CHAPTER

78

Engine Exhaust

(CFM56 ENGINES (CFM56-7))

CHAPTER 78
ENGINE EXHAUST

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ENGINE EXHAUST SYSTEM - INTRODUCTION

Purpose

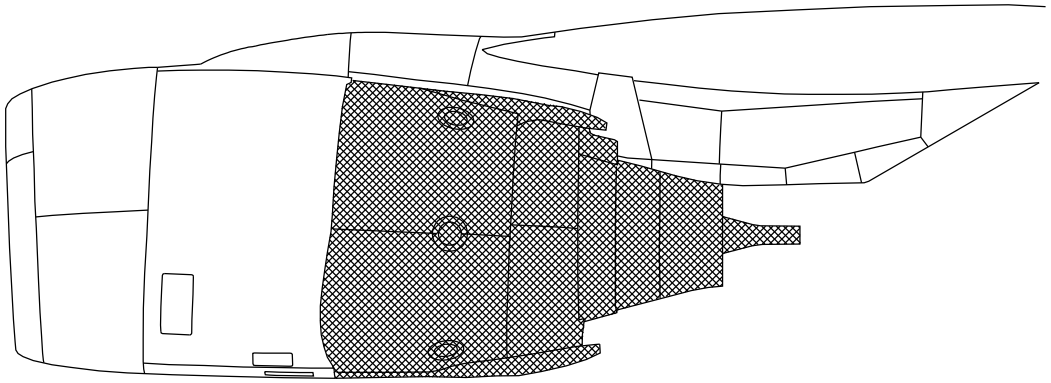
The engine exhaust system controls the direction of the engine exhaust gases.

The engine exhaust system has these sub-systems:

- Turbine exhaust
- Thrust reverser (T/R).

Abbreviations and Acronyms

- A/T - autothrottle
- CDS - common display system
- CDU - control display unit
- DCV - directional control valve
- DEU - display electronics unit
- EAU - engine accessory unit
- EEC - electronic engine control
- ELEC - electrical
- ENG - engine
- FCC - flight control computer
- GND - ground
- HIV - hydraulic isolation valve
- INBD - inboard
- ind - indication
- ISV - isolation valve
- LVDT - linear variable differential transformer
- P - panel
- prox - proximity
- REF - reference
- RLY - relay
- RTO - rejected take off
- S - seconds
- seq - sequence
- SL - sync lock
- stby - standby
- SW - switch
- sync - synchronizing
- sys - system
- T/R - thrust reverser



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ENGINE EXHAUST SYSTEM - INTRODUCTION

ENGINE EXHAUST SYSTEM - GENERAL DESCRIPTION

General

The engine exhaust system controls the direction of the turbine exhaust gases and the fan air exhaust gases.

Turbine Exhaust System

The turbine exhaust system supplies an exit for the engine exhaust gases. This exit increases the velocity of the exhaust gases. This increases engine thrust.

The major components of the turbine exhaust system are the exhaust nozzle and the exhaust plug.

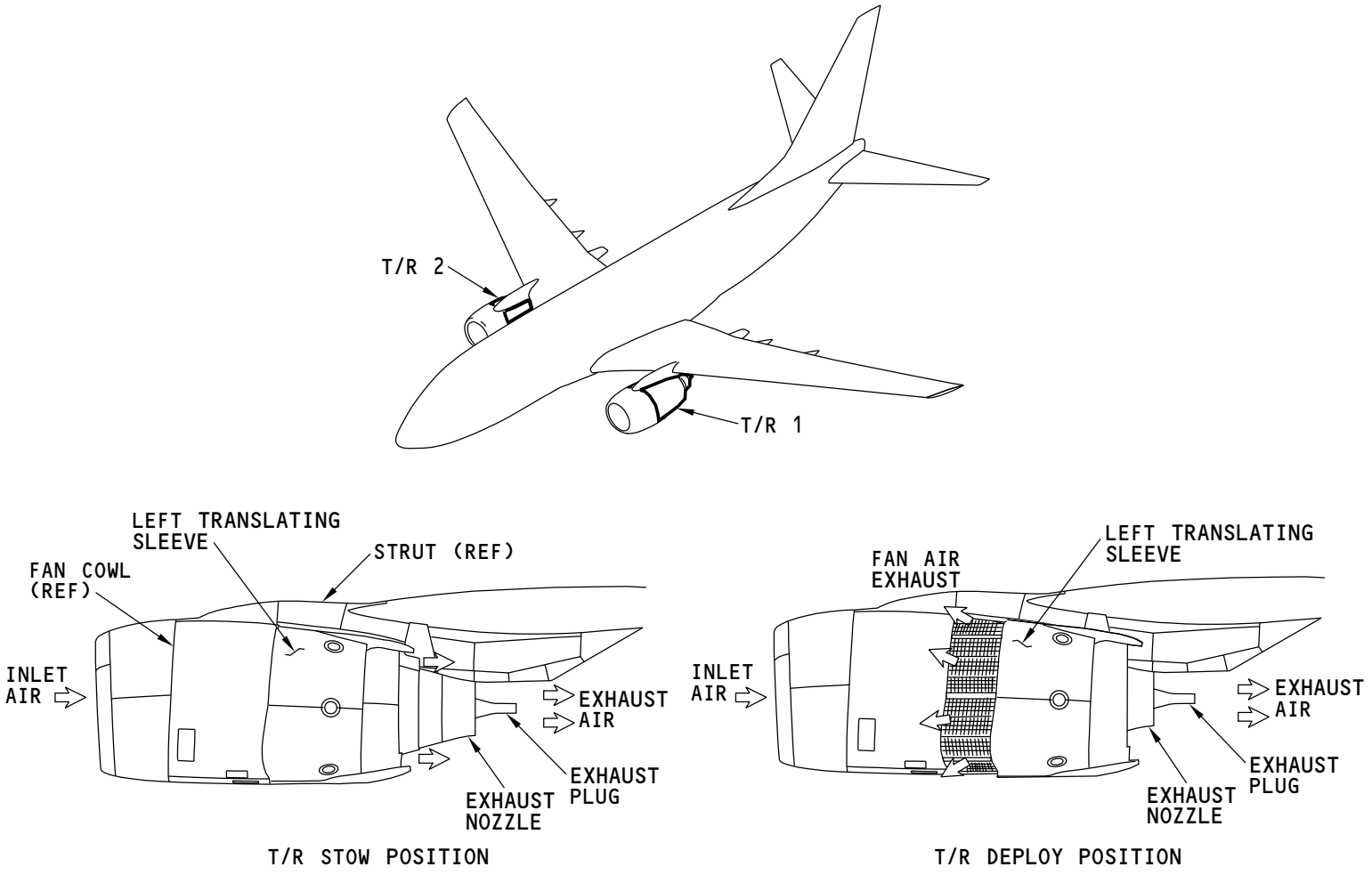
Thrust Reverser System

The thrust reverser (T/R) system changes the direction of the fan air exhaust to help create reverse thrust. The flight crew uses reverse thrust to slow the airplane after landing or during a rejected takeoff (RTO). The turbine exhaust airflow direction does not change during reverse thrust. The T/R system has a electro-hydraulic control system and an indicating system.

The T/R system has two thrust reversers. T/R 1 is the thrust reverser for engine 1 (left). T/R 2 is the thrust reverser for engine 2 (right).

Each T/R has a left and right half. Each half has a translating sleeve which moves aft (deploy position) for reverse thrust. The two sleeves work independently from each other. Fan air exhaust goes out radially and forward when the translating sleeves are in the deploy position.

Four hinges attach each T/R half to the strut. You must deactivate the thrust reverser before you open a T/R half. Latches are at the bottom of the two halves. The latches keep the two halves together.



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ENGINE EXHAUST SYSTEM - GENERAL DESCRIPTION

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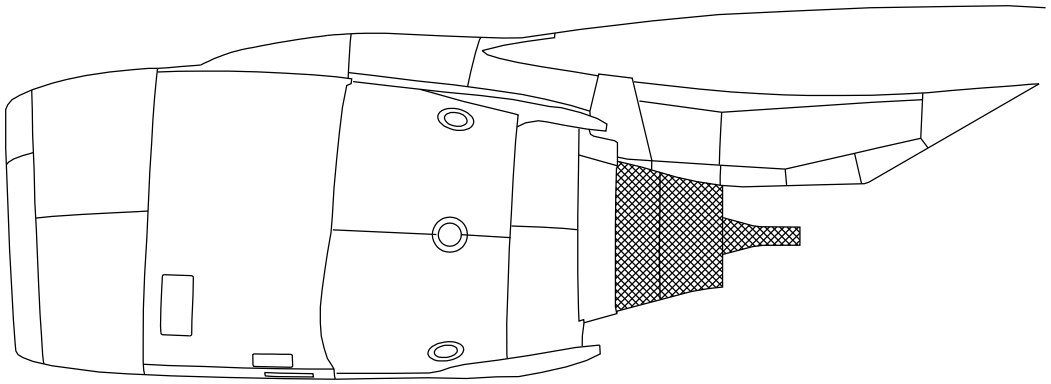
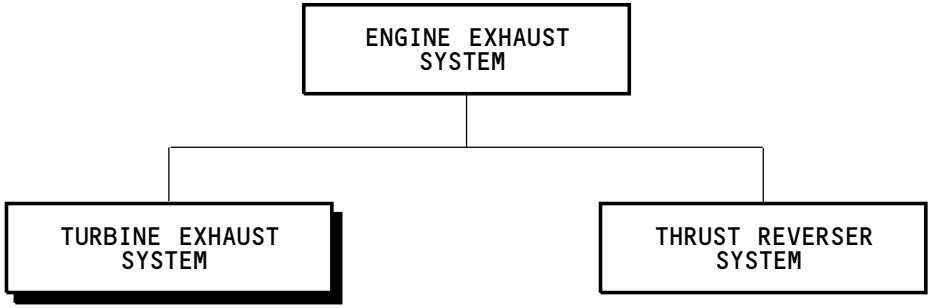
TURBINE EXHAUST SYSTEM - INTRODUCTION

Purpose

The turbine exhaust system supplies an exit for the turbine exhaust gases. The system increases the turbine exhaust gas velocity to increase engine thrust.





M88119 S0004632480_V1

TURBINE EXHAUST SYSTEM - INTRODUCTION

TURBINE EXHAUST SYSTEM - GENERAL DESCRIPTION

General

The turbine exhaust system uses a nozzle and a plug to control the direction of the turbine exhaust gases.

Components

These are the turbine exhaust system components:

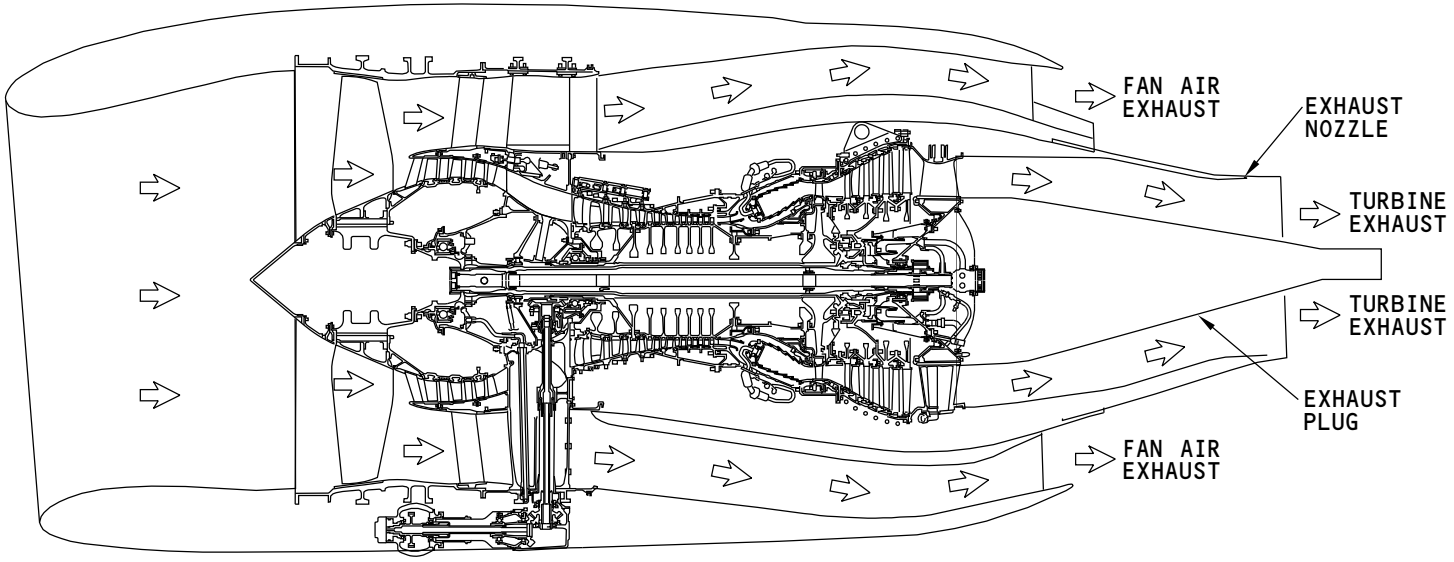
- Plug
- Nozzle.

Physical Description

The exhaust nozzle controls the outer edge of the turbine exhaust flow. The nozzle attaches to the engine turbine case.

The exhaust plug controls the inner edge of the turbine exhaust flow. The plug attaches to the engine turbine case.

The plug and the nozzle are made of nickel alloy.



ENGINE AIRFLOW

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TURBINE EXHAUST SYSTEM - GENERAL DESCRIPTION

TURBINE EXHAUST SYSTEM - EXHAUST NOZZLE

Purpose

The exhaust nozzle assembly controls the outer edge of the turbine exhaust flow. The aft part also controls the inner edge of the fan air exhaust flow.

General

The exhaust nozzle assembly has these components:

- Inner sleeve
- Labyrinth seals
- Fairing
- Fences.

Bolts attach the inner sleeve to the turbine exhaust case.

The exhaust nozzle uses labyrinth seals to contain fire. Bolts attach the seals to the inner sleeve.

The fairing helps smooth the inner edge of the fan air exhaust flow. Rivets attach the fairing to the inner sleeve.

The nozzle fences control the airflow of the fan air exhaust over the nozzle assembly.

Location

The exhaust nozzle assembly is on the aft end of the engine. You open the fan cowls and thrust reverser halves to get access.

Training Information Point

An alignment pin on the inner sleeve, near the 12:00 position, helps you align the nozzle assembly during installation.

The leading edge flaps can extend and damage a T/R half when the half is in the open (maintenance) position. Follow the AMM procedures to prevent leading edge flaps operation.

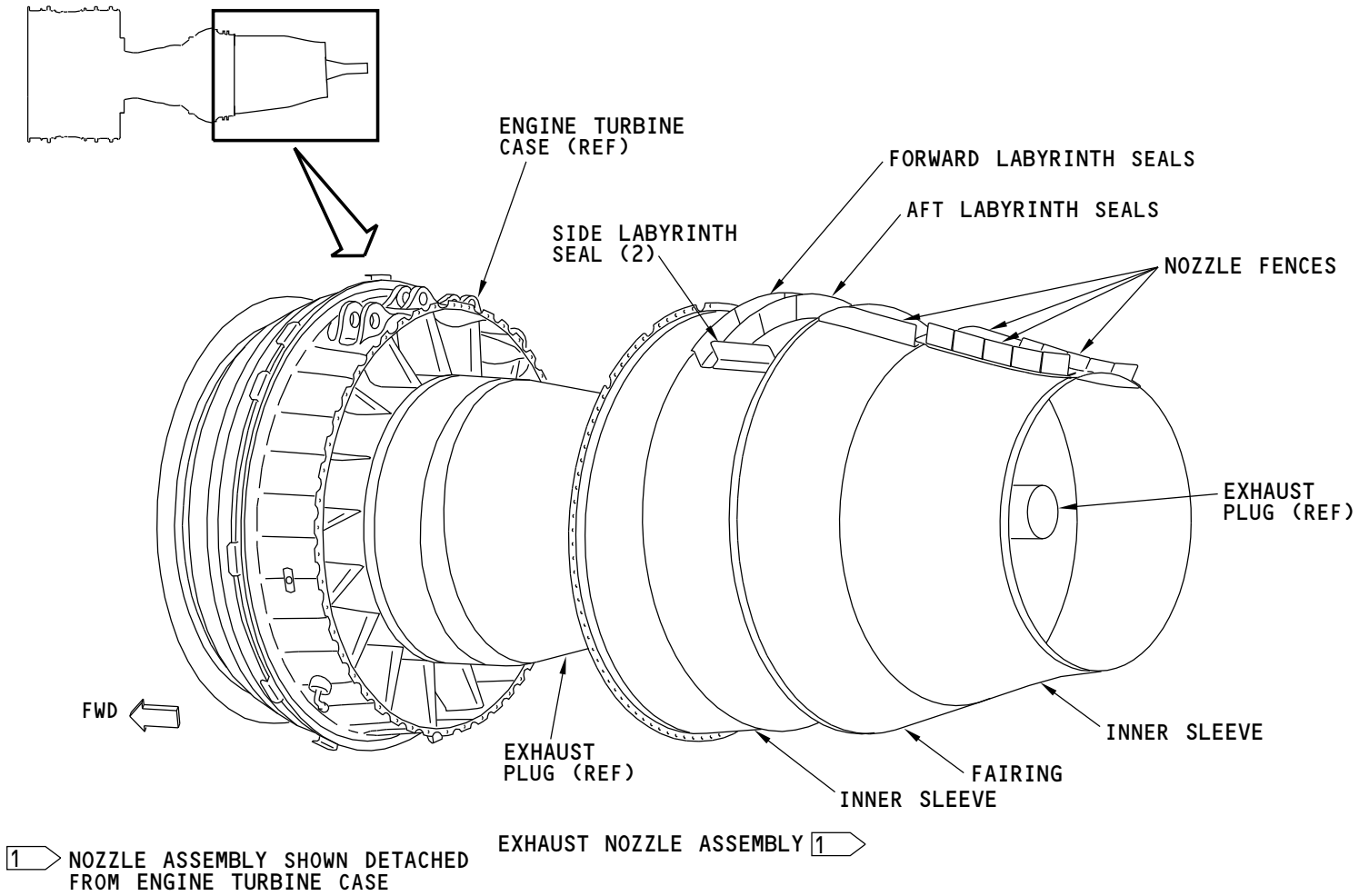
T/R halves in the open position can also damage the leading edge flaps if you deploy the T/R.

There are two different exhaust nozzles: long exhaust nozzle and short exhaust nozzle.

For the engines with short exhaust nozzle and short plug, the measurement between the aft edge of nozzle at the 6 o'clock position and the aft edge of the exhaust plug at 6 o'clock position is 37.8 +/- 0.5 inches (960.12 +/- 12.70 mm).

For the engines with long exhaust nozzle and long plug, the measurement between the aft edge of nozzle at the 6 o'clock position and the aft edge of the exhaust plug at 6 o'clock position is 22.6 +/- 0.5 inches (574.04 +/- 12.70 mm).

WARNING: DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSERS. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.



