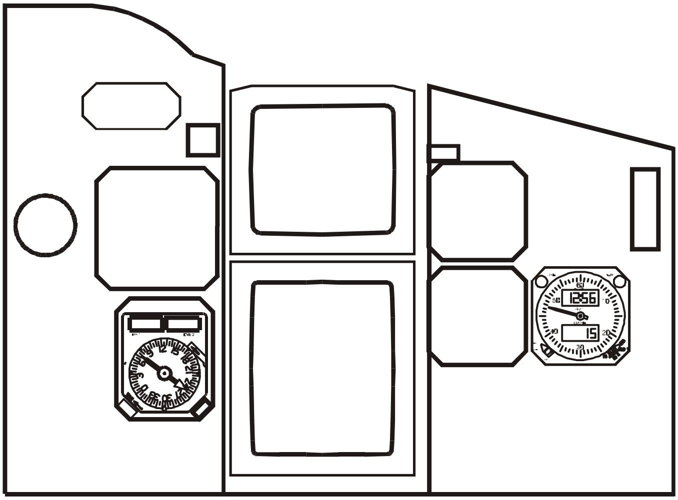
COCKPIT LIGHTS

Standby Instrument Floodlight
White Dome Light
Magnetic Compass Light

Airplane Configuration - In Flight Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are useable with only the battery and standby busses powered.	▯ Indicates Inoperative Instruments

7376-6013

3 5 Basic Equipment Operating – First Officer Panel

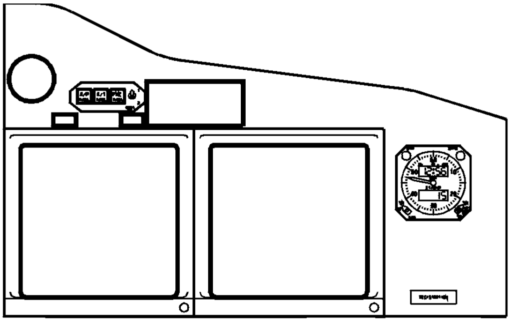


COCKPIT COMMUNICATION	COCKPIT LIGHTS
Audio Selector Panels	Standby Instrument Floodlight
Flight Interphone	White Dome Light
Passenger Address System	Magnetic Compass Light

Airplane Configuration - In Flight Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are useable with only the battery and standby busses powered.	▯ Indicates Inoperative Instruments

7376-6014

7 8 9 Basic Equipment Operating – First Officer Panel



FLIGHT DECK COMMUNICATION

Audio Selector Panels
Flight Interphone
Passenger Address System

FLIGHT DECK LIGHTS

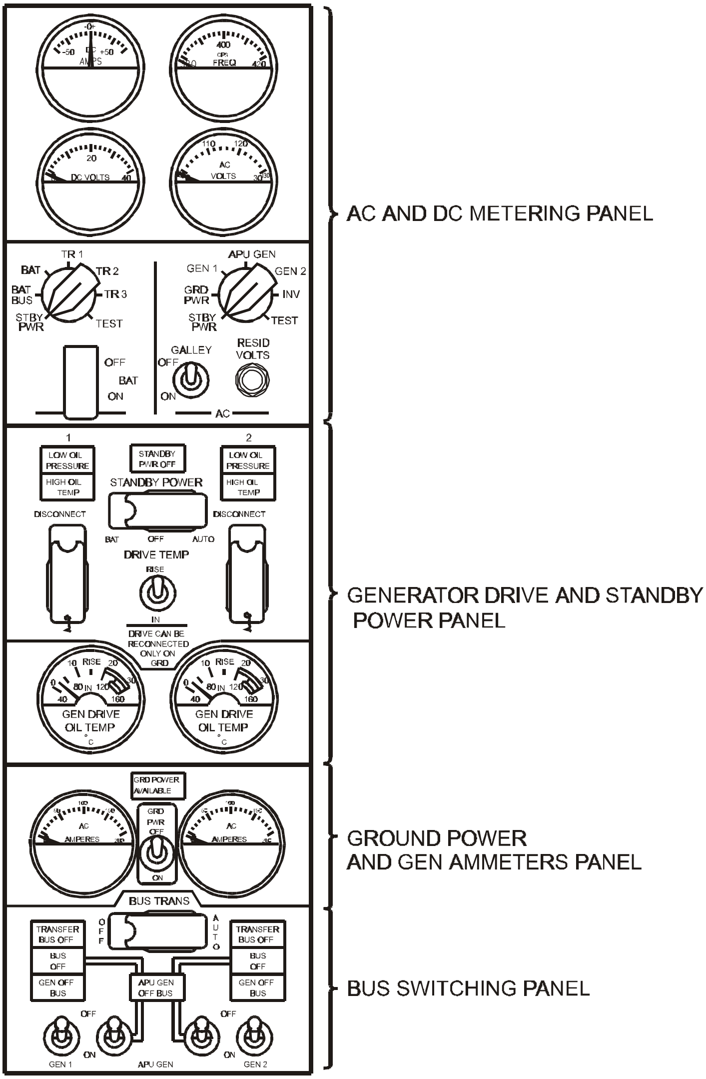
Standby Instrument Floodlight
White Dome Light
Magnetic Compass Light