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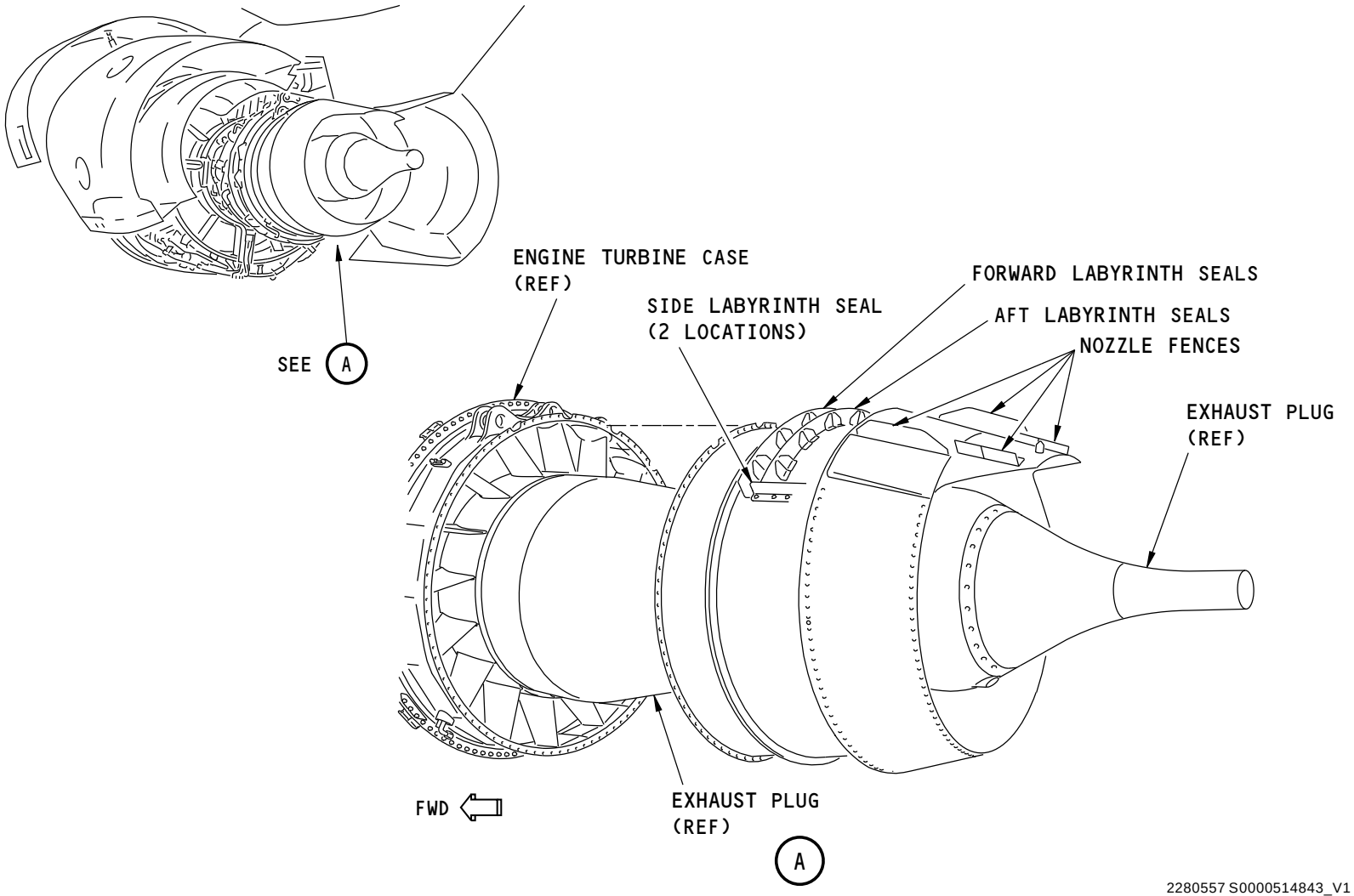
TURBINE EXHAUST SYSTEM - LONG EXHAUST NOZZLE



TURBINE EXHAUST SYSTEM - SHORT EXHAUST NOZZLE

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TURBINE EXHAUST SYSTEM - EXHAUST PLUG

Purpose

The exhaust plug assembly controls the inner edge of the turbine exhaust flow.

The engine vent system uses a hole at the aft end of the exhaust plug to vent to ambient air.

See the engine oil chapter for more information about the engine vent system. (CHAPTER 79)

General

The exhaust plug assembly has these major components:

- Forward plug
- Aft plug.

Bolts attach the aft plug to the forward plug. Bolts attach the forward plug to the engine turbine exhaust case.

Location

The exhaust plug is on the aft end of the engine turbine case. You must do these tasks to get access to the exhaust plug bolts:

- Open the fan cowls to the full open position
- Open the thrust reverser cowls (halves)
- Remove the exhaust nozzle.

Training Information Point

You must remove the exhaust nozzle and the aft plug before you remove the forward plug.

An alignment pin on the forward plug, near the 12:00 position, helps you align the forward plug during installation.

The aft plug has a small notch near the 12:00 position. This notch helps you align the aft plug during installation.

The leading edge flaps can extend and damage a T/Rs half when the half is in the open (maintenance) position. Follow the AMM procedures to prevent leading edge flaps operation.

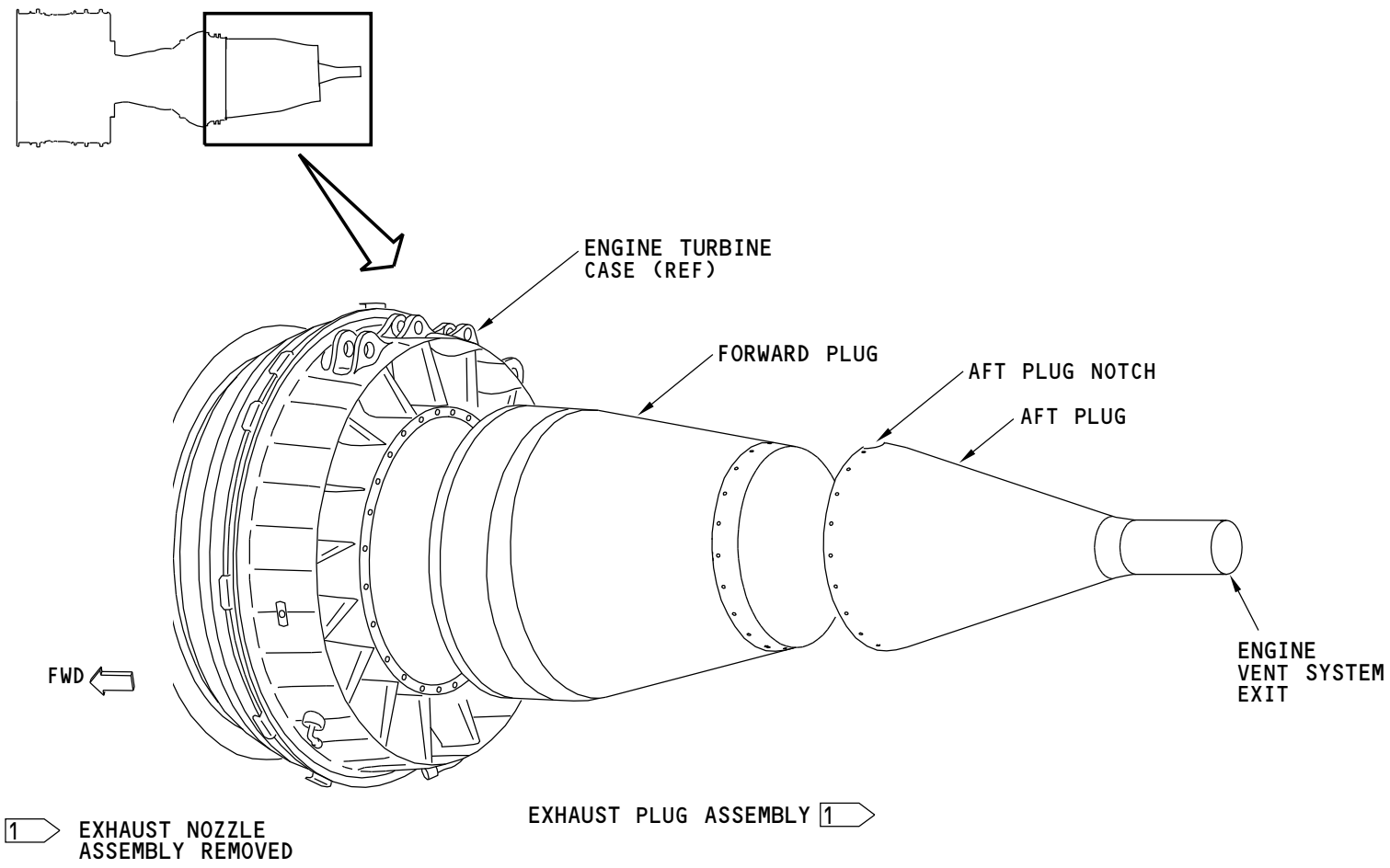
T/R halves in the open position can also damage the leading edge flaps if you deploy the T/R.

There are two different exhaust plugs: long plug and short plug.

For the engines with short exhaust nozzle and short plug, the measurement between the aft edge of nozzle at the 6 o'clock position and the aft edge of the exhaust plug at 6 o'clock position is 37.8 +/- 0.5 inches (960.12 +/- 12.70 mm).

For the engines with long exhaust nozzle and long plug, the measurement between the aft edge of nozzle at the 6 o'clock position and the aft edge of the exhaust plug at 6 o'clock position is 22.6 +/- 0.5 inches (574.04 +/- 12.70 mm).

WARNING: DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSERS. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.



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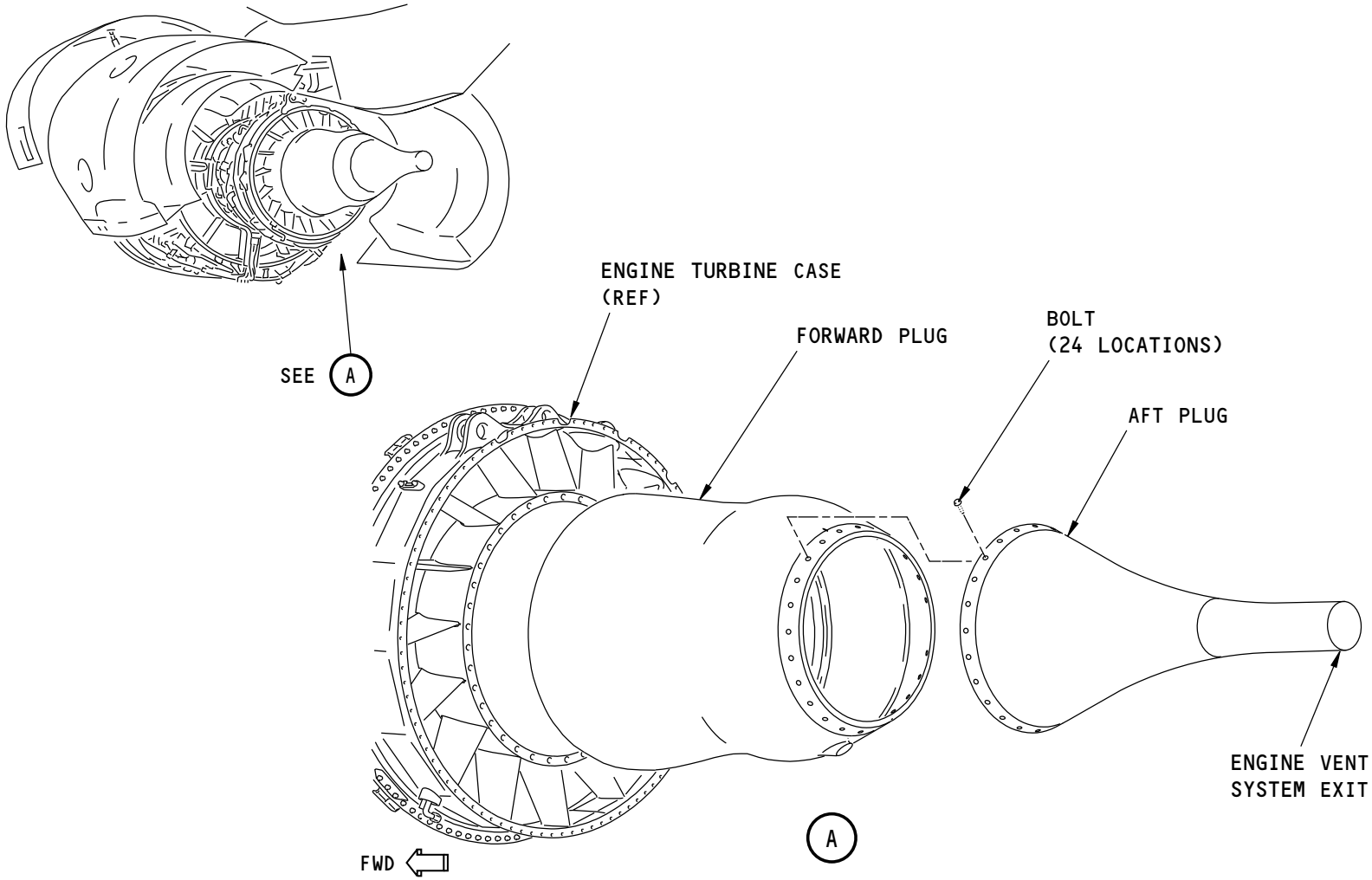
TURBINE EXHAUST SYSTEM - LONG EXHAUST PLUG



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TURBINE EXHAUST SYSTEM - SHORT EXHAUST PLUG

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THRUST REVERSER SYSTEM - INTRODUCTION

General

The thrust reverser (T/R) system has these subsystems:

- Thrust reverser
- Control
- Indicating.

Thrust Reverser System

The T/R system controls the direction of engine fan air exhaust for forward and reverse thrust.

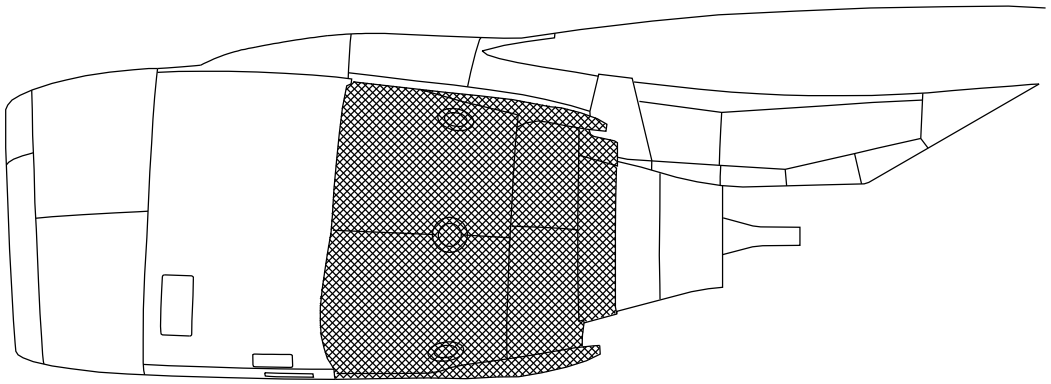
Reverse thrust helps decrease the speed of the airplane after landing or during a rejected take off (RTO).

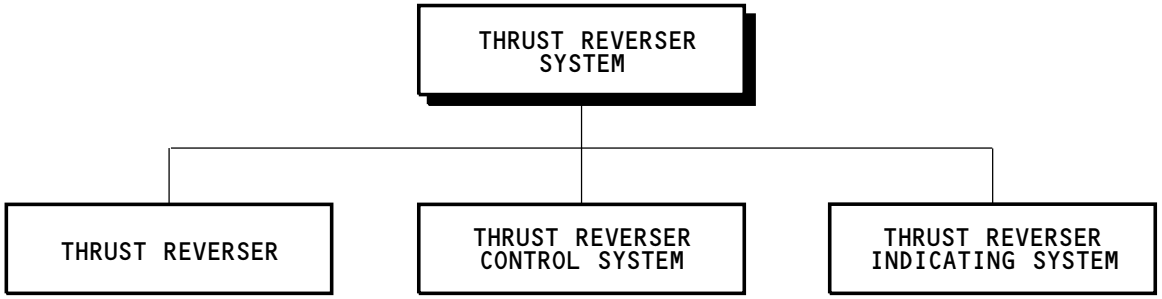
T/R Control System

The T/R control system controls electrical and hydraulic power to the T/R system.

T/R Indicating System

The T/R indicating system supplies T/R system and T/R control system indication in the flight compartment.





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THRUST REVERSER SYSTEM - INTRODUCTION

THRUST REVERSER SYSTEM - GENERAL DESCRIPTION

General

The thrust reverser (T/R) system has these subsystems:

- Thrust reverser system
- Thrust reverser control system
- Thrust reverser indicating system.

Thrust Reverser System

The T/R system changes the direction of the fan air exhaust to help decrease the speed of the airplane after landing or during a rejected takeoff (RTO).

The T/R system has two thrust reversers. T/R 1 is the thrust reverser for engine 1 (left). T/R 2 is the thrust reverser for engine 2 (right).

Each T/R has a left and right half. Each half has a translating sleeve which moves aft for reverse thrust. The two sleeves on each T/R work at the same time but are independent of each other. It is permitted for one sleeve to move before the other. The two sleeves do not have to move together, but do have to deploy/stow in the time limits. The two sleeves can have a lag in movement because of the frictional differences between tolerance stack-ups in the thrust reverser assembly for the inboard and outboard sleeves. Three hydraulic actuators move each sleeve. Rotary flex shafts make sure that the hydraulic actuators extend and retract at the same rate.

T/R Control System

The T/R control system lets you deploy the T/R when the airplane is less than 10 feet (3 meters) from the ground. You give a deploy signal to the control system when you raise a reverse thrust lever.

You supply a stow signal when you return the reverse thrust lever to the stow position.

The T/R control valve module controls hydraulic power to the hydraulic actuators. The reverse thrust lever operates the switches necessary to send a deploy or stow signal to the T/ R control valve module.

The sync locks prevent the operation of the hydraulic actuators when there is no deploy signal.

The primary purpose of the engine accessory unit (EAU) is to control the T/R stow operation. The EAU supplies front panel built-in-test equipment (BITE) to help you do troubleshooting of the control system. The EAU uses two T/R proximity sensors for each translating sleeve for control. The EAU also interfaces with the T/R indicating system to control the REVERSER light.

T/R Indicating System

The T/R indicating system supplies these indications in the flight compartment:

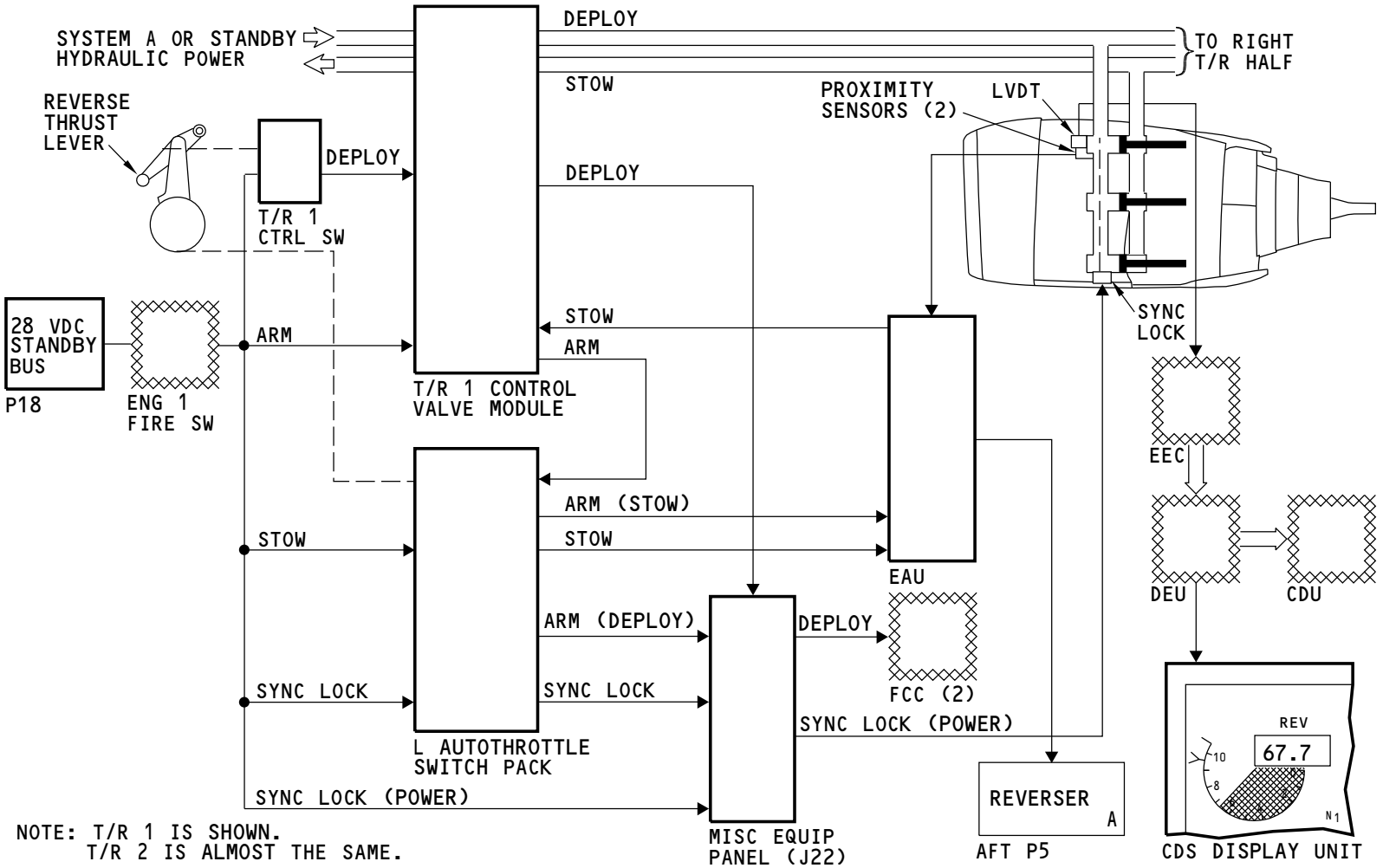
- REV message on common display system (CDS)
- REVERSER light on the P5 aft overhead panel
- Linear variable differential transformer (LVDT) data on the control display unit (CDU).

The common display system (CDS) shows the REV message. This message refers to the positions of a T/R's translating sleeves. Each T/R has LVDTs which supply translating sleeve position data to the electronic engine control (EEC).

When on, the REVERSER light shows that there is a failure in one of these areas:

- T/R control system
- Mechanical failure which prevents the control system from correct operation.

The REVERSER light comes on for 10 seconds during a T/R stow operation. The light will stay on if the T/R does not stow in 10 seconds. The EAU controls this light.



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THRUST REVERSER SYSTEM - GENERAL DESCRIPTION

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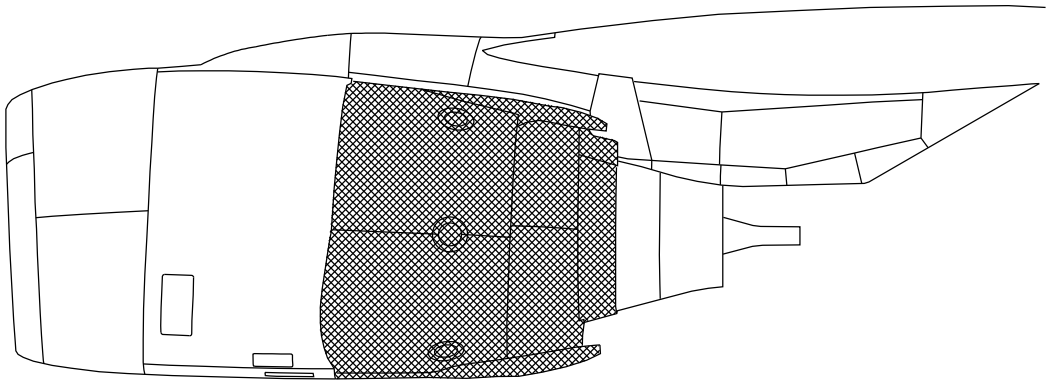
THRUST REVERSER - INTRODUCTION

Purpose

The thrust reverser (T/R) system controls the direction of engine fan air exhaust for forward and reverse thrust.

Reverse thrust helps decrease the speed of the airplane after landing or during a rejected take off (RTO).



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THRUST REVERSER - INTRODUCTION

THRUST REVERSER - GENERAL DESCRIPTION

General

The T/R is a translating sleeve and cascade design. Each T/R has a left and right fan duct half with a translating outer wall (sleeve). The two sleeves on each T/R work at the same time but are independent of each other. It is permitted for one sleeve to move before the other. The two sleeves do not have to move together, but do have to deploy/stow in the time limits. The two sleeves can have a lag in movement because of the frictional differences between tolerance stack-ups in the thrust reverser assembly for the inboard and outboard sleeves.

Each T/R half has these components:

- Translating sleeve
- 3 Hydraulic actuators and 2 sync shafts
- 6 Cascades
- 5 Blocker doors
- 5 Blocker door drag links
- 1 T/R opening actuator
- Torque box
- Fan duct inner wall
- 3 Access doors
- Upper and lower sliders and tracks.

The sleeves are in the stow position when they are in the full forward position. The sleeves are in the deploy position when they are in the full aft position. The sleeves have sliders which let the sleeves move forward and aft in tracks.

Each blocker door drag link attaches a blocker door to the inner duct.

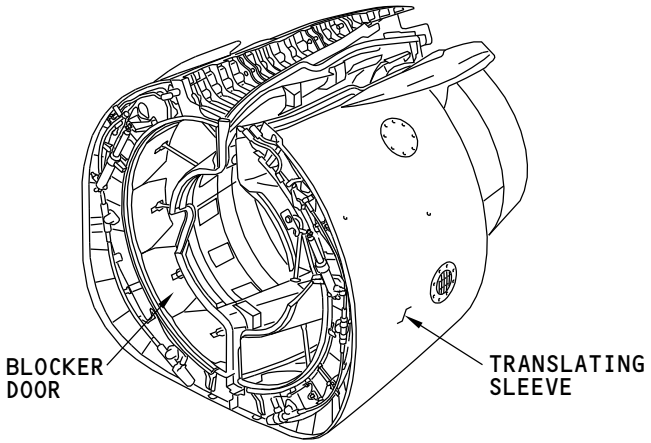
Functional Description

The T/R control system uses the hydraulic actuators to move the translating sleeves. The sleeves move aft of the cascades during a deploy operation.

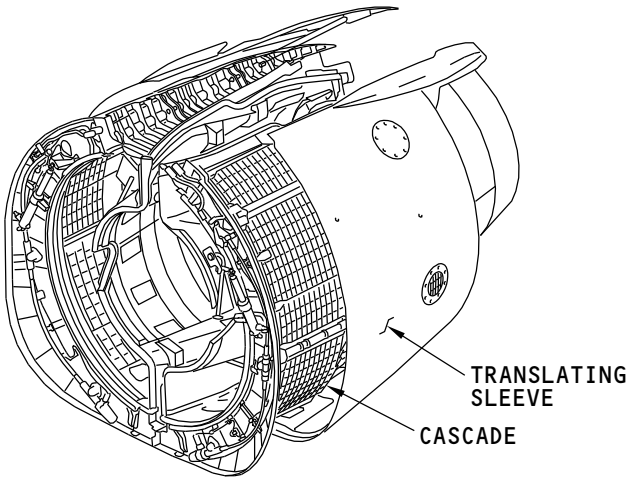
Each drag link permits its blocker door to move into the fan air exhaust flow as the sleeve move aft.

The blocker doors change the direction of the fan air exhaust out through the cascades. This causes reverse thrust. The cascades do not move.

See the thrust reverser control system section for more information about T/R control. (SECTION 78-36)



THRUST REVERSER
(STOW POSITION)



THRUST REVERSER
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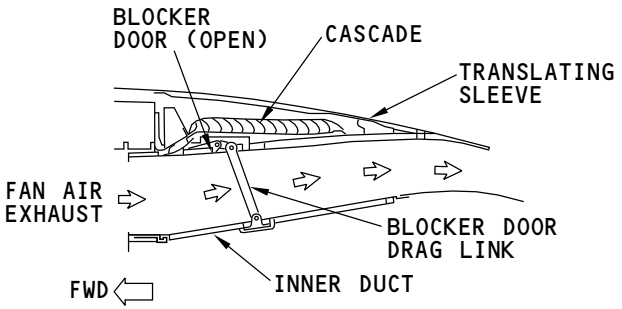
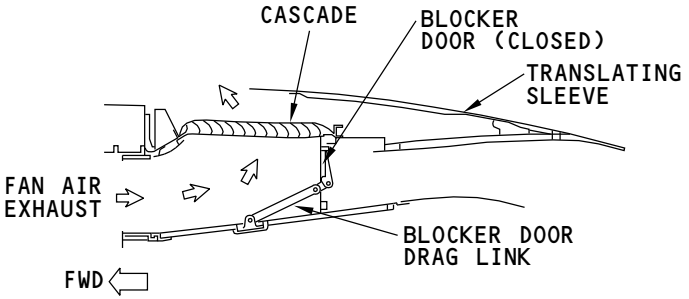


FORWARD THRUST



REVERSE THRUST

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THRUST REVERSER - GENERAL DESCRIPTION

THRUST REVERSER - COMPONENT LOCATION

General

Each thrust reverser has two halves. These are the thrust reverser components on each half:

- Translating sleeve
- Hydraulic actuators
- Sync shafts
- Cascade segments
- Blocker doors
- Blocker door drag links
- Opening actuator
- Krueger flap deflector (inboard halves only)
- Rubstrip
- Tension latches
- Fire seals
- Insulation blanket
- Torque box, innerwall and aft cascade support ring
- Access doors
- Upper main track slider
- Lower main track slider
- Main track liner
- Auxiliary track liner
- Upper auxiliary track slider
- Lower auxiliary track slider
- Bullnose seal and retainer.

Thrust Reverser

The thrust reverser is made of three major components; the translating sleeve, the fan duct cowl, and the aft cowl. The inner surface of the translating sleeve and the outer surface of the fan duct cowl forms the fan duct for the fan air exhaust. A cross-section view thru the thrust reverser, aft of the fan, shows a reduction in cross sectional area over the length of the fan duct; this feature is used to create thrust from the fan exhaust air.

Thrust Reverser Fan Duct Cowl

The fan duct cowl is part of the thrust reverser assembly. There are a left and right fan duct cowl for each engine. The fan duct cowl assembly consists of the following: a one piece inner wall with upper and lower bifurcation and acoustic features, the forward torque box, the cascade aft attachment ring, the cascade segments, the upper hinge and track beam, the lower latch and track beam, the opening actuator attachment fittings and the main and auxiliary tracks and track liners for the translating sleeve.

The cascade segments and inner wall are made of composite materials. The torque box and upper hinge beam and lower latch beam are made of aluminum.

The inner wall forms part of the fan duct of the thrust reverser. The inner wall is a large one-piece composite structure that forms the upper bifurcation, the cowl that covers the engine core, and the lower bifurcation. On the airflow side, the inner wall has acoustic features. The hinge beam is attached to the upper bifurcation and the latch beam is attached to the lower bifurcation.

The fan duct inner wall is a composite structure with the drag link anchor fittings, lower bifurcation compression pad fittings and upper bifurcation compression receiver fittings. The aluminium hinge beam is attached to the inner wall upper bifurcation. The aluminium latch beam is attached to the inner wall lower bifurcation. The fan duct inner wall is covered with a corrosion resistant steel (CRES) faced thermal insulation blanket and fire barrier. The inner wall also has blocker door drag link fittings, the upper and lower bifurcation fire seals, vertical fire seals and engine core v-blade, the upper bifurcation compression cups and lower bifurcation compression pads. Most of the inner wall is made of honeycomb composite materials.

THRUST REVERSER - COMPONENT LOCATION

The torque box is a semi-circular structure that connects the upper hinge beam and the lower latch beam. The torque box also has a v-blade that engages the v-groove in the engine fan case. The hydraulic locking and non-locking actuators are installed through the torque box and the forward actuator gimbals are pinned to fittings on the torque box. The deploy and retract hydraulic tubing are located by tubing clamps mounted on the torque box. Wire bundles for the rotary variable differential transducer (RVDT), the proximity sensors on the locking actuators and the sync lock/manual drive unit are attached to the torque box with wire bundle clamps. The forward attachment points for the cascade segments are on the aft side of the torque box.

Each T/R half has two v-blades. One v-blade is mounted on the front thrust reverser torque box which engages a v-groove on the engine fan case. The second v-blade is mounted to the front of the fan duct inner wall of the thrust reverser that covers the engine core. The second v-blade engages a v-groove on the engine core case. The v-blades transfer the longitudinal thrust forces on the thrust reverser in forward flight and reverse thrust back into the engine and strut structure.

The cascade aft attachment ring is a semi-circular structure connects the upper hinge beam with the lower latch beam. The ring provides the aft attachment points for the cascade segments.

Each T/R half has a hinge beam structure at the top of the thrust reverser that has four connection points for two strut hinge fittings and two tie rods. The two center hinge beam connection points attach to the two strut hinge fittings that carry the thrust reverser static weight. The forward and aft hinge beam connection points attach to tie rods that pass through the strut. The strut hinge fittings have spherical ball bushings. The strut tie rods ties the front and aft position of the two thrust reverser halves. The upper hinge beam also has bracket structure for the forward and aft fairing that covers the hinges. The upper bifurcation compression cups engage the ends of three strut-mounted compression rods. The three compression cups are mounted on fittings on the left and right upper bifurcations. The compression rods are the primary load path to transfer the fan duct pressure load between the thrust reverser halves. Continued operation is not permitted with the compression rods damaged or missing. The compression rods are suspended from brackets under the strut. The compression rods are not adjustable at the rod ends. The compression cups are adjustable with shims.

A corrosion resistant steel (CRES) firewall plate is attached at the front of each thrust reverser hinge beam to separate the hinge beam and strut structure from overheat or fire from the engine fan case mounted components. A corrosion resistant steel (CRES) firewall plate is attached at the front of each lower torque box to separate the latch beam structure from overheat or fire from the engine fan case mounted components.

There are three compression wear plates mounted on fittings on the left lower bifurcation.

The latch wearplates and shims are mounted to the side of the tension latches and are adjusted when the strut or the thrust reverser is replaced.

The tracks for the translating sleeve are machined into the hinge beam and the latch beam. Track liners are installed in the tracks. There is a main track and an auxiliary track on each beam. The main track engages the main track sliders on the inner wall of the translating sleeve and carries the weight of the translating sleeve. The auxiliary track engages the auxiliary track sliders on the outer wall of the translating sleeve.

THRUST REVERSER - COMPONENT LOCATION

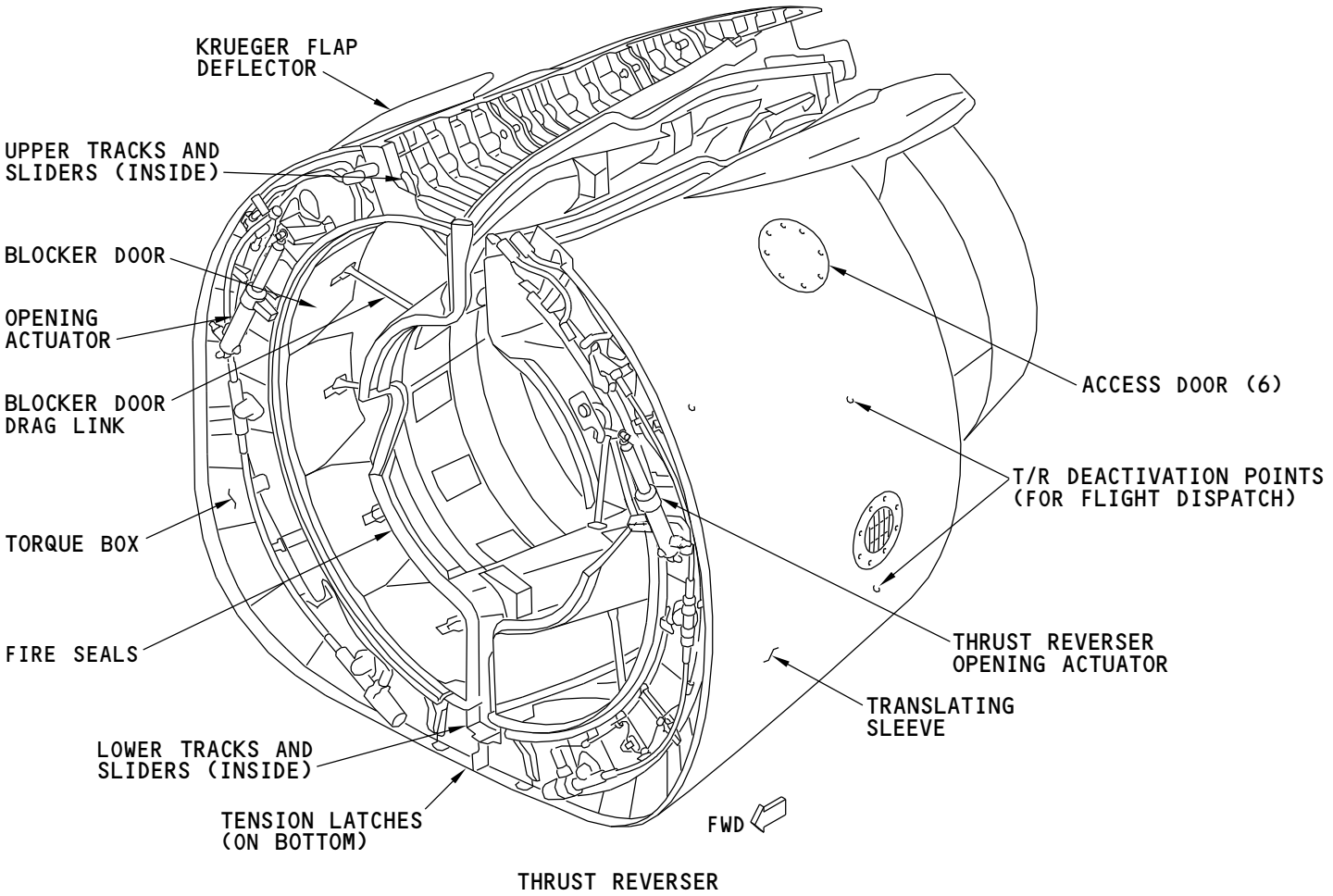
On the lower latch beam, around the latch housings, there are four shear pins on the left thrust reverser and four shear pin bushings on the right thrust reverser. The shear pins fit into the bushings when the thrust reverser is closed and latched. The purpose of the shear pins and bushings is to align the bottom of the thrust reversers together. If a shear pin or bushing is missing, there would be an increase in loads and wear on the remaining shear pins and bushings. The forward shear pin and bushing and the aft shear pin and bushing cannot be missing. Any missing shear pin or bushings must be replaced.

Bulb-type fire seals are mounted in metal retainer tracks on the length of the upper bifurcation and the lower bifurcation to the latch beam. A bulb type fire/aerodynamic seal is mounted around the circumference of the inner wall, aft of the inner wall v-blade. A bulb type fire seal is mounted on the inner wall lower bifurcation of the left thrust reverser half. A bulb type fire seal is mounted on the inner wall upper bifurcation of the left and right thrust reverser half. When the thrust reverser is closed and latched, the bulb type fire seals are compressed against the metal seal depressors on the strut, the engine upper fancase, the structure around the engine core case. The fire seals help to contain a engine core external component fire under the inner wall. Some of the fire seals act also act as aerodynamic seals which close off air gaps that can cause an operational economic penalty.

The thermal insulation blankets are installed on brackets that are installed on the inner surface of the inner wall. Thermal insulation blankets are mounted on the inside surface of the fan duct cowl and upper and lower bifurcation. These blankets are a thermal insulation and fire barrier which is necessary to keep the thrust reverser structurally serviceable and can decrease the damage and repair costs from a duct burst or fire. The thermal insulation prevents fire and engine operation heat damage to the composite inner wall of the fan duct cowl.

Rubstrips are mounted on the circumference of the torque box as a wear surface for the fan cowl panels and the translating sleeves.

A total of six tension latches, at the bottom of the T/R, keep the two halves together. The tension latches are mounted in the latch beam on the left thrust reverser half. The hooks on the tension latches engage latch bolts that are mounted in the latch beam on the right thrust reverser half. There are two tension latches that are mounted together at the forward end of the latch beam. These two tension latches are necessary to keep the v-blades engaged in the v-grooves if a fan blade out or rejected take off event occurs.



THRUST REVERSER

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THRUST REVERSER - COMPONENT LOCATION

THRUST REVERSER - TRANSLATING SLEEVE

Purpose

The translating sleeves have two purposes when the T/Rs are in the stow position:

- Protect the cascades and other internal components
- Control the outer edge of the fan air exhaust flow.