Airplane Configuration - In Flight Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are usable with only the batteries and standby busses powered.	▯ Indicates Inoperative Instruments

7737909

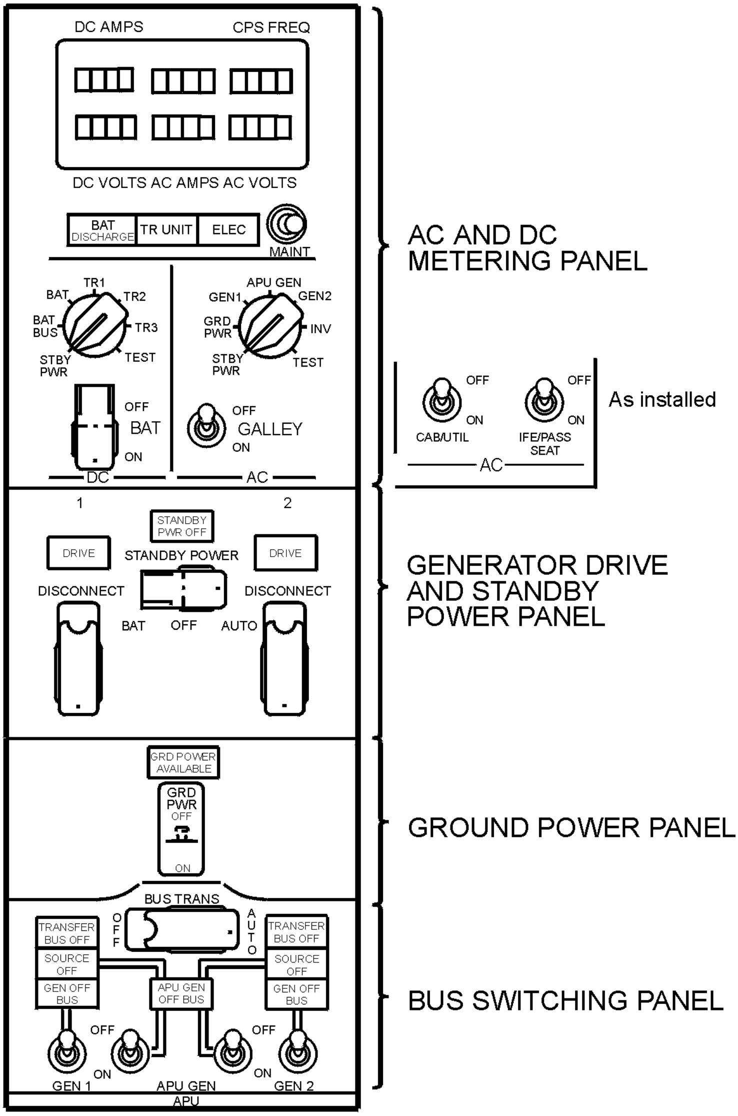
CONTROLS AND INDICATORS

③ 3 5 ELECTRICAL PANEL



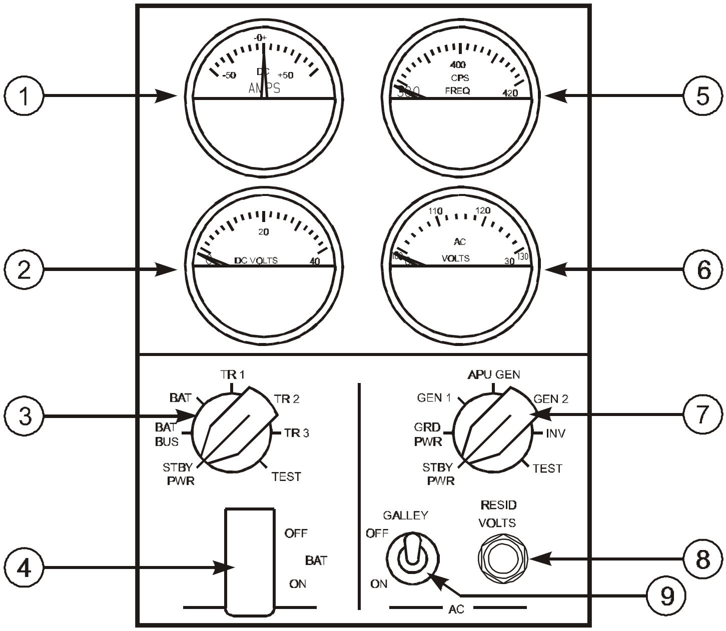
7376-6015

7 8 9 ELECTRICAL PANEL



7376-6026

③ 3 5 AC AND DC METERING PANEL



FORWARD OVERHEAD PANEL

7376-6016

① DC Ammeter

- Indicates current of source selected by the DC Meters Selector.

② DC Voltmeter

- Indicates voltage of source selected by the DC Meters Selector.

③ DC Meters Selector

- Selects the DC source for the DC Voltmeter and the DC Ammeter indications.

TEST – Used by maintenance.

④ Battery Switch

OFF – No power to the battery bus (with Electrical Standby Power Switch in OFF or AUTO).

ON – With main bus No. 2 energized, TR 3 furnishes power to the battery bus.

- If main bus No. 2 is not powered, the hot battery bus powers the battery bus.

⑤ Frequency Meter

- Indicates frequency of source selected by the AC Meters Selector.

⑥ AC Voltmeter

130V SCALE – Indicates voltage of source selected.

30V SCALE – Indicates residual voltage of generator selected when Residual Volts Switch is pressed.

⑦ AC Meters Selector

- Selects the AC source for the AC Voltmeter and Frequency Meter indications.

TEST – Used by maintenance.

⑧ Residual Volts Switch

PRESS – 30V scale of AC Voltmeter indicates residual voltage of generator selected.

- Associated Generator Switch must be OFF, (with associated Generator Switch ON, AC Voltmeter drives off scale and residual voltage cannot be read).