The translating sleeves have two purposes when the T/Rs are in the deploy position:

- Expose the cascades
- Move the blocker doors into the fan air exhaust flow.

Location

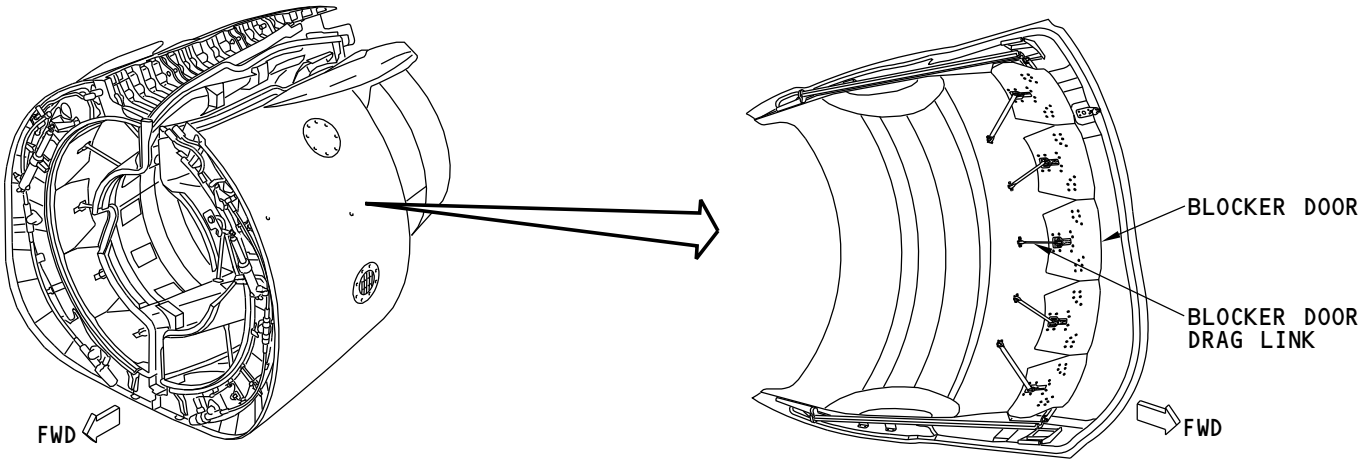
The T/R sleeves are aft of the fan cowl. Sliders and tracks attach the sleeve to the structure.

Physical Description

The T/R sleeve is a composite assembly with an inner and outer skin.

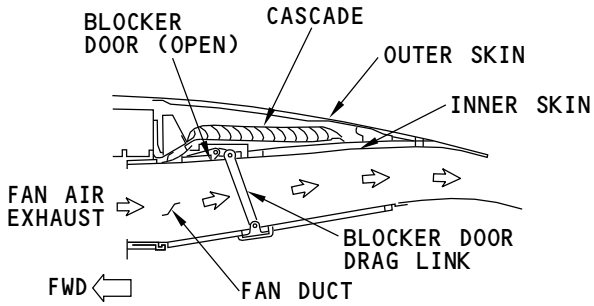
The outer skin completes the aerodynamic contour of the engine cowls and protects internal components.

The inner skin is the outer wall of the fan duct. Blocker doors and acoustic panels make up a large part of the inner skin.

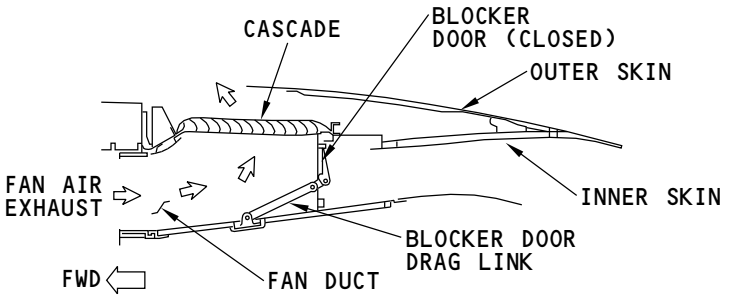


THRUST REVERSER

TRANSLATING SLEEVE
(INNER COWL STRUCTURE NOT SHOWN)



FORWARD THRUST (STOW POSITION)



REVERSE THRUST (DEPLOY POSITION)

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THRUST REVERSER - TRANSLATING SLEEVE

THRUST REVERSER - HYDRAULIC ACTUATORS AND SYNC SHAFTS - GENERAL DESCRIPTION

Purpose

The hydraulic actuators move the translating sleeves during T/R deploy and stow operations.

The sync shafts make the hydraulic actuators extend and retract at the same speed. The sync shafts also let you manually operate the hydraulic actuators.

General

Each T/R half has three hydraulic actuators. The actuators extend during a deploy operation and retract during a stow operation. Each T/R half has one locking actuator and two non-locking actuators. The locking actuator must unlock for the other hydraulic actuators on that same half to operate.

The locking actuators have a position feedback mechanism and a manual unlock lever. The position mechanism operates a linear variable differential transformer (LVDT). The manual unlock lever lets you unlock the locking actuator for a manual translation of the T/R sleeve.

See the thrust reverser indicating system section for more information about the LVDT. (SECTION 78-36)

There are two sync shafts on each T/R half.

Location

The locking actuators are the top actuators on each T/R half. The two non-locking actuators are below the locking actuators. All actuators attach to the torque box and to the translating sleeve.

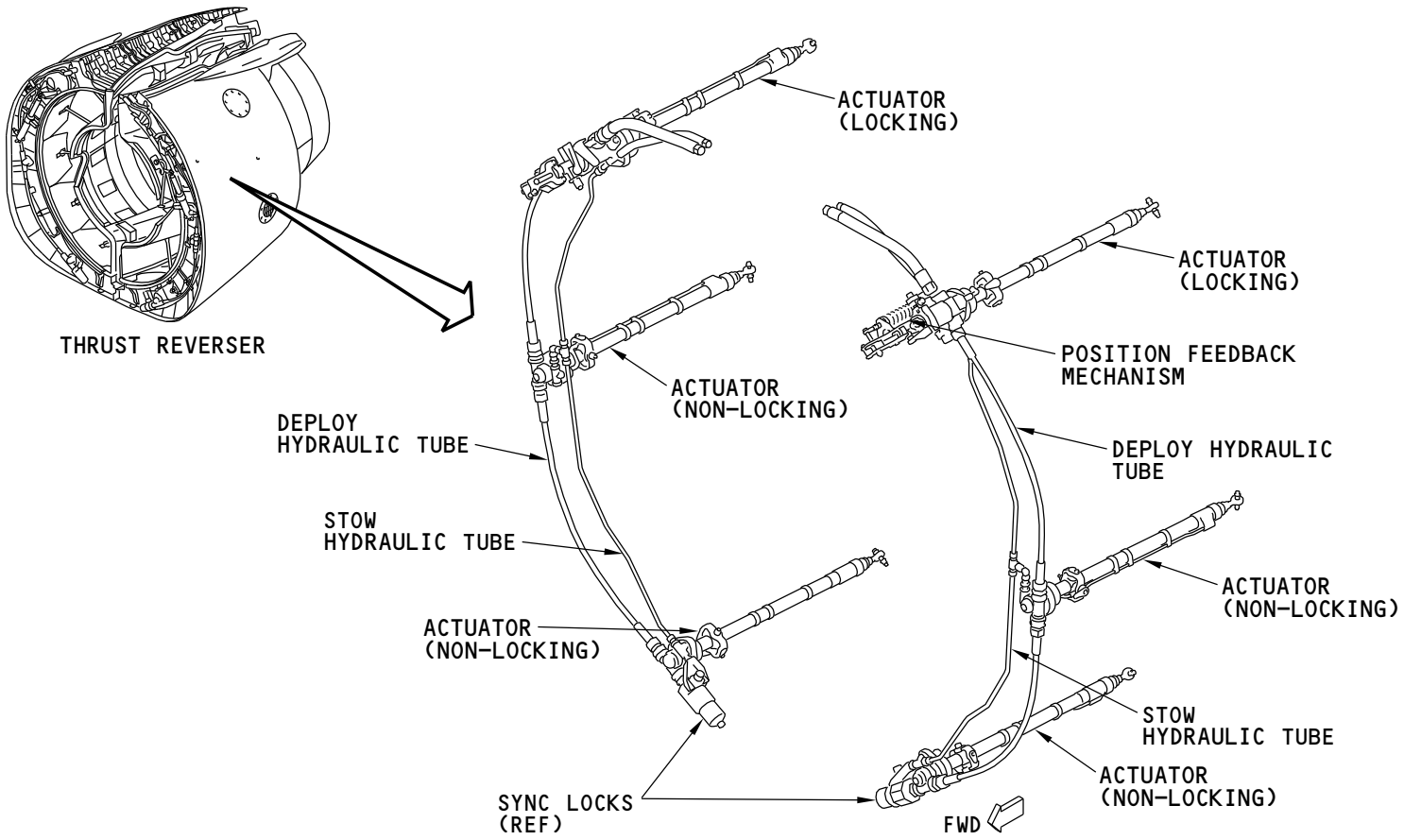
You open the fan cowl and move the translating sleeve aft to get access to the hydraulic actuators.

The upper sync shaft is inside the deploy hydraulic tube, between the upper and center actuators. The lower sync shaft is inside the deploy hydraulic tube, between the center and lower actuators. The deploy tubes are larger than the stow tubes. You open the fan cowl to get access to the tubing.

Training Information Point

You use the sync lock to manually operate the hydraulic actuators and sync shafts.

See the thrust reverser control system section for more information about the sync lock. (SECTION 78-34)



M88137 S0004632504_V1

THRUST REVERSER - HYDRAULIC ACTUATORS AND SYNC SHAFTS - GENERAL DESCRIPTION

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THRUST REVERSER - HYDRAULIC ACTUATORS - FUNCTIONAL DESCRIPTION

General

There are two types of T/R hydraulic actuators:

- Locking
- Non-locking.

Each T/R half has one locking actuator and two non-locking actuators. The locking actuators have a feedback mechanism and a manual unlock lever.

The feedback mechanism operates the linear variable differential transformer (LVDT). The LVDT supplies translating sleeve position data to the indicating system. See the thrust reverser indicating system section for more information. (SECTION 78-36)

The manual unlock lever lets you manually unlock the locking actuator. The manual unlock lever is also a target for the T/R sleeve lock sensor. See the thrust reverser control system section for more information about this sensor. (SECTION 78-34)

Location

The locking actuators are near the top of each T/R half. The two non-locking actuators are below the locking actuators. All actuators attach to the torque box at the forward end and to the translating sleeve at the aft end.

You open the fan cowl and move the translating sleeve aft to get access to the hydraulic actuators.

Physical Description

All of the hydraulic actuators have these parts and connections:

- Extend (deploy) pressure port
- Retract (stow) pressure port
- Gimbal assembly
- Sync shaft and tubing connections.

The locking actuators also have these components:

- Manual unlock lever
- Position feedback mechanism
- Internal lock mechanism.

Hydraulic pressure at the extend port unlocks the locking actuator during normal T/R operation. You can use the manual unlock lever to unlock the actuator for a manual translation of a sleeve.

Pressure Ports

The T/R control valve controls the hydraulic power to the actuators. Hydraulic fluid goes to the extend and retract pressure ports of each actuator during a deploy operation. Hydraulic power unlocks the locking actuator so it can operate. All actuators extend and move the translating sleeve aft.

The T/R control valve sends hydraulic fluid to the retract pressure ports of each actuator during a stow operation. With hydraulic pressure at these ports, the actuators retract and move the translating sleeve forward. The hydraulic fluid at the extend port returns through the hydraulic control valve module to the hydraulic reservoir.

Gimbal Assembly

A gimbal assembly attaches the head end of each hydraulic actuator to the aft side of the torque box. You must move the translating sleeves aft to get access to the gimbal assembly.

Sync Shaft and Tubing Connections

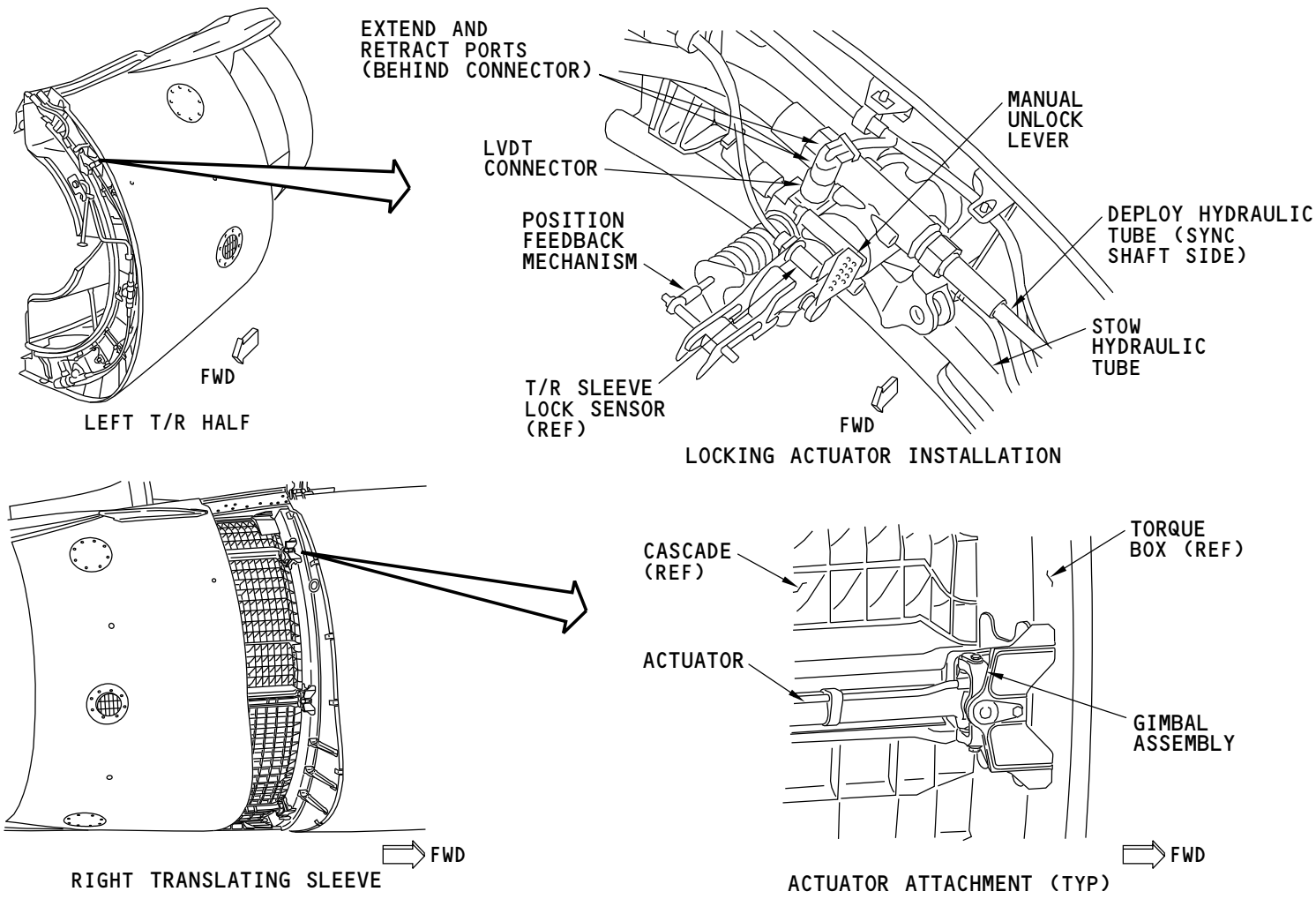
The sync shafts connect the drive mechanisms of the actuators together. The shafts are inside of the deploy hydraulic tubing which connects to the extend pressure port. The sync shaft connection is at the pressure port.

Training Information Point

All non-locking type actuators are interchangeable. All locking type actuators are interchangeable.

THRUST REVERSER - HYDRAULIC ACTUATORS - FUNCTIONAL DESCRIPTION

CAUTION: DO NOT PERMIT THE ACTUATOR ROD END TO TURN OR BE TURNED WHEN YOU HANDLE THE ACTUATOR. DAMAGE TO THE INTERNAL FEEDBACK MECHANISM CAN OCCUR.



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THRUST REVERSER - HYDRAULIC ACTUATORS - FUNCTIONAL DESCRIPTION

THRUST REVERSER - CASCADE SEGMENTS

Purpose

The cascades control the direction of the fan air exhaust during a T/R deploy operation. This helps create reverse thrust. The cascades also give structural strength to the T/R.

General

Each T/R has 12 cascades. Numbers identify the cascade locations. T/R 1 cascade numbers increase clockwise when looking forward. T/R 2 cascade numbers increase counter clockwise when looking forward.

Location

Bolts attach the cascades to the torque box on the forward edge and to the cascade support ring on the aft edge.

You deploy the T/R to get access to the cascades.

Physical Description

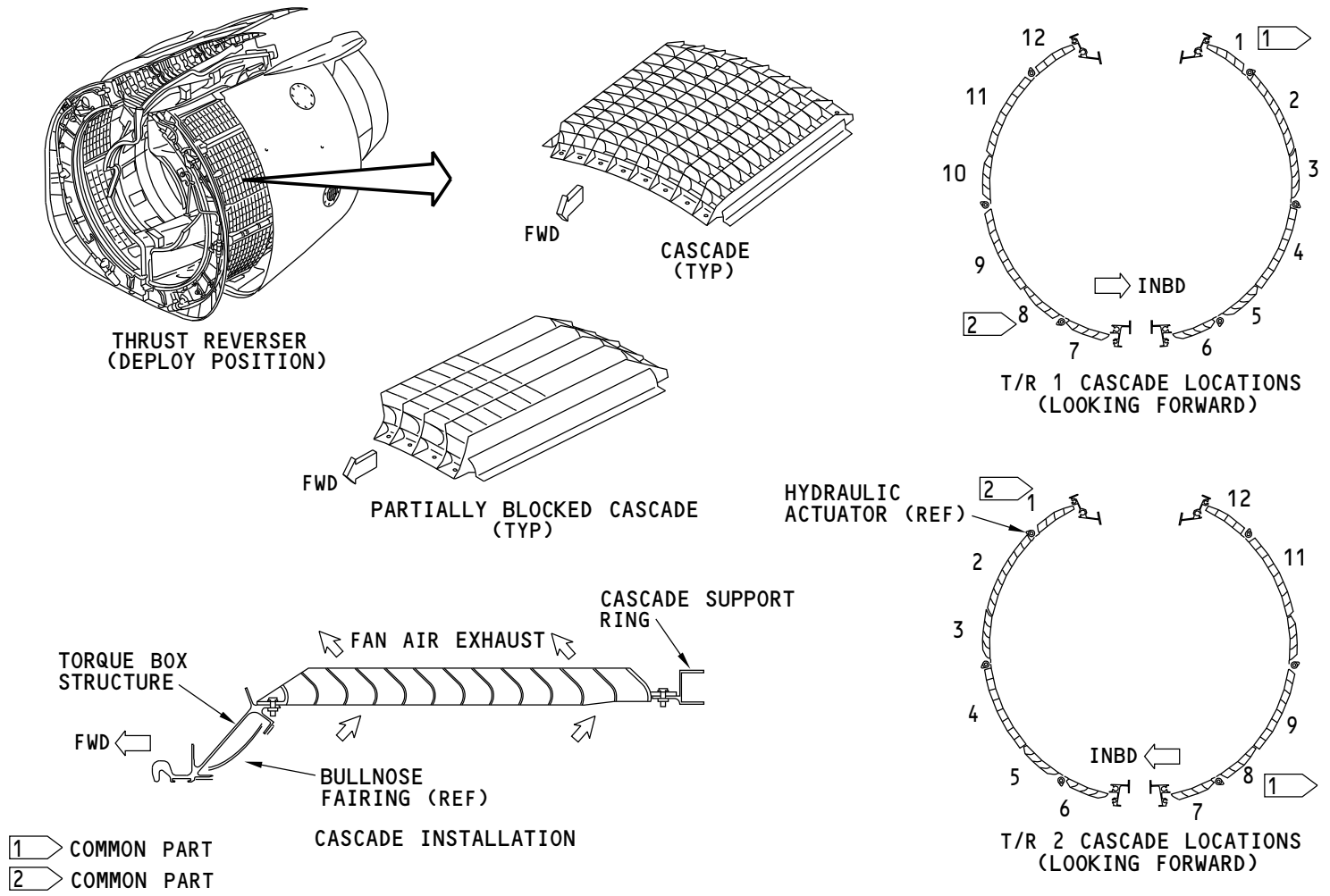
The cascades are graphite epoxy.

There are 22 different cascade (part numbers) for each airplane. Each type causes the fan air exhaust airflow to go out in a different direction. Cascades 2 and 3 are partially blocked on each T/Rs. These cascades do not let air go through a portion of their vanes.

Training Information Point

The T/R sleeves must be in the deploy position to inspect, remove or install the cascades.

WARNING: DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONS AND DAMAGE TO EQUIPMENT.



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THRUST REVERSER - CASCADE SEGMENTS

THRUST REVERSER - BLOCKER DOORS AND BLOCKER DOOR DRAG LINKS

Purpose

The blocker doors change the direction of the fan air exhaust flow during a T/R deploy operation.

The blocker doors make part of the fan duct outer wall when the T/R is in the stow position.

The blocker door drag links connect the blocker doors to the fan duct inner wall.

Location

The blocker doors are part of the translating sleeve. They are usually smooth with the inner contour of the translating sleeve.

The blocker door drag links are in the fan duct.

Physical Description

Each translating sleeve has five graphite-epoxy blocker doors. There are three different sizes of blocker doors on each sleeve.

Two hinges connect each blocker door to the forward end of the inner sleeve. The blocker door drag links connect the blocker doors to the fan duct inner wall. A cover goes over the drag link to blocker door attachment. Numbers identify blocker door location.

Functional Description

Each translating sleeve moves aft during a T/R deploy operation. This movement causes the blocker doors to move into the fan duct. The fan air exhaust changes direction and exits through the cascades. This helps create reverse thrust.

Training Information Point

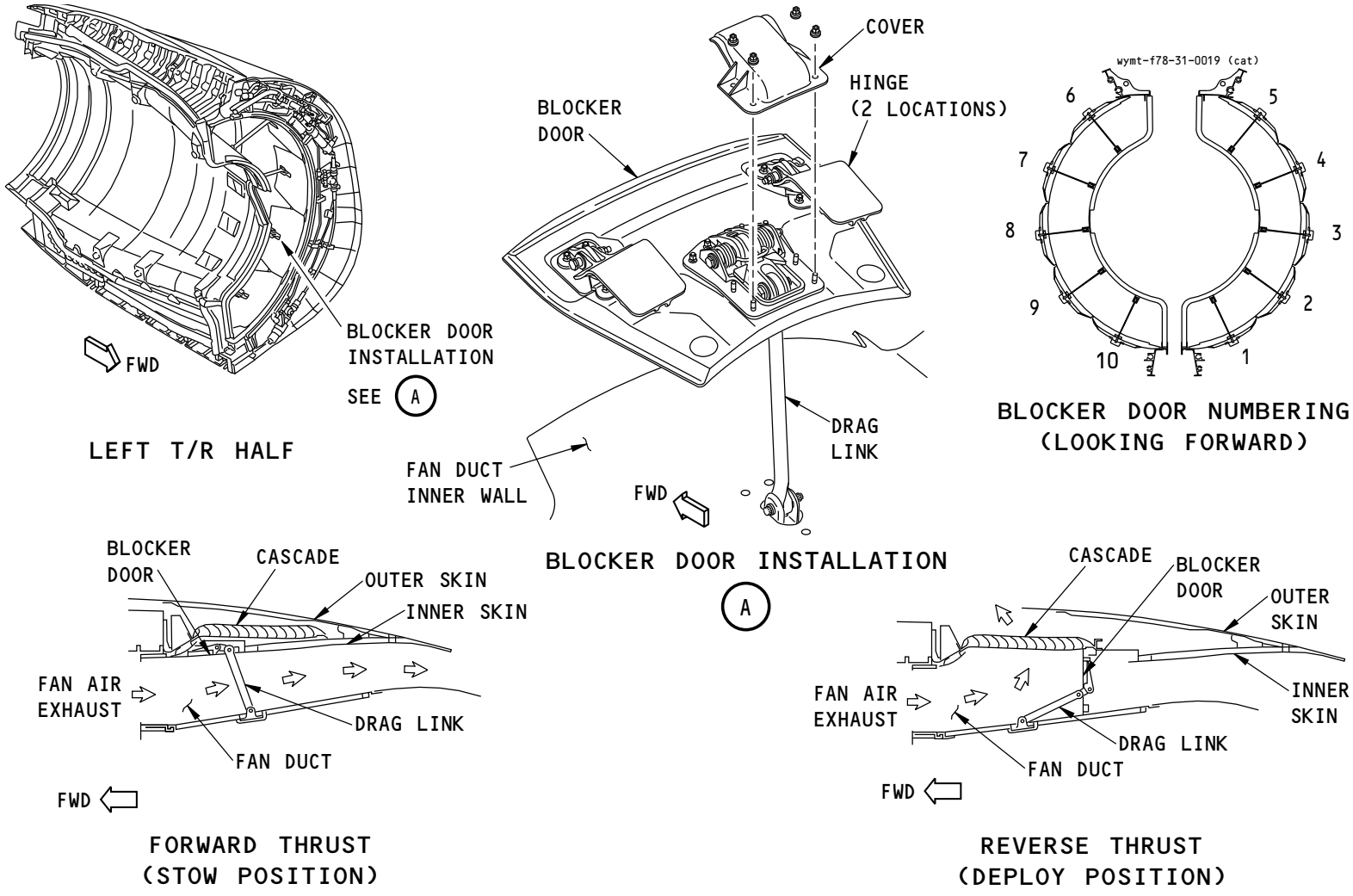
You must move the translating sleeve aft to inspect or work on the blocker door and the blocker door drag links.

You must open the T/R half to inspect the blocker door drag link connections at the fan duct inner wall.

WARNING: DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

WARNING: DO NOT GO INTO THE FAN DUCT WHEN THE THRUST REVERSER IS IN THE OPEN POSITION. YOUR WEIGHT CAN CAUSE THE HOLD OPEN ROD FOR THE THRUST REVERSER TO BREAK. INJURY TO YOU AND DAMAGE TO THE EQUIPMENT CAN OCCUR.

CAUTION: DO NOT PULL ON THE BLOCKER DOOR DRAG LINKS OR USE THE DRAG LINKS FOR SUPPORT. YOU CAN DAMAGE THE DRAG LINKS.



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THRUST REVERSER - BLOCKER DOORS AND BLOCKER DOOR DRAG LINKS

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THRUST REVERSER - THRUST REVERSER OPENING ACTUATOR

Purpose

You use the T/R opening actuator to open the T/R cowl (half). Each engine has two T/R opening actuators. Each actuator opens its cowl to approximately 45 degrees from the closed position.

Location

Each T/R opening actuator is on the forward face of its T/R cowl. The upper end of the T/R opening actuator attaches to the T/R cowl. The lower end attaches to the engine fan frame extension ring. You open the fan cowls to get access to the T/R opening actuators.

Physical Description

The T/R opening actuator has these components:

- Hydraulic piston housing
- Rod
- Lock collar mechanism
- Inlet fitting
- Internal snubber assembly.

The rod extends approximately 12 inches (30.5 cm). The inlet fitting permits you to connect a hand pump necessary to operate the actuator.

The actuator is automatically locked in the extended position by a cylindrical pawl lock mechanism. For operator safety, the lock can not be disengaged while under load, the cowl load must be lifted off the lock with hydraulic pressure prior to unlocking the actuator. The lock can be manually unlocked and will stay unlocked until retraction is selected at the hand pump. A ball-spring detent in the piston head holds the lock in the unlocked position, until the operator opens the pressure release on the hand pump.

An integral auxiliary reservoir is provided in the actuator with sufficient fluid to fill the swept volume of the piston in the event that the thrust reverser cowl doors are forcibly opened (instead of using the hand pump). Suction created by the manual extension of the piston allows free flow through the flow control valve from the reservoir. This provides a controlled closing rate as in normal operation, so there is no sudden drop when the cowl is released.

A flow control/check valve is provided in the actuator to allow free flow from the hand pump or the auxiliary reservoir during extension, and to regulate the flow during retraction. The flow control limits the retract time from 15 to 20 seconds under normal temperature conditions and varying cowl loads. A screen in the valve prevents large particles from entering the actuator. A quick disconnect fitting, protected by a dust cover is connected to the GSE hand pump for extension and retraction.

A relief valve in the actuator limits pressure to 4800-5200 psig (33091 - 35848 kPa) during hand pump operation if the hand pump relief pressure is incorrect or thermal expansion of fluid within the actuator. Fluid flows (external) from the bleed hole in the relief plug when the actuator is over pressurized.

Functional Description

Fluid from the hand pump causes the T/R opening actuator rod to extend and open the T/R cowl. As the actuator approaches the full extend position, the lock collar goes into the lock position. A red band on the rod shows when the collar in the lock position.

Fluid goes from the opening actuator back to the hand pump when you close the T/R cowl.

Operation

There are two procedures to open the T/R's. The pump procedure is the best. You use the manual procedure only if no pump is available.

THRUST REVERSER - THRUST REVERSER OPENING ACTUATOR

You use a hand pump to operate the T/R opening actuator. As the rod extends, the T/R cowl opens and the lock collar moves into the lock position. You can see and hear the lock collar move to the lock position. The red band confirms the lock collar position. Refer to the pump procedure in the airplane maintenance manual (AMM).

The AMM also has the manual open and closing procedure. With the manual procedure, you lift and move the cowl up until the actuator lock goes into the lock position.

Training Information Point

The leading edge flaps can extend and damage the T/R cowls (halves) when they are in the open (maintenance) position. Follow the AMM procedures to prevent the leading edge flap operation before you open the T/R's.

An actuator safety lock is put around the T/R opening actuator's rod after the T/R cowl is open. The actuator safety lock prevents the actuator rod retraction from the thrust reverser weight if the lock collar fails. Two quick release pins hold the actuator safety lock around the T/R opening actuator rod.

You use a hold open fitting (special tool) to keep the T/R halves open during an engine change. This fitting holds the T/R halves at approximately 45 degrees open. The outboard T/R halves can open more than 45 degrees. A hold open rod can keep these T/R halves open at 55 degrees. Refer to the AMM for procedures.

WARNING: DO NOT GO BETWEEN THE ENGINE AND THE THRUST REVERSER WITHOUT THE ACTUATOR SAFETY LOCK INSTALLED. IF THE THRUST REVERSER SUDDENLY CLOSES, INJURY TO PERSONS OR DAMAGE TO EQUIPMENT CAN OCCUR.

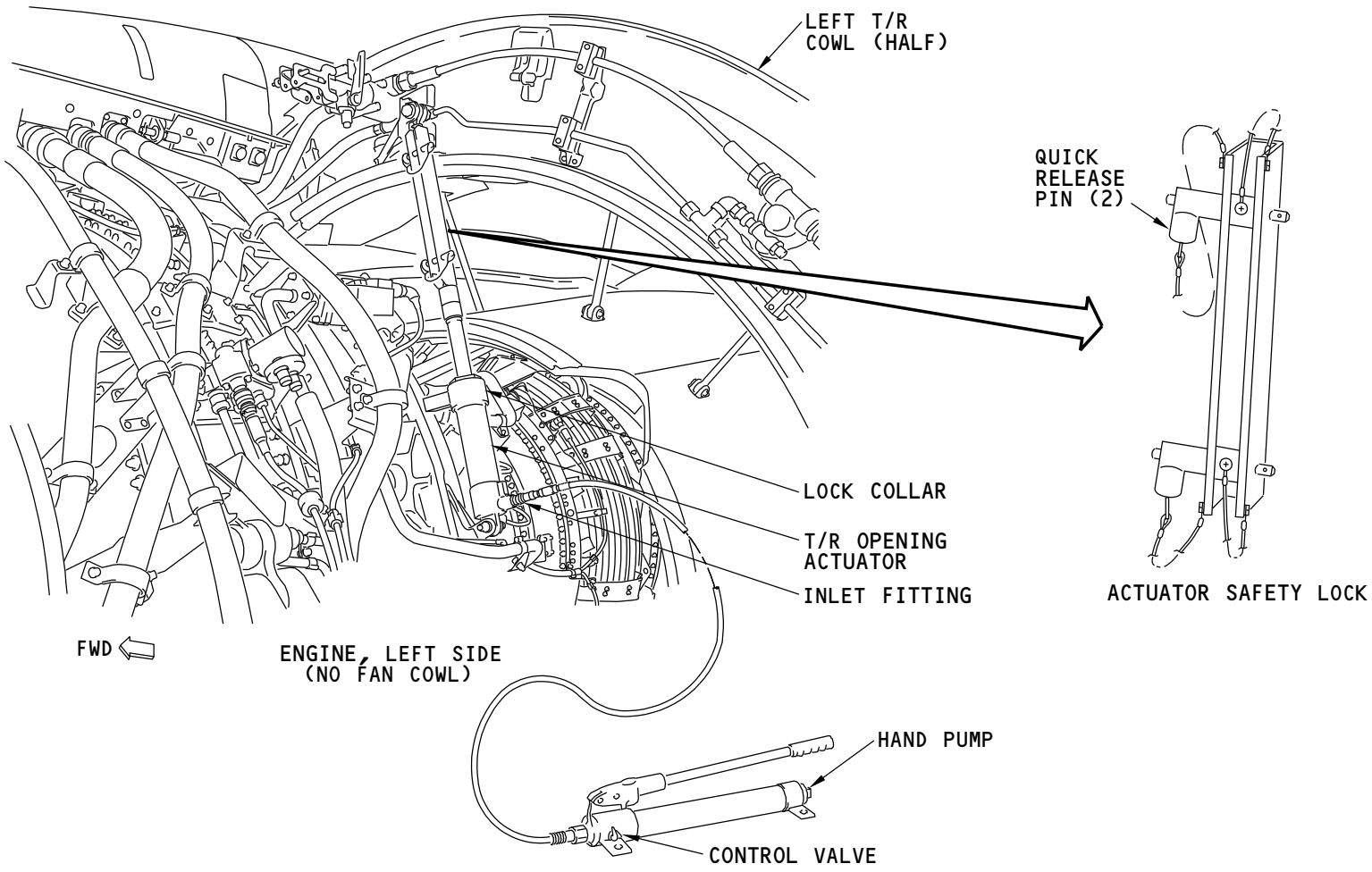
WARNING: MAKE SURE YOU DO THE DEACTIVATION PROCEDURE FOR THE THRUST REVERSER. IF THE THRUST REVERSER IS NOT LOCKED, IT CAN ACCIDENTALLY OPERATE AND CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

WARNING: DO NOT OPERATE THE OPENING SYSTEM FOR THE THRUST REVERSER IF THE WIND VELOCITY IS MORE THAN 40 KNOTS. THE OPENING SYSTEM FOR THE THRUST REVERSER CAN HAVE A FAILURE IN LARGE WINDS WHICH CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

WARNING: IF YOU USE THE MANUAL PROCEDURE TO OPEN THE THRUST REVERSER AGAIN AND AGAIN, THE HYDRAULIC FLUID FOR THE POWER OPENING SYSTEM CAN DECREASE. THIS WILL DECREASE THE SNUBBING ACTION. IF THE HYDRAULIC FLUID IN THE POWER OPENING SYSTEM DECREASES, THE REVERSER HALF CAN CLOSE TOO FAST. THIS CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT. YOU MUST OPEN AND CLOSE THE REVERSER HALVES REGULARLY WITH THE PUMP METHOD TO REPLACE THE HYDRAULIC FLUID.

CAUTION: MAKE SURE THE ADJACENT FAN COWL PANEL IS FULLY OPEN BEFORE YOU OPEN THE REVERSER HALF. IF THE ADJACENT FAN COWL PANEL IS NOT FULLY OPEN, YOU CAN DAMAGE IT WHEN YOU OPEN THE REVERSER HALF.

CAUTION: DO NOT CAUSE THE THRUST REVERSER SLEEVE TO MOVE TO THE DEPLOYED POSITION WHEN THE THRUST REVERSER IS OPEN. THIS CAN CAUSE DAMAGE TO THE TRANSLATING SLEEVE AND THE LEADING EDGE FLAP.



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THRUST REVERSER - THRUST REVERSER OPENING ACTUATOR

THRUST REVERSER - KRUEGER FLAP DEFLECTOR AND FAIRING

Purpose

The krueger flap deflector keeps separation between the inboard leading edge (krueger) flap and the inboard thrust reverser outer skin during these conditions:

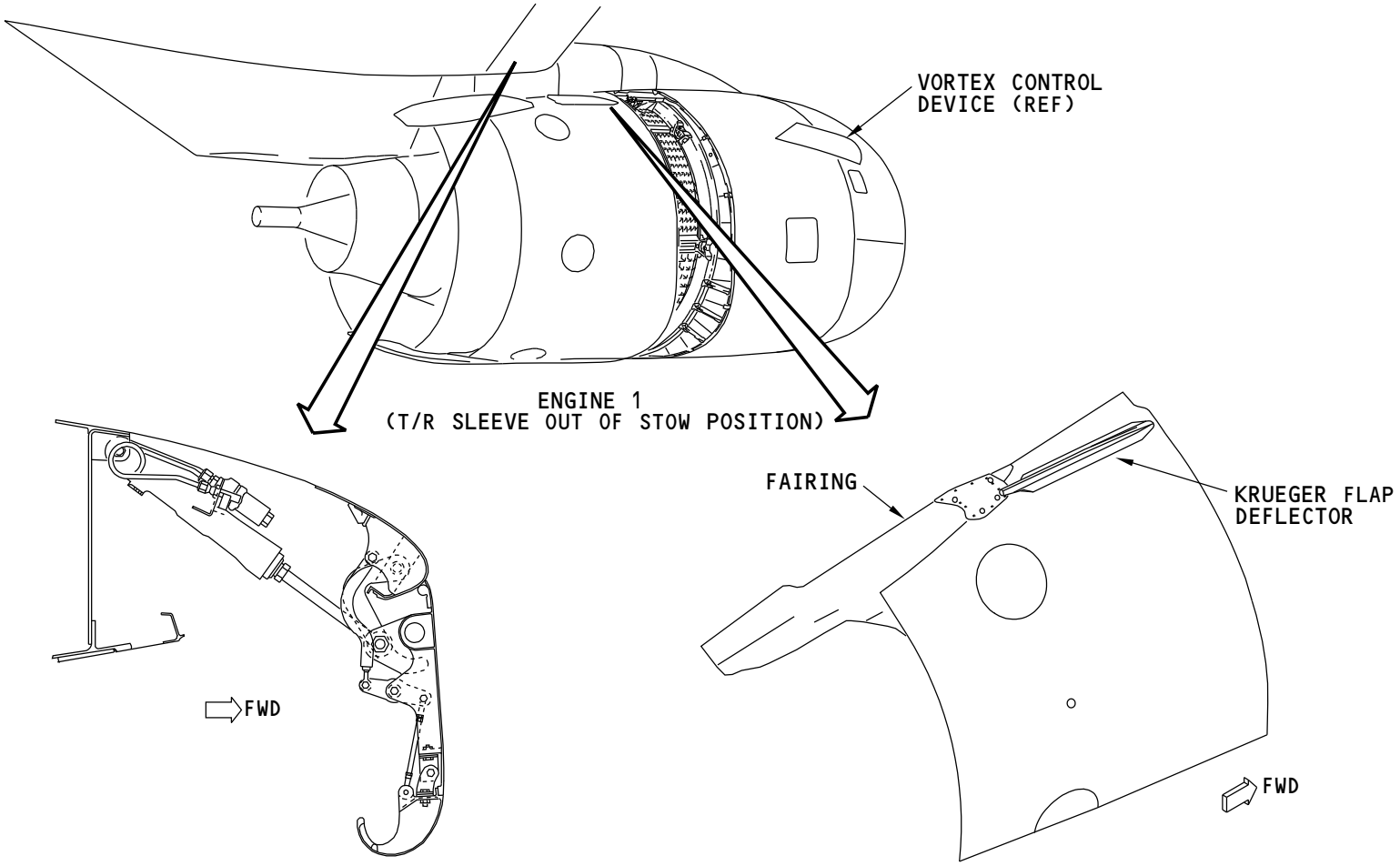
- The inboard leading edge flap in the extend position
- Anytime the T/R is out of the stow position.