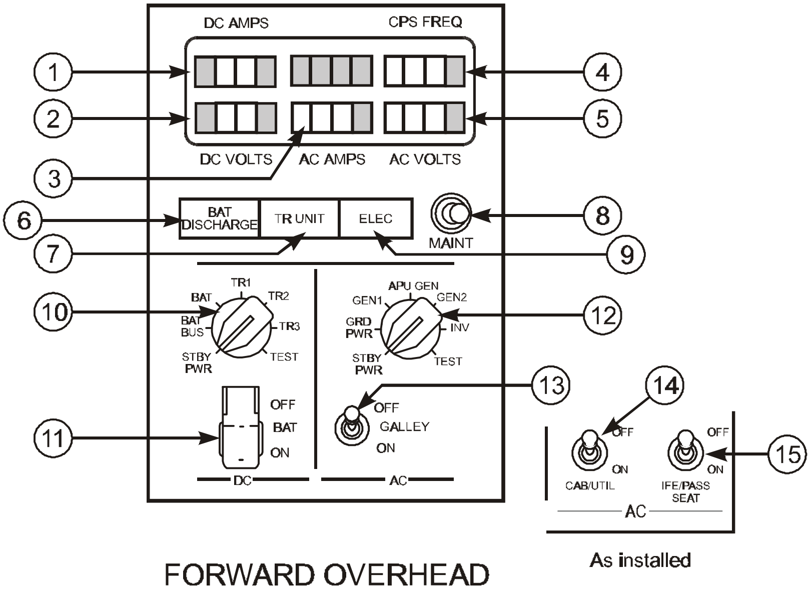
⑨ GALLEY Power Switch

OFF – No electrical power is supplied to the galleys.

ON – Electrical power is provided to the galleys.

- Galley power is available only when both generator busses are powered.

7 8 9 AC AND DC METERING PANEL



FORWARD OVERHEAD PANEL

7376-6017

① DC Ammeter

- Indicates current of source selected by the DC Meters Selector.

② DC Voltmeter

- Indicates voltage of source selected by the DC Meters Selector.

③ AC Ammeter

- Indicates current of source selected by AC meter selector.

④ Frequency Meter

- Indicates frequency of source selected by the AC Meters Selector.

⑤ AC Voltmeter

- Indicates voltage of source selected by AC meter selector.

⑥ Battery (**BAT**) **DISCHARGE** Light

Illuminated (amber) – Excessive battery discharge detected with BAT switch ON.

⑦ **TR UNIT** Light

Illuminated (amber)

- On the ground – any TR has failed.
- In flight – TR1 failed or TR2 and TR3 failed.

⑧ Maintenance (MAINT) Test Switch

Used by maintenance.

⑨ Electrical (**ELEC**) Light

Illuminated (amber) – A fault exists in DC power system or standby power system.

Note: Operates only with aircraft on ground.

⑩ DC Meters Selector

- Selects the DC source for the DC Voltmeter and the DC Ammeter indications.

TEST – Used by maintenance.

⑪ Battery (BAT) Switch

OFF –

- Removes power from battery bus and switched hot battery bus when operating with normal power sources available.
- Removes power from battery bus, switched hot battery bus, DC standby bus, static inverter, and AC standby bus when battery is only power source.

ON (guarded position) –

- Provides power to switched hot battery bus.
- Energizes relays to provide automatic switching of standby electrical system to battery power with loss of normal power.

⑫ AC Meter Selector

Selects AC source for AC voltmeter, AC ammeter and frequency meter indications.

TEST – Used by maintenance.

⑬ GALLEY Power Switch

OFF – Removes electrical power from galleys.

ON – Electrical power is supplied to galleys when AC transfer busses are powered.

⑭ CAB/UTIL Switch

OFF – Removes power from left and right recirculation fans, forward and aft door area heaters, drain mast heaters, lavatory water heaters, ECS gasper fan, all 115V AC galley busses, 115V AC shaver outlets, logo light, and potable water compressor.

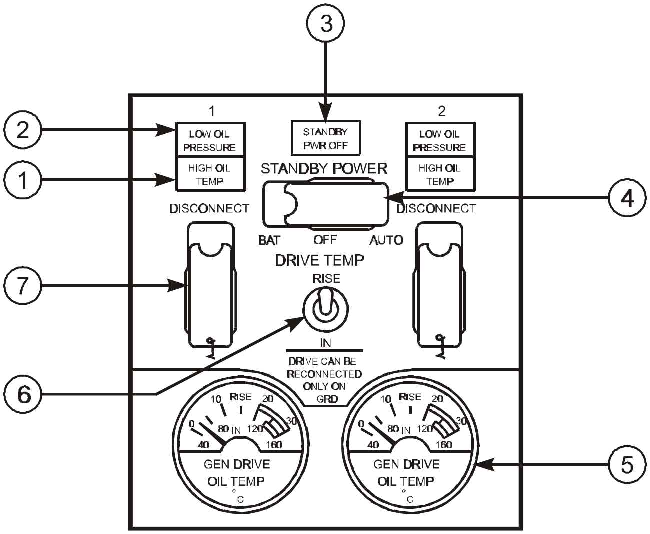
ON – Electrical power is supplied to left and right recirculation fans, forward and aft door area heaters, drain mast heaters, lavatory water heaters, ECS gasper fan, all 115V AC galley busses, 115V AC shaver outlets, logo light, and potable water compressor.

⑮ IFE/PASS SEAT Switch

OFF – Removes power from 115V AC audio entertainment equipment, 115V AC video entertainment equipment, 115V AC airphone equipment, and passenger seat electronic outlets.

ON – Electrical power is supplied to 115V AC audio entertainment equipment, 115V AC video entertainment equipment, 115V AC airphone equipment, and passenger seat electronic outlets.

③③⑤ CSD AND STANDBY POWER PANEL



FORWARD OVERHEAD PANEL

7376-6018

① Generator Drive **HIGH OIL** Temperature (**TEMP**) Light (amber)

Illuminated – Generator drive oil temperature exceeds operating limits.

② Generator Drive **LOW OIL PRESSURE** Light (amber)

Illuminated – Generator drive oil pressure is below minimum operating limits.

③ **STANDBY** Power (**PWR**) **OFF** Light (amber)

Illuminated – AC standby bus is inactive.

④ STANDBY POWER Switch

AUTO (guarded position) –

Condition: In flight, or on the ground, and AC busses powered.

- The AC standby bus is powered by AC transfer bus No. 1. The DC standby bus is powered by DC bus No. 1.

Condition: In flight, loss of all AC power.

- The AC standby bus is powered by the battery bus through the static inverter. The DC standby bus is powered by the battery bus directly.
- A fully charged battery will provide a minimum of 30 minutes of standby power.

Condition: On the ground, loss of all AC power.

- No automatic transfer of power to the standby busses.

OFF (center position) – **STANDBY PWR OFF** light illuminates

- Standby busses and static inverter are not powered.

BAT (unguarded position) –

- The AC standby bus is powered by the battery bus through the static inverter.
- The DC standby bus is powered by the battery bus.
- The battery bus is powered by the hot battery bus, regardless of battery switch position.

⑤ Generator Drive Oil Temperature Indicator

- Displays the temperature of the oil used in the generator drive.

RISE Scale (outer) – Displays the temperature rise within the generator drive.

- Higher than normal temperature rise indicates excessive generator load or poor condition of the generator drive.
- Lack of adequate cooling will generally cause the temperature rise to decrease.

IN Scale (inner) – Displays the temperature of the oil entering the generator drive.

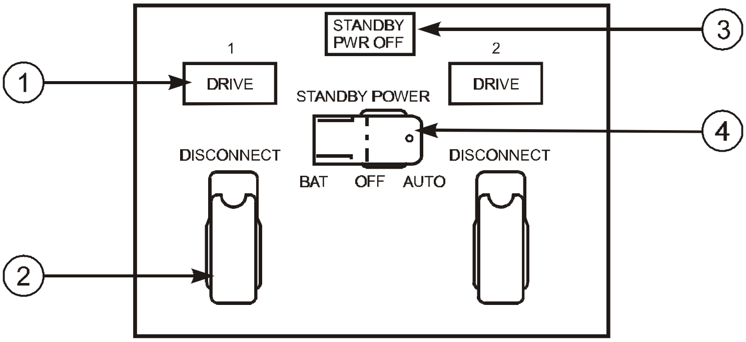
⑥ Generator Drive Temperature Switch

RISE / IN – Selects RISE or IN temperature to be displayed on the Generator Drive Oil Temperature Indicator.