The fairing gives an aerodynamic surface for airflow around the top of the thrust reverser.

Location

The krueger flap deflector is on the inboard T/R half of each engine. The deflector is near the top of the T/R half. Bolts on the inside of the translating sleeve hold the deflector in position. You move the translating sleeve aft to get access to these bolts.

The fairing is just aft of the deflector. Bolts attach the fairing to the T/R half structure.



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THRUST REVERSER - KRUEGER FLAP DEFLECTOR AND FAIRING

THRUST REVERSER - TENSION LATCHES

Purpose

The tension latches hold the T/R halves together.

General

There are six tension latches for each T/R. Numbers identify each latch. Latch number one is the latch most forward. Latch number six is the latch most aft. All latches are interchangeable.

Location

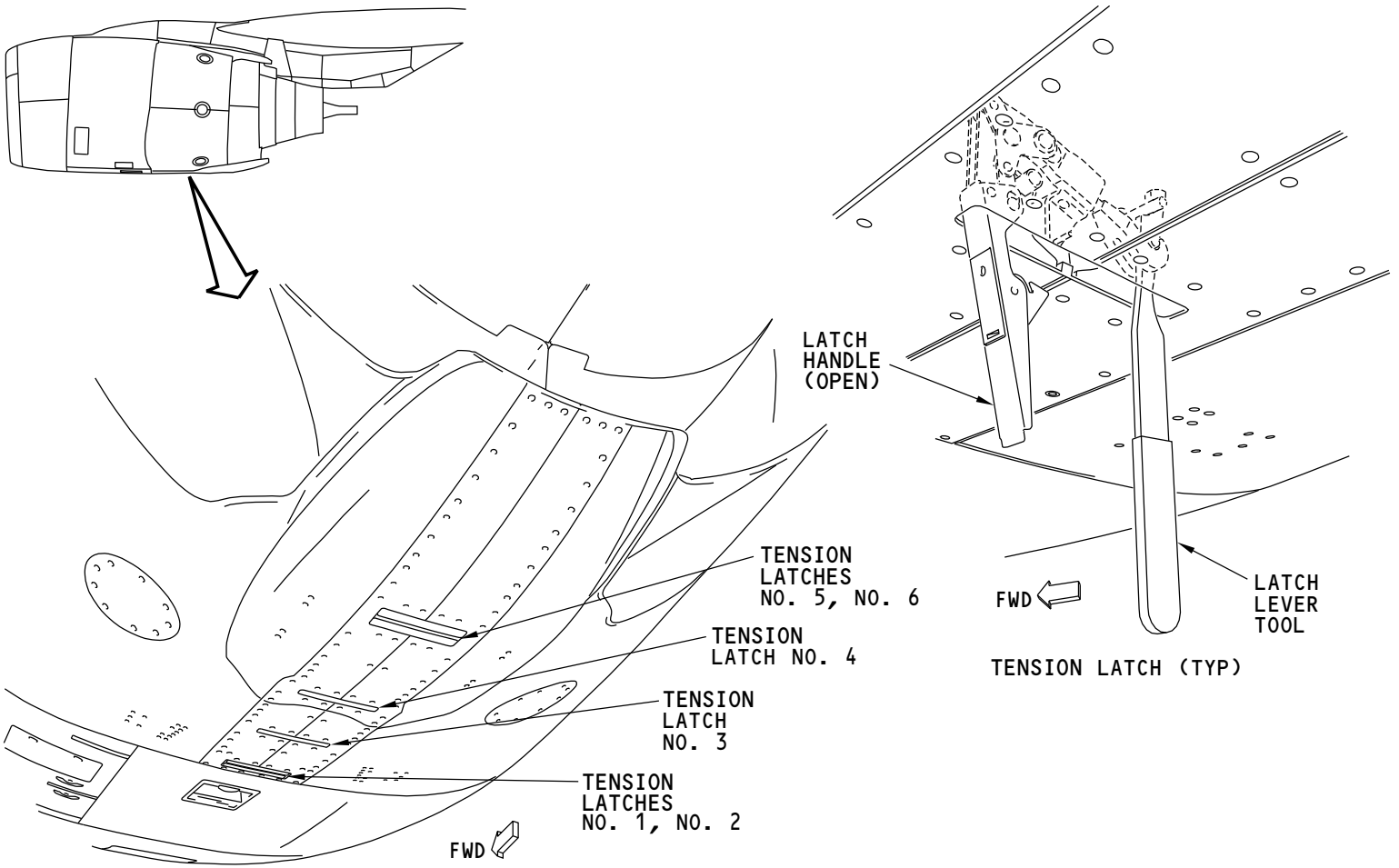
All tension latches are at the bottom of the T/R halves. The latch handles and mechanisms are on the left T/R half. The latch keeper pins are on the right T/R half.

Training Information Point

Always open the latches in order from aft (No. 6) to forward (No. 1).

Always close the latches in order from forward (No. 1) to aft (No. 6).

You use the latch lever tool (special tool) to help bring the T/R halves together. This makes it easy to close the tension latches.



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THRUST REVERSER - TENSION LATCHES

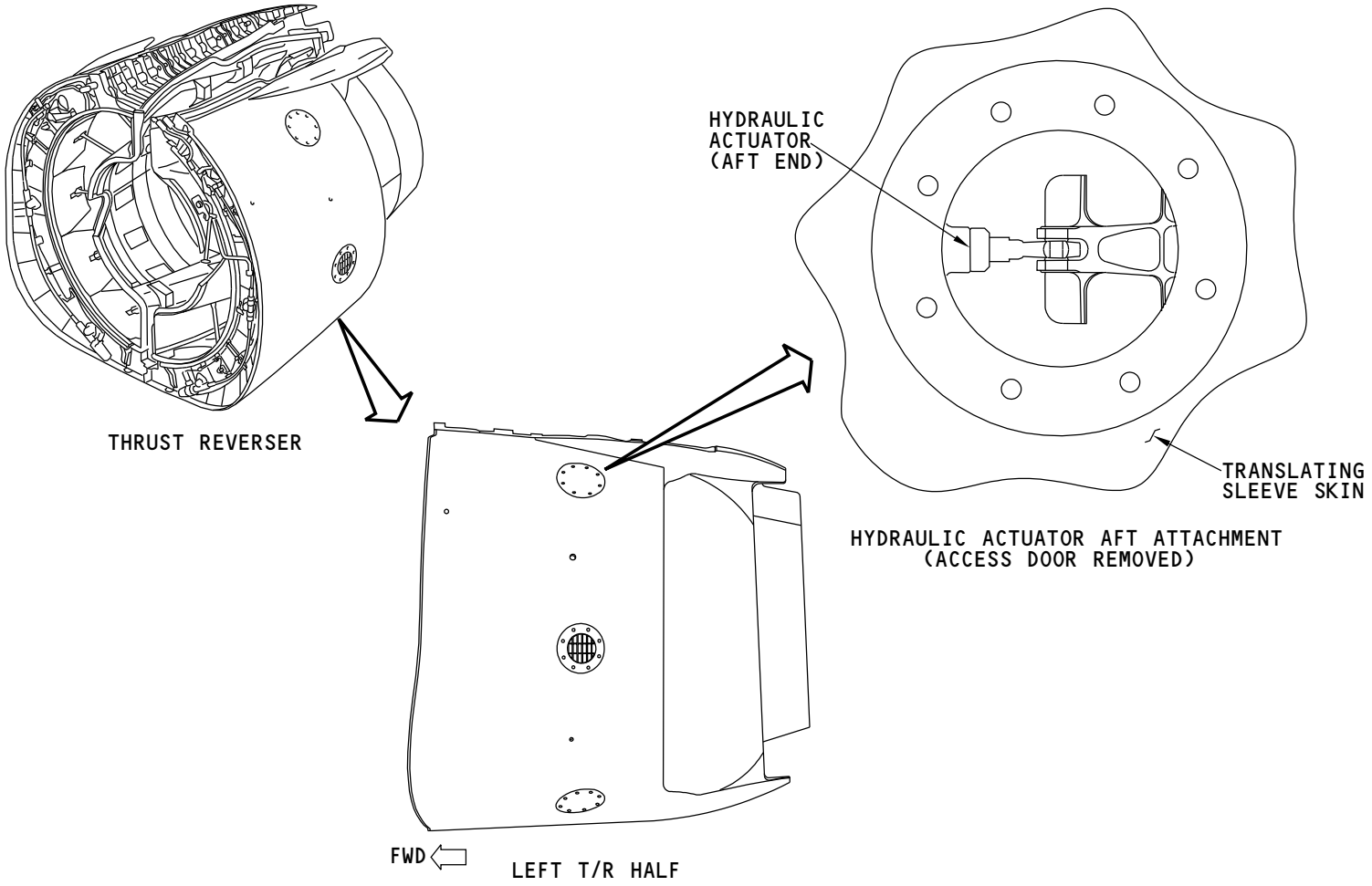
THRUST REVERSER - ACCESS DOORS

General

Each T/R cowl (half) has three access doors.

You remove the access doors to get access to the T/R hydraulic actuator's aft attach point.

The center access door also supplies an exit for fan air exhaust if it goes by the bullnose seal when the T/R is in the stow position. Refer to the bullnose seal and retainer page in the section for more information.



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THRUST REVERSER - ACCESS DOORS

THRUST REVERSER - AUXILIARY AND MAIN TRACK LINER

Purpose

The T/R auxiliary and main track liners hold the sliders which let the translating sleeves move forward and aft.

Location

The auxiliary and main tracks are on the upper and lower hinge beams of each T/R half. The liners are inside of the tracks.

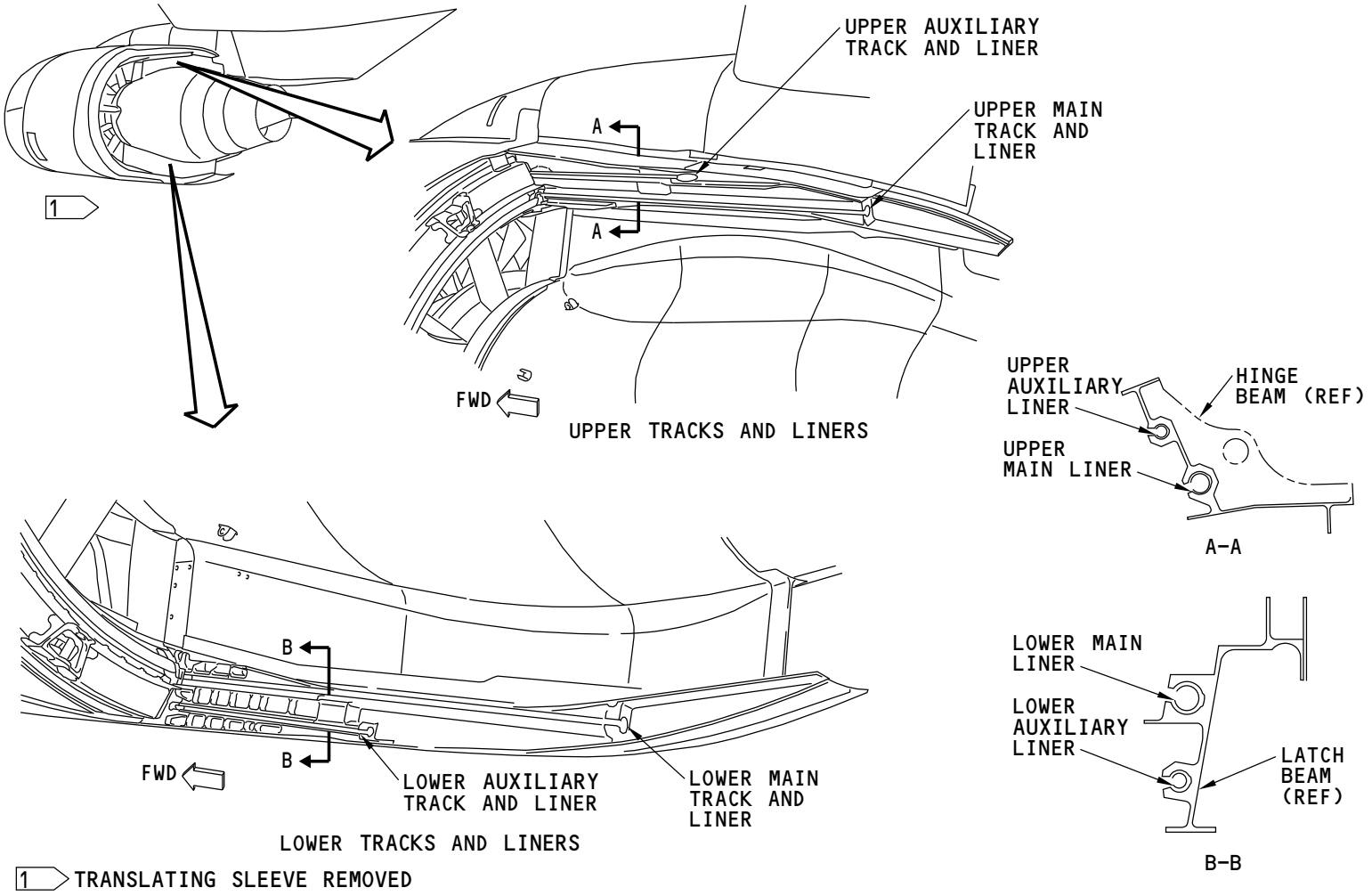
Physical Description

Each track has a liner inside. The track liners are stainless steel. The tracks are an aluminum alloy.

Training Information Point

You must remove the translating sleeve to do a complete inspection of the liners. You must also remove the translating sleeve to replace the track liners.

WARNING: DO THE DEACTIVATION PROCEDURE FOR THE THRUST REVERSER TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONS OR DAMAGE TO EQUIPMENT.



M88144 S0004632520_V1

THRUST REVERSER - AUXILIARY AND MAIN TRACK LINER

THRUST REVERSER - AUXILIARY AND MAIN TRACK SLIDER

Purpose

The auxiliary and main track sliders permit the translating sleeves to move forward and aft in the tracks.

Location

The auxiliary and main track sliders are on the top and the bottom of each translating sleeve.

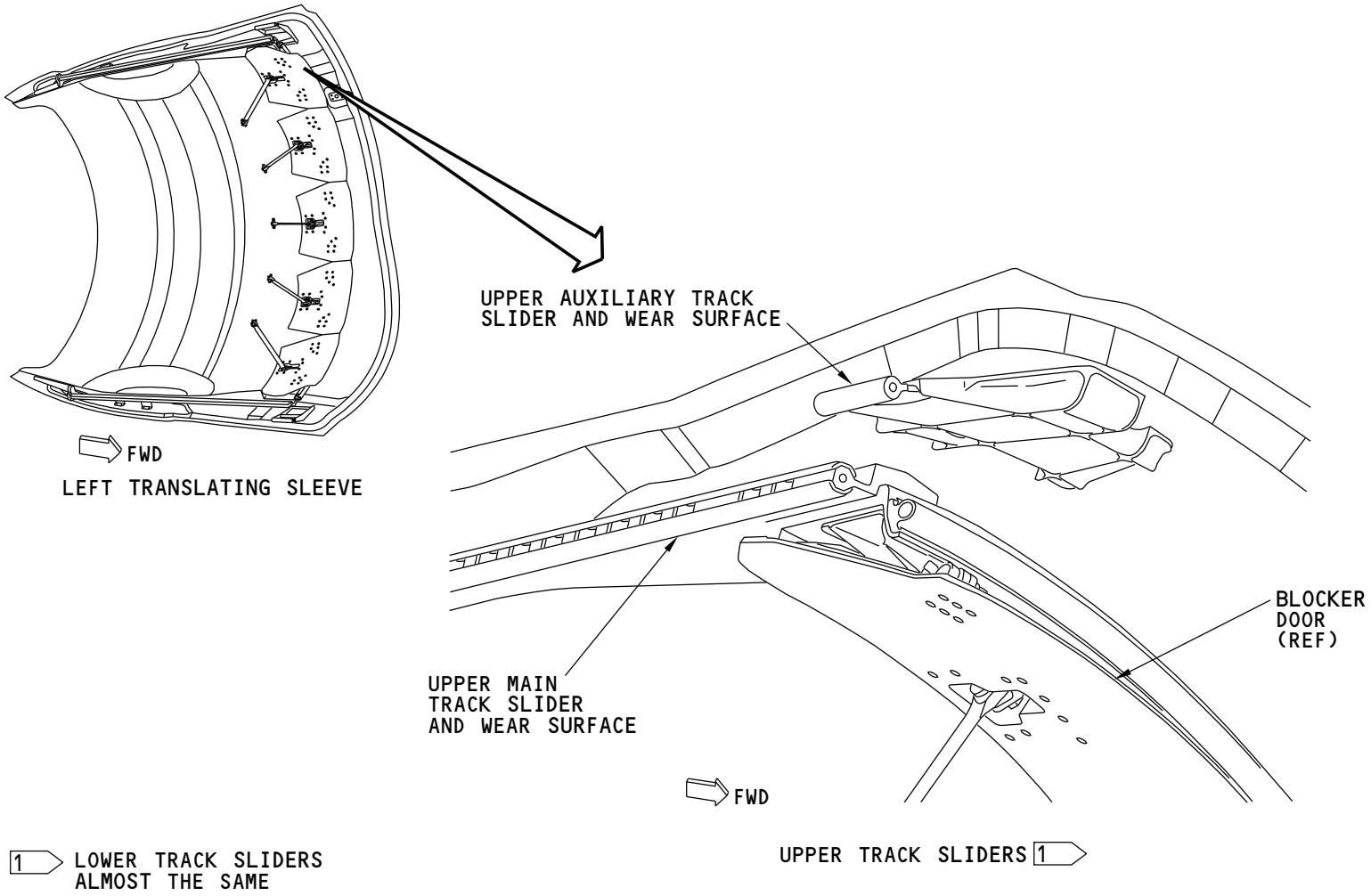
Physical

The sliders have a wear surface that reduces the friction between the sliders and the track liners.

Training Information Point

You must remove the translating sleeve to do a complete inspection of the sliders. You must also remove the translating sleeve to replace the sliders or the wear surfaces.

WARNING: DO THE DEACTIVATION PROCEDURE FOR THE THRUST REVERSER TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONS OR DAMAGE TO EQUIPMENT.



M88145 S0004632522_V1

THRUST REVERSER - AUXILIARY AND MAIN TRACK SLIDER

THRUST REVERSER - RUBSTRIP

General

The rubstrips are the interface between the translating sleeve and these areas of structure:

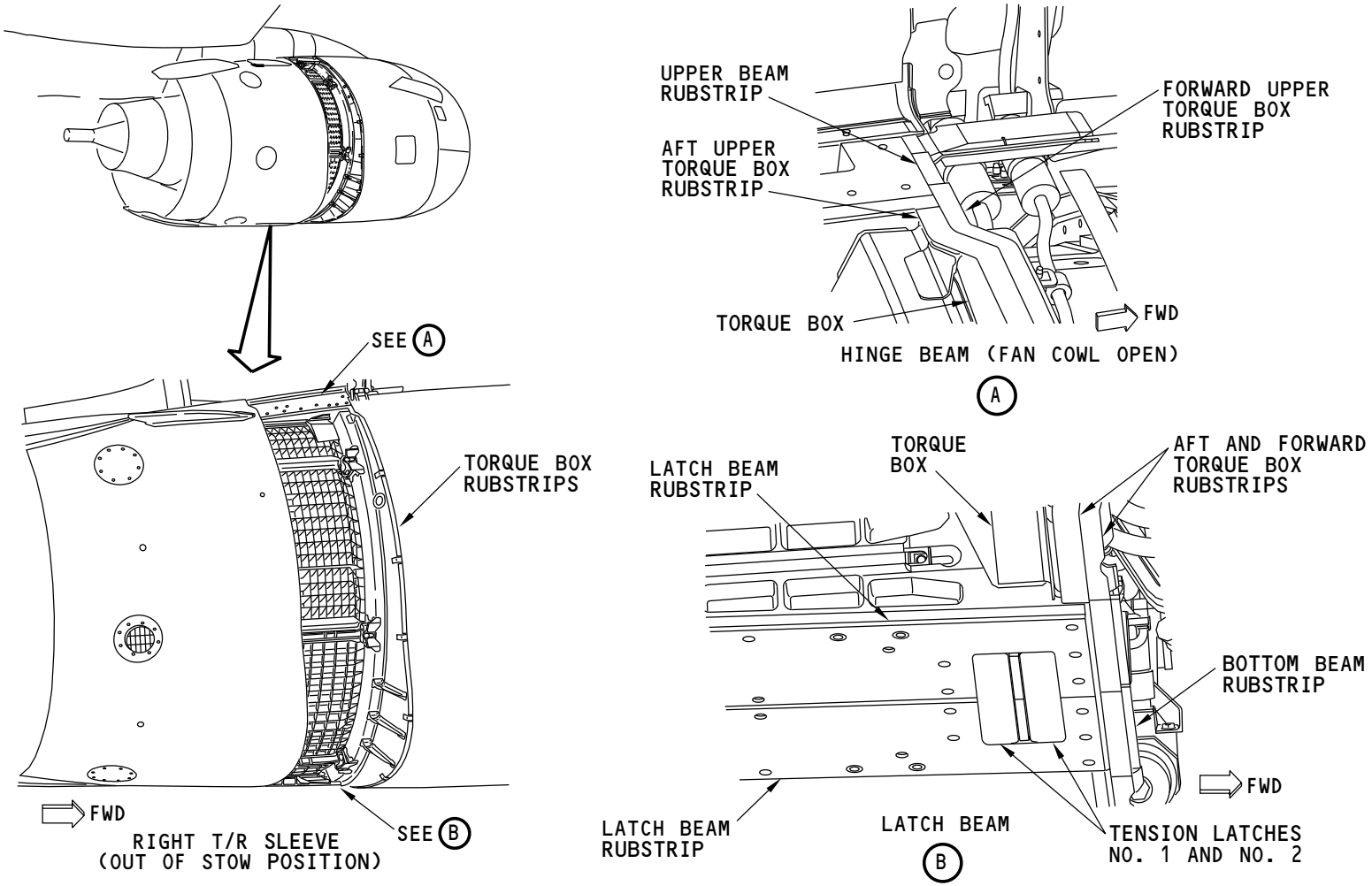
- T/R torque box
- Hinge (upper) beam.

These rubstrips are the interface between the engine fan cowl and these areas of structure:

- T/R torque box
- Hinge (upper) beam
- Latch beam.

Location

All rubstrips are along the forward or aft side of the T/R torque box.



M88146 S0004632524_V1

THRUST REVERSER - RUBSTRIP

THRUST REVERSER - BULLNOSE SEAL AND RETAINER

Purpose

The bullnose seal prevents fan exhaust airflow into the inner part of the T/R translating sleeve when the T/R is in the stow position.

The bullnose retainer holds the bullnose seal to the acoustic panel assembly.

Location

The bullnose seal and retainer are on forward end of the inner wall structure of the translating sleeve. They are inboard of the blocker doors.

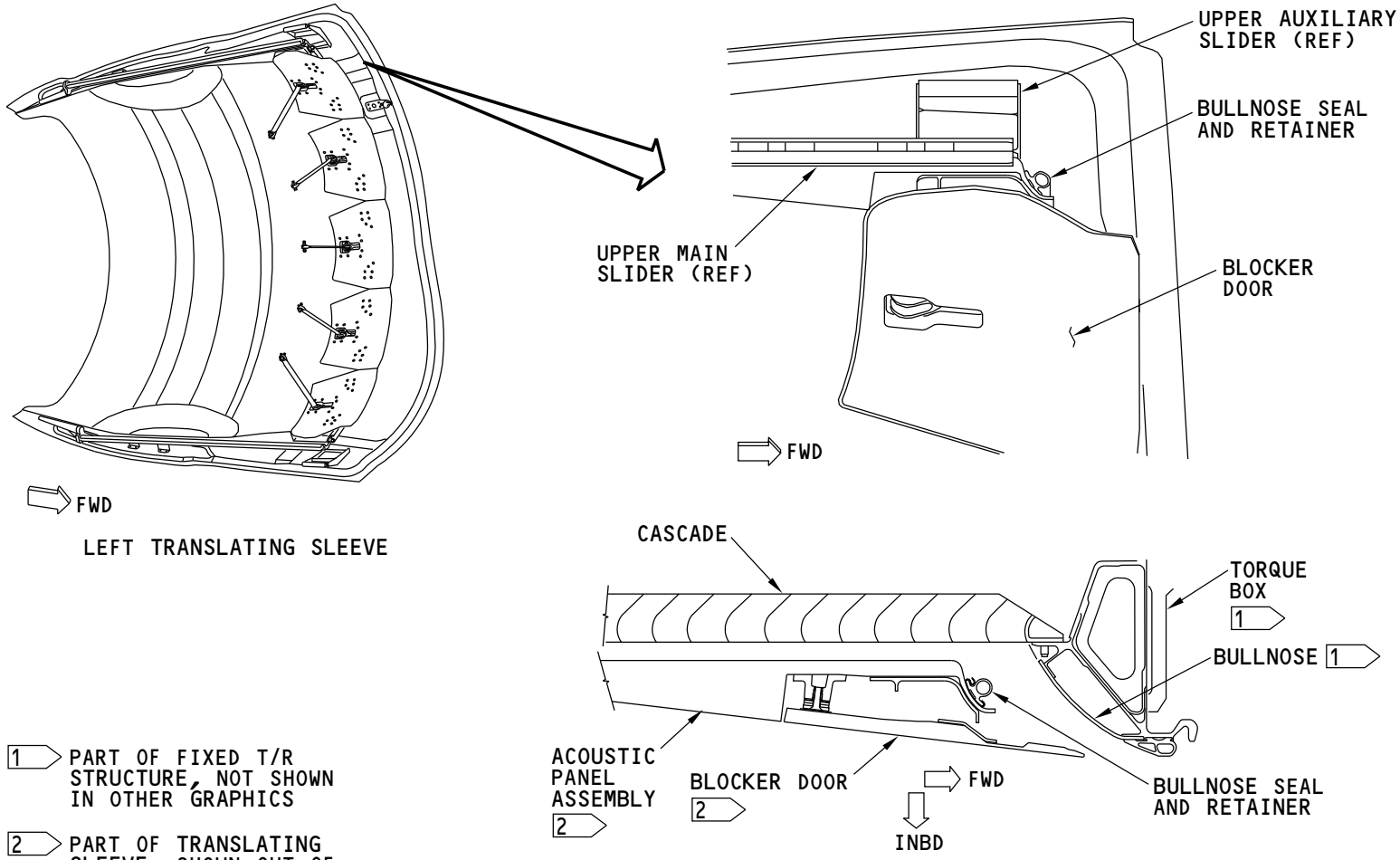
The retainer attaches to the acoustic panel assembly. Grooves in the retainer hold the bullnose seal in position.

You move the translating sleeves aft to get access to the bullnose seal and retainer.

Functional Description

The bullnose seal compresses against the bullnose fairing when the T/R is in the stow position. This prevents fan air exhaust airflow into the inner part of the translating sleeve.

The center access panel supplies an exit for any air that gets past the bullnose seal. This prevents damage to the sleeve components if the seal fails. Refer to the access panel page in this section for more information.



M88147 S0004632526_V1

THRUST REVERSER - BULLNOSE SEAL AND RETAINER

THRUST REVERSER - FIRE SEALS

Purpose

The fire seals keeps an engine fire in the turbine case area away from these:

- T/R components
- Engine fan
- Components in the engine fan case area
- Engine strut.

Purpose

The fire seals help to contain an undercowl fuel-fed fire.

The upper rubber fire seals closes the gap between the strut structure and the upper bifurcation inner walls. The lower rubber fire seal closes the gap between the lower bifurcation inner walls of the left and right thrust reverser halves.

The rubber fire seals also function as an aerodynamic seal and a fluid seal. The fire seals must be able to perform the sealing function ever when exposed to fuel, hydraulic fluid, engine oil, alkaline based cleaning solutions, isopropyl alcohol based deicing fluids and ethylene gycol based deicing fluids.

Location

All fire seals are along the upper and forward edges of the T/R cowls (halves).

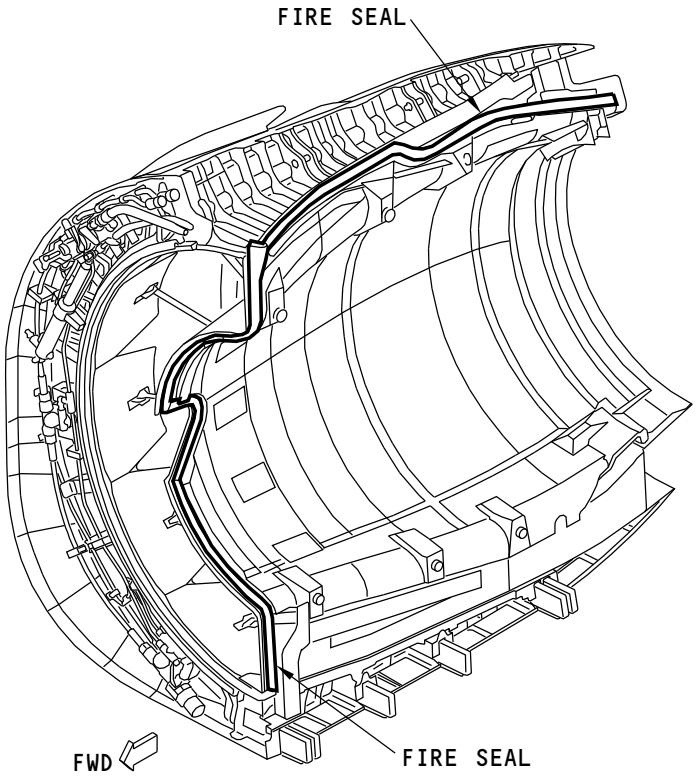
The upper bulb-seal fire seals are mounted in retainer tracks on the inner surface of the upper bifurcation inner wall on the left and right thrust reverser halves. These fire seals contact metal seal depressors mounted on the strut.

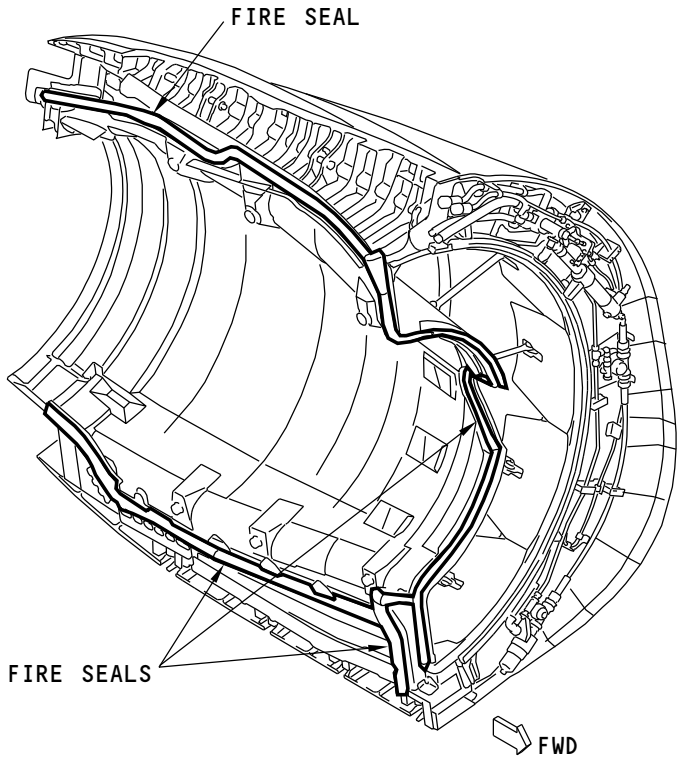
The lower bulb-seal are mounted in retainer tracks on the inner surface of the lower bifurcation wall on the left half. These fire seals contact seal depressors mounted on the right half.

A bulb type fire/aerodynamic seal is mounted around the circumference of the inner wall, aft of the inner wall v-blade. The circumferential bulb-seal fire seals contact the engine case.

Physical Description

The rubber fire seals are constructed from a silicone rubber that is reinforced with fabric layers. The rubber fire seals are bulb-seals that have a circular cross-section and foot that fits in a metal seal retainer track. The bulb-seals can be hollow or can be filled in some segments with a sponge foam to prevent collapse of the seal where the seal fits in small radius curvature turns. The rubber fire seals are also molded into specific shapes for some areas.





M88149 S0004632528_V1

THRUST REVERSER - FIRE SEALS

THRUST REVERSER - DEACTIVATION FOR FLIGHT DISPATCH - TRAINING INFORMATION POINTS

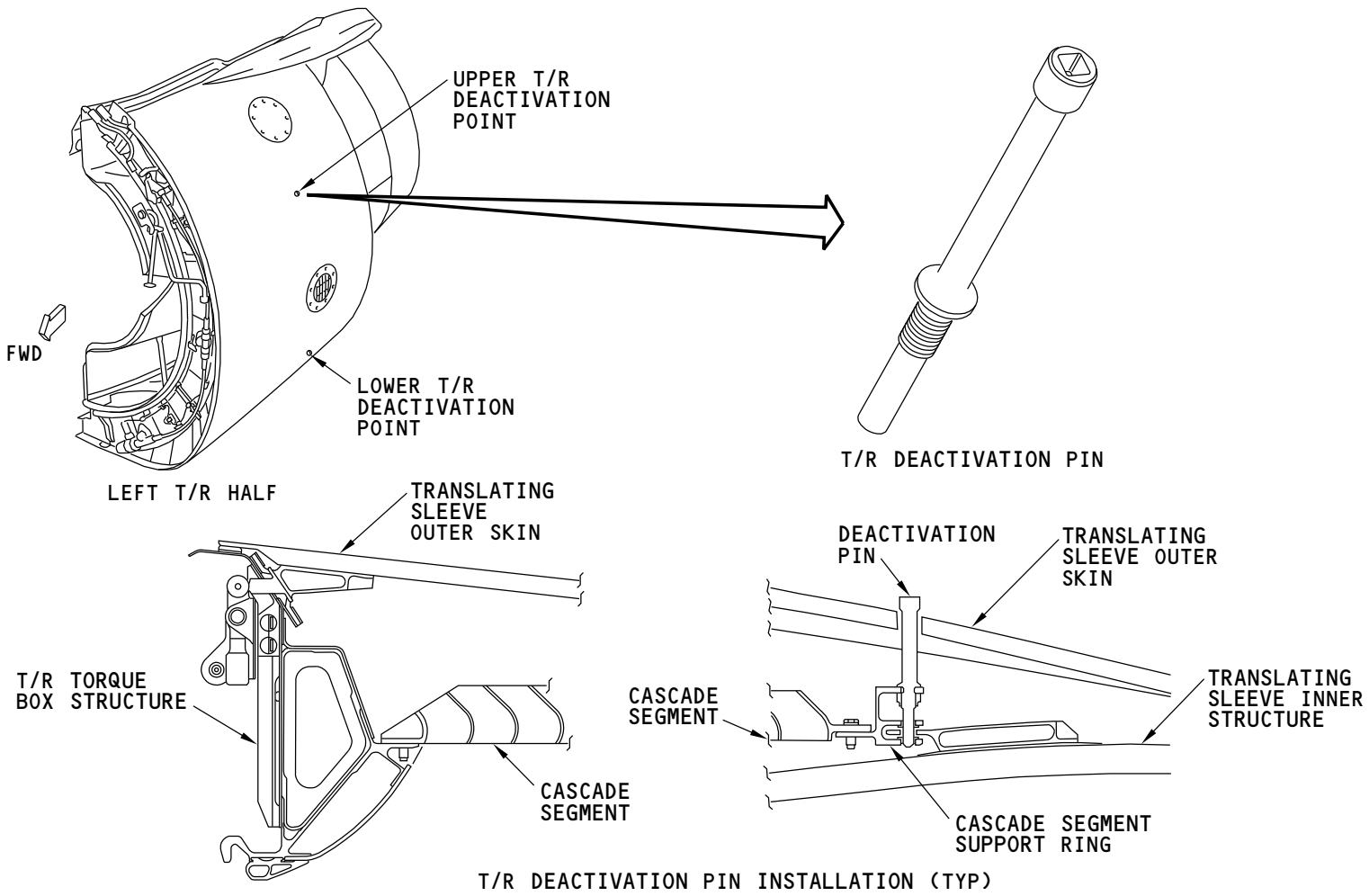
General

Each T/R translating sleeve has two deactivation points. You install two pins at these points to deactivate the T/R for airplane dispatch.

Each translating sleeve has two holes at the deactivation points. Rubber plugs are usually in these holes. You remove these plugs before you install the pins. The pins are usually in the fly away kit.

The pins mechanically connect the translating sleeve structure to the stable cascade support ring. This prevents the movement of the T/R sleeve.

Be sure to follow the thrust reverser deactivation for flight dispatch procedure found in the airplane maintenance manual (AMM).



T/R DEACTIVATION PIN INSTALLATION (TYP)

M88150 S0004632530_V1

THRUST REVERSER - DEACTIVATION FOR FLIGHT DISPATCH - TRAINING INFORMATION POINTS

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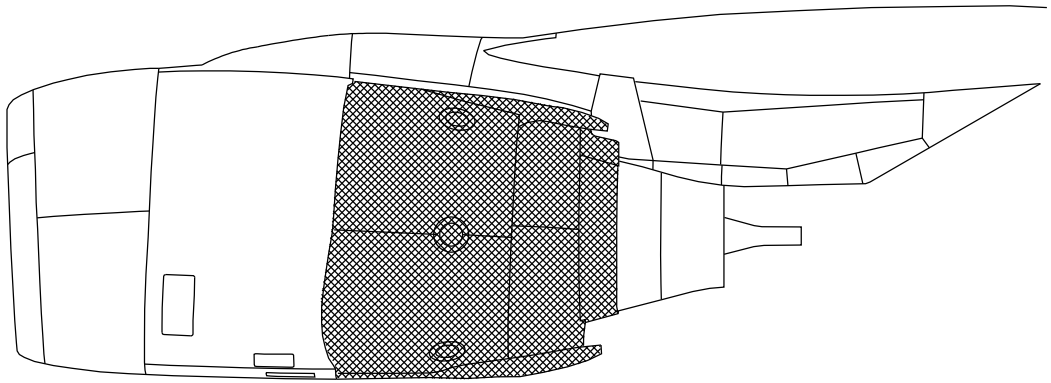
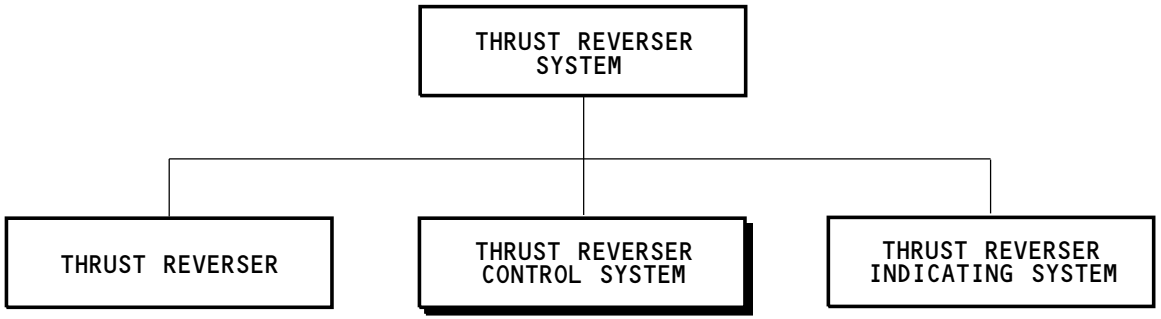
THRUST REVERSER CONTROL SYSTEM - INTRODUCTION

Purpose

The thrust reverser control system controls hydraulic and electrical power to the thrust reverser for stow and deploy operations.