⑦ Generator Drive Disconnect Switch (guarded and safetied)

- Disengages generator drive.
- Generator Drive cannot be re-engaged in the air.

7 8 9 GENERATOR DRIVE AND STANDBY POWER PANEL



FORWARD OVERHEAD PANEL

7376-6019

① Generator **DRIVE** Lights

Illuminated (amber) – Integrated drive generator (IDG) low oil pressure caused by one of the following:

- IDG failure
- Engine shutdown
- IDG automatic disconnect due to high oil temperature.
- IDG disconnected through generator drive DISCONNECT switch.

② Generator Drive DISCONNECT Switches (guarded)

Disconnects IDG if electrical power is available and engine start lever is in IDLE. IDG cannot be reconnected in the air.

③ **STANDBY** Power (**PWR**) **OFF** Light

Illuminated (amber) – One or more of the following busses are unpowered:

- AC standby bus
- DC standby bus
- Battery bus.

④ STANDBY POWER Switch

AUTO (guarded position)

- In flight, or on the ground, and AC transfer busses powered:
  - AC standby bus is powered by AC transfer bus 1
  - DC standby bus is powered by TR1 and TR2. TR3 is a backup source.
- In flight, or on the ground, loss of all AC power:
  - AC standby bus is powered by battery through static inverter
  - DC standby bus is powered by battery.

OFF (center position)

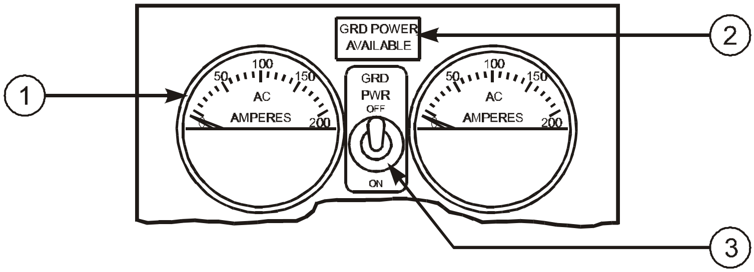
- **STANDBY PWR OFF** light illuminates.
- AC standby bus, static inverter, and DC standby bus are not powered.

BAT (unguarded position)

- AC standby bus is powered by battery through static inverter.
- DC standby bus and battery bus are powered directly by battery.

GROUND POWER AND GEN AMMETERS PANEL

③ 3 5



FORWARD OVERHEAD PANEL

7376-6020

① Generator AC Ammeter

- Indicates engine generator load in amperes.

② Ground (**GRD**) **POWER AVAILABLE** Light (blue)

Illuminated – The external power bus is powered by ground power supply.

- Remains illuminated as long as ground cart is plugged in and available.

③ Ground Power (GRD PWR) Switch

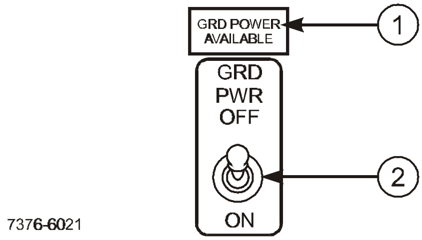
Three position switch, spring-loaded to neutral.

OFF – Disconnects ground power from both generator busses.

ON – If momentarily moved to the ON position and ground power is available:

- Removes previously connected power source from both generator busses.
- Closes external power contactors and connects ground power to both generator busses if power quality is correct.
- Switches the ground service bus to the No. 1 generator bus.
- Deactivates the Ground Service Switch.

7 8 9



FORWARD OVERHEAD PANEL

① Ground (**GRD**) **POWER AVAILABLE** Light

Illuminated (blue) – Ground power is connected and meets aircraft power quality standards.

② Ground Power (GRD PWR) Switch

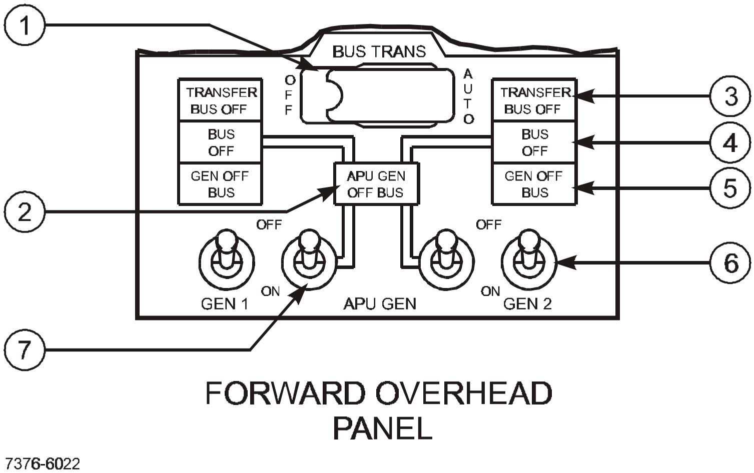
Three position switch, spring-loaded to neutral.

OFF – Disconnects ground power from AC transfer busses.

ON – If momentarily moved to ON position and ground power is available:

- Removes previously connected power from AC transfer busses.
- Connects ground power to AC transfer busses if power quality is correct.

③ 3 5 BUS SWITCHING



① Bus Transfer Switch

AUTO (guarded position) – Allows automatic transfer of transfer bus upon failure of generator bus, and allows TR2 and TR3 to supply No. 1 DC bus.

- A TR failure can be detected by a zero reading on the DC ammeter of the selected TR.

OFF – Isolates transfer busses by preventing operation of the bus transfer relays, and opens TR3 disconnect relay.

- Prevents the battery charger from switching to its alternate source of power.

② **APU** Generator (**GEN**) **OFF BUS** Light (blue)

Illuminated – APU is not supplying a generator bus and APU is above 95% of rated turbine speed.

③ **TRANSFER BUS OFF** Light (amber)

Illuminated – Transfer bus is inactive.

④ **BUS OFF** Light (amber)

Illuminated – Generator bus is inactive.

⑤ Generator (**GEN**) **OFF BUS** Light (blue)

Illuminated – Generator is not supplying the generator bus.

⑥ Generator Switch

Three position switch, spring-loaded to center position.

OFF – De-excites generator and disconnects it from the generator bus.

ON – Connects the generator output to the generator bus when power quality is correct.

- If generator was de-excited, connects field power supply to exciter.

⑦ APU Generator (GEN) Switch

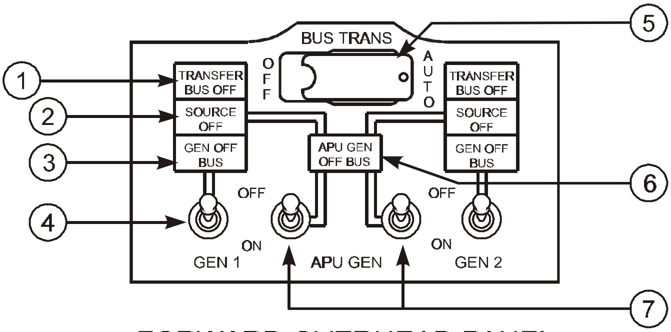
Three position switch, spring-loaded to center position.

OFF – Disconnects APU generator from the generator bus. Will also de-excite APU generator if the other generator bus is not being powered by the APU.

ON – Excites APU generator field, if previously tripped off, and connects APU generator output to the generator bus when power quality is correct.

Note: Both APU GEN switches operate the same on the ground. In the air only one bus can be powered by the APU generator.

7 8 9 BUS SWITCHING



FORWARD OVERHEAD PANEL

7376-6023

① **TRANSFER BUS OFF** Lights

Illuminated (amber) –Transfer bus is not powered.

② **SOURCE OFF** Lights

Illuminated (amber) – Transfer bus is not powered by source selected by related generator switch.

- Selected source has failed and automatic bus transfer function has closed bus tiebreakers (BTBs) to power transfer bus from another source.
- No source selected to power transfer bus.

③ Generator (**GEN**) **OFF BUS** Lights

Illuminated (blue) – IDG is not supplying power to the transfer bus.

④ Generator (GEN) Switches

Three position switch, spring-loaded to center position.

OFF – Disconnects IDG from AC transfer bus by opening generator circuit breaker.

ON – Connects IDG to AC transfer bus by disconnecting previous power source and closing generator circuit breaker.

⑤ BUS Transfer (TRANS) Switch

AUTO (guarded position) – BTBs operate automatically to maintain power to AC transfer busses from any operating generator or external power.

- DC cross tie relay automatically provides normal or isolated operation as required.

OFF – Isolates AC transfer bus 1 from AC transfer bus 2 if one IDG was supplying power to both AC transfer busses.

- DC cross tie relay opens to isolate DC bus 1 from DC bus 2.

Note: In flight, if the APU generator is supplying power to both AC transfer busses, the OFF position opens BTB 2 and AC transfer bus 2 cannot be powered.

⑥ **APU** Generator (**GEN**) **OFF BUS** Light

Illuminated (blue) – APU is running and not powering a bus.

⑦ APU Generator (GEN) Switches

Three position switch, spring-loaded to center position.

OFF –

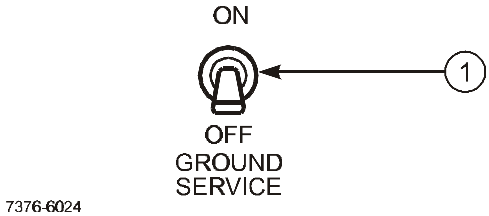
- APU generator powering both AC transfer busses
  - Moving a single APU GEN switch to OFF illuminates related **SOURCE OFF** light. APU continues to power AC transfer busses.
  - Subsequently moving other APU GEN switch to OFF disconnects APU generator from tie bus and removes APU power from AC transfer busses.
- APU generator powering one AC transfer bus; IDG powering one AC transfer bus.
  - Moving related APU GEN switch to OFF disconnects APU generator from tie bus and AC transfer bus. IDG powers AC transfer busses.

ON –

- Neither AC transfer bus powered by IDG – moving a single APU GEN switch to ON:
  - Connects both AC transfer busses to the APU generator.
  - Disconnects external power, if connected.
  - Illuminates opposite transfer bus **SOURCE OFF** light remains until the other APU GEN switch is moved to ON.
- Both AC transfer busses powered by IDGs – moving an APU GEN switch ON:
  - Powers the related AC transfer bus from the APU generator.
  - Other AC transfer bus continues to receive power from the IDG.

GROUND SERVICE SWITCH

③ 3 5



FWD ATTENDANT PANEL

① GROUND SERVICE Switch

(Solenoid held ON, spring-loaded to OFF)

- Makes it unnecessary to energize the main aircraft AC and DC busses when power is required for ground service only.
- The ground service bus powers the battery charger, Equipment Cooling Switch (NORMAL), and miscellaneous service lights and outlets.

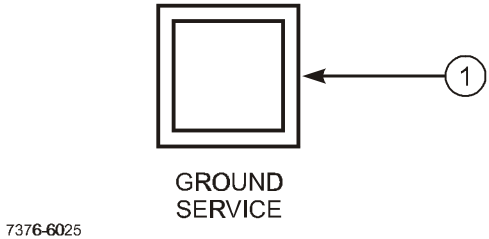
ON – Connects the external power to the ground service bus.

- Does not remain ON if the Ground Power Switch is ON.

OFF – Disconnects the ground service bus from the external power.

- Trips OFF when the Ground Power Switch is positioned to ON.

7 8 9



FWD ATTENDANT PANEL

① GROUND SERVICE Switch

Momentary push-button switch.

Provides manual control of ground service busses. Enables servicing aircraft using external power without activating AC transfer busses.

Illuminated (white)

ON – Connects the external power to the ground service busses.

OFF – Disconnects the external power from the ground service busses.

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