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THRUST REVERSER CONTROL SYSTEM - INTRODUCTION

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THRUST REVERSER CONTROL SYSTEM - GENERAL DESCRIPTION

General

The thrust reverser control system controls hydraulic power and electrical power to deploy and stow the thrust reverser (T/R) translating sleeves. The system uses 24/28v dc electrical power and reverse thrust lever position for control.

You can deploy the thrust reversers when the airplane is less than 10 feet (3 meters) from the ground. The flight control computers (FCC) and a radio altimeter operated relay supply airplane altitude information. An air sensing relay supplies the air/ground logic. The fire handle must be down for the control system to use the electrical power.

Each T/R control valve module controls hydraulic power to deploy or stow their T/R. Each module contains the electrical and hydraulic components necessary to control the hydraulic flow to the T/R hydraulic actuators. There are two T/R control valve modules on the airplane. One for each T/R.

Sync shafts on each translating sleeve make sure the sleeve's three actuators operate at the same speed. The actuators can operate only if the shaft is free to turn.

A sync lock connects to the bottom hydraulic actuator on each T/R half. The sync lock must unlock for the sync shafts to turn. During normal T/R operation, the sync locks energize to unlock. The sync lock is also a manual drive mechanism. You use the sync lock to manually move the T/R translating sleeves for maintenance operations.

The engine accessory unit (EAU) has the electrical circuits necessary for stow operation. The EAU also uses input from sleeve proximity sensors for auto-restow logic.

The reverser thrust levers operate switches on the autothrottle switch packs. These switches control signals to these components:

- EAU
- Sync locks
- Control valve module.

Deploy Operation

This happens when you raise the reverse thrust lever to deploy a T/R:

- Switches in the autothrottle switch pack move to energize the sync lock and an arm signal goes through the T/R control valve module
- The T/R control switch moves and a deploy signal goes through the T/R control valve module
- The T/R control valve module sends hydraulic fluid to the actuators to move the translating sleeves aft.

See the engine controls chapter for more information about the thrust lever interlock system. (CHAPTER 76)

A flight control computer (FCC) or one of two relays in the nose wheel well area (J22, J24) supply an electrical ground necessary to deploy the T/Rs. Deploy hydraulic power can not go to the T/R if the air/ground or altitude conditions are not met.

Stow Operation

This happens when you lower the reverse thrust lever back to the stow position:

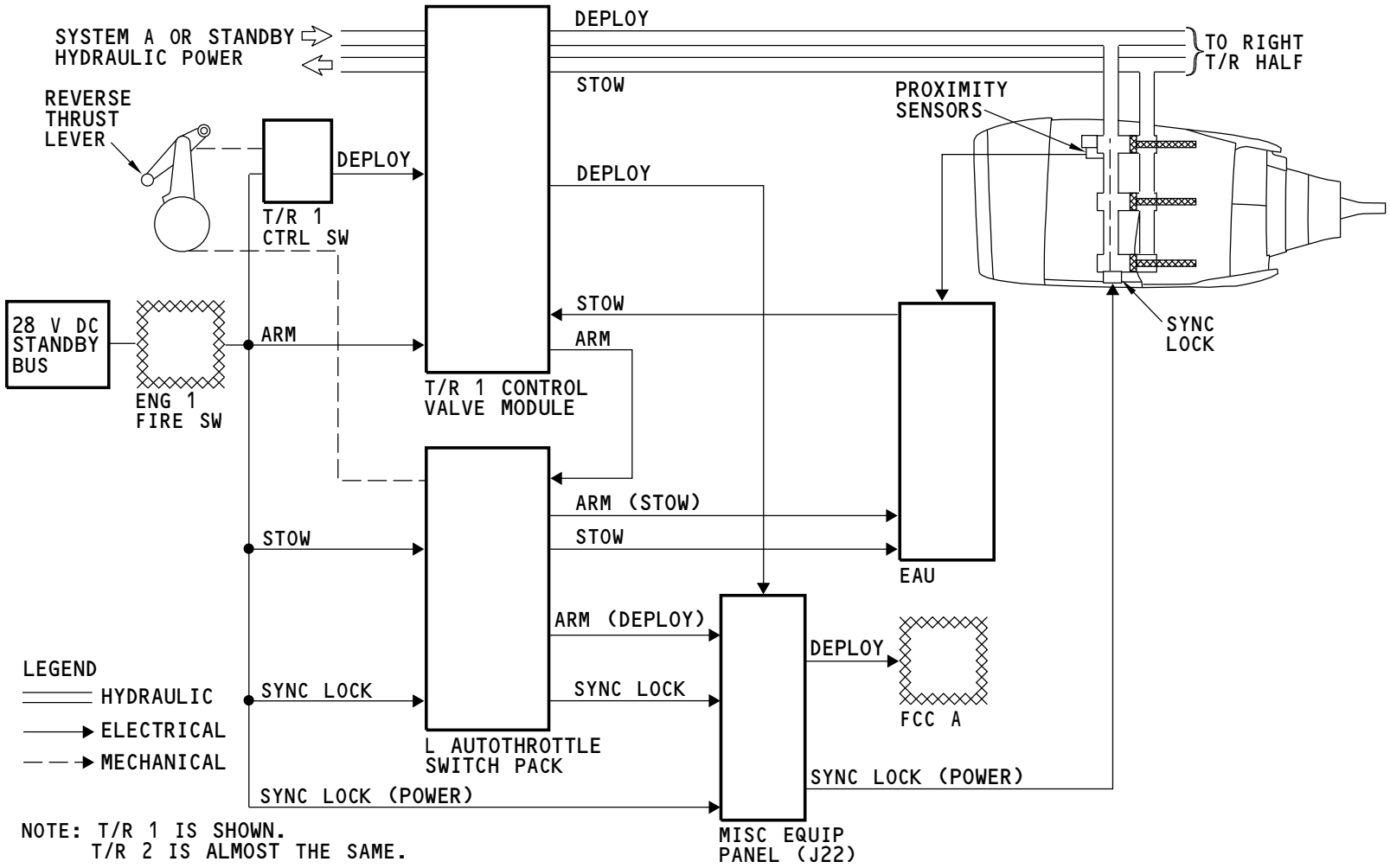
- The T/R control switch removes the deploy signal to the T/R control valve module
- The engine accessory unit (EAU) auto-restow circuits test
- Switches in the autothrottle switch pack move to send an arm signal and a stow signal through the EAU to the T/R control valve module
- The T/R control valve module sends hydraulic fluid to the actuators to move the translating sleeves back to the stow position.
- The sync locks go to the lock position after 18 seconds.

Auto-Restow

The EAU uses internal logic (auto-restow) to tell the T/R control valve module to stow the T/R anytime these conditions happen:

- The EAU receives input from a proximity sensor on a sleeve that the sleeve is not in the stow or locked position, and
- The engine's reverse thrust lever for that T/R is in the stow position.

The EAU use proximity sensors for the auto-restow logic. The auto-restow circuits usually operate for 10 seconds during normal T/R stow operation.



M88151 S0004632536_V1

THRUST REVERSER CONTROL SYSTEM - GENERAL DESCRIPTION

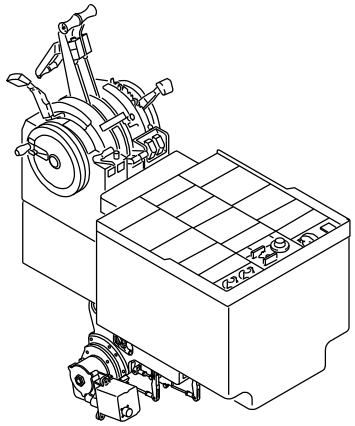
THRUST REVERSER CONTROL SYSTEM - COMPONENT LOCATIONS

General

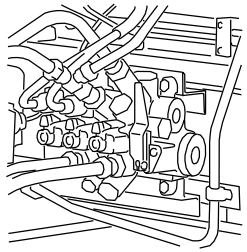
The thrust reverser (T/R) control components are at these areas of the airplane:

- Upper and lower control stand
- EE compartment
- T/R halves
- Main gear wheel well.

The graphic shows the general location of the control system components. Refer to the component page to see exact location.

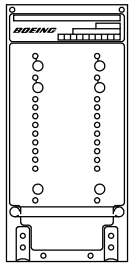


CONTROL STAND
- CONTROL SW
- ARM SW
- STOW SW
- SYNC LOCK SW

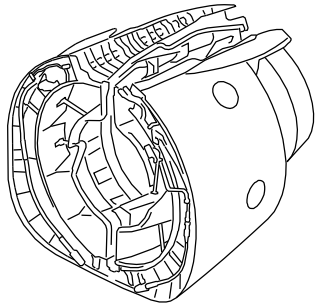


MAIN GEAR WHEEL WELL, KEEL BEAM
- T/R CONTROL VALVE MODULES
- HYDRAULIC VOLUMETRIC FUSES
- HYDRAULIC SHUTTLE VALVES

JUNCTION BOXES J22, J24
- T/R CONTROL RELAYS
- TIME DELAY MODULES



ELECTRONIC EQUIPMENT COMPARTMENT
- ENGINE ACCESSORY UNIT (M528)



THRUST REVERSER HALVES
- HYDRAULIC ACTUATORS
- SYNC SHAFTS
- SYNC LOCKS
- TRANSLATING SLEEVE LOCK AND STOW SENSORS

M88152 S0004632538_V1

THRUST REVERSER CONTROL SYSTEM - COMPONENT LOCATIONS

THRUST REVERSER CONTROL SYSTEM - ARM, STOW AND SYNC LOCK SWITCHES

Purpose

The arm and stow switches control the arm and deploy signals to the T/R control system. The system uses these signals to control hydraulic power to the T/R.

The sync lock switches control power to the circuits which control sync lock power.

Location

All of the switches are in the autothrottle (A/T) switch packs, below the flight compartment aisle stand. There are two switch packs. The switch packs are between the two A/T servo mechanisms.

You go through the lower nose compartment access door to get access to the A/T switch packs. You must remove the A/T pack to get access to any of the switches.

General

The arm switch supplies electrical power to the arm solenoid in the thrust reverser (T/R) control valve module. There are two arm switches. One switch for each T/R.

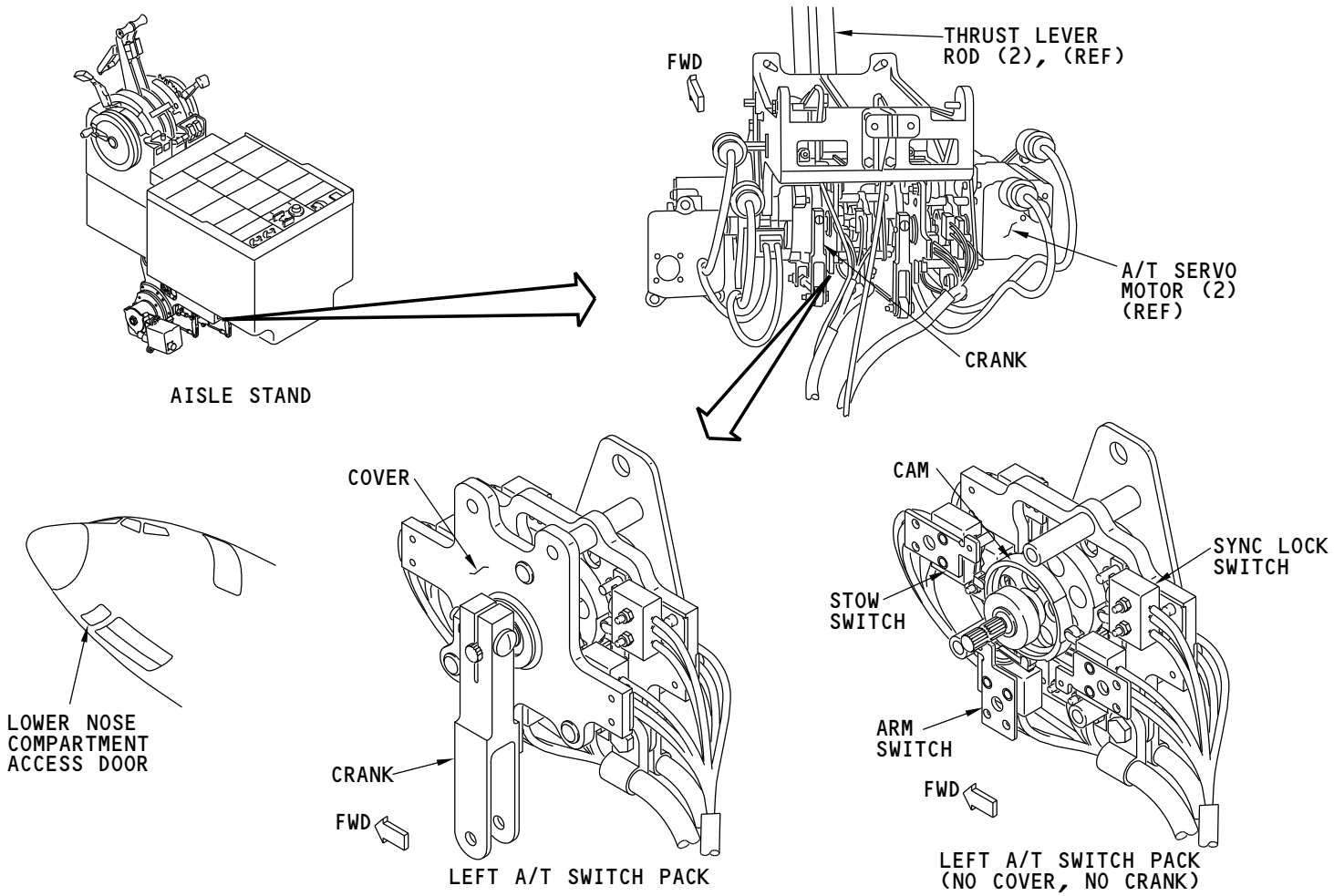
The stow switch supplies power to the engine accessory unit (EAU) stow logic circuits. There are two stow switches. One switch for each T/R.

The sync lock switch supplies power to the T/R sync lock circuits. There are two sync lock switches. One switch for each T/R.

Functional Description

The thrust lever rod moves when you move its reverse thrust lever. This movement transmits through a series of linkages to turn the crank.

The A/T switch pack cam turns with the crank. Movement of the cam operates the switches.



M88153 S0004632540_V1

THRUST REVERSER CONTROL SYSTEM - ARM, STOW AND SYNC LOCK SWITCHES

THRUST REVERSER CONTROL SYSTEM - CONTROL SWITCH

Purpose

The control switch supplies electrical power to the deploy solenoid in the T/R control valve module during a T/R deploy operation. There are two control switches, one for each T/R.

See the functional description part of this section for more information about how the T/R control system uses the control switches.

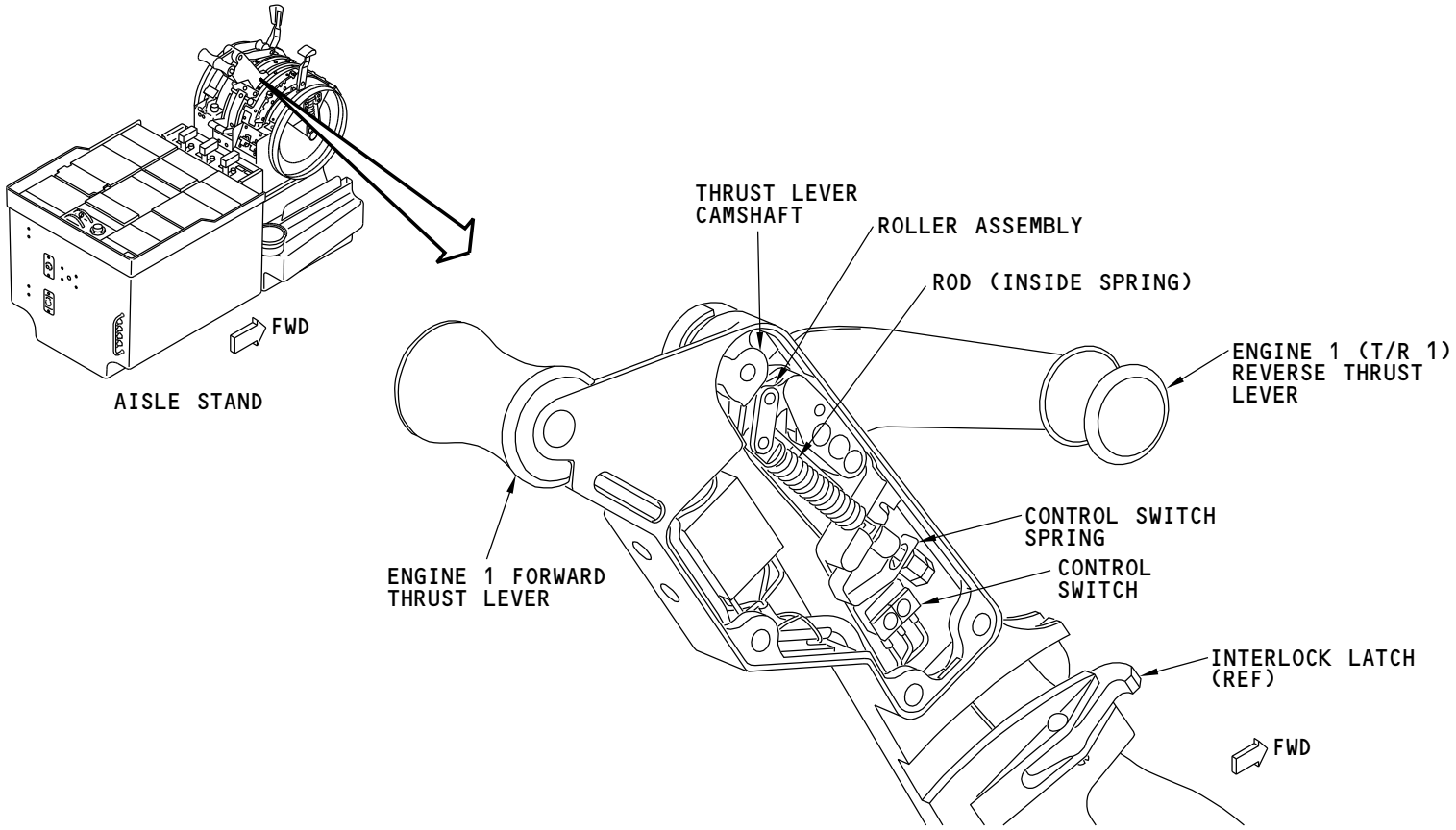
Location

The control switches are in the thrust levers. Each thrust lever has one switch. You must remove the cover on the side of the thrust lever to get access to the switch.

Functional Description

The thrust lever camshaft turns when you move the reverse thrust lever. The camshaft causes the roller assembly and rod to move down when you raise the reverse thrust lever. The control switch spring compresses and operates the control switch.

The spring around the rod keeps the rod and the roller assembly against the cam. The rod and the roller move back to their normal position when you lower the reverse thrust lever. The control switch spring relaxes and the switch moves back to the stow position.



M88154 S0004632542_V1

THRUST REVERSER CONTROL SYSTEM - CONTROL SWITCH

THRUST REVERSER CONTROL SYSTEM - THRUST REVERSER SLEEVE LOCK PROXIMITY SENSOR

Purpose

The thrust reverser sleeve lock proximity sensor supplies a hydraulic actuator lock/unlock signal to the engine accessory unit (EAU).

The EAU uses this signal for these functions:

- Normal T/R stow control
- Auto-restow control
- Fault logic and fault indication
- Fault isolation.

Refer to the functional description in this section for more information about how the EAU uses this input.

See the thrust reverser indicating system section for more information about T/R fault indication. (SECTION 78-36)

Location

The sensor is on the head end of the T/R locking actuator. You open the fan cowl to get access to the sensor. Each T/R locking hydraulic actuator has a sleeve lock proximity sensor. Therefore, there is one sensor for each T/R translating sleeve.

General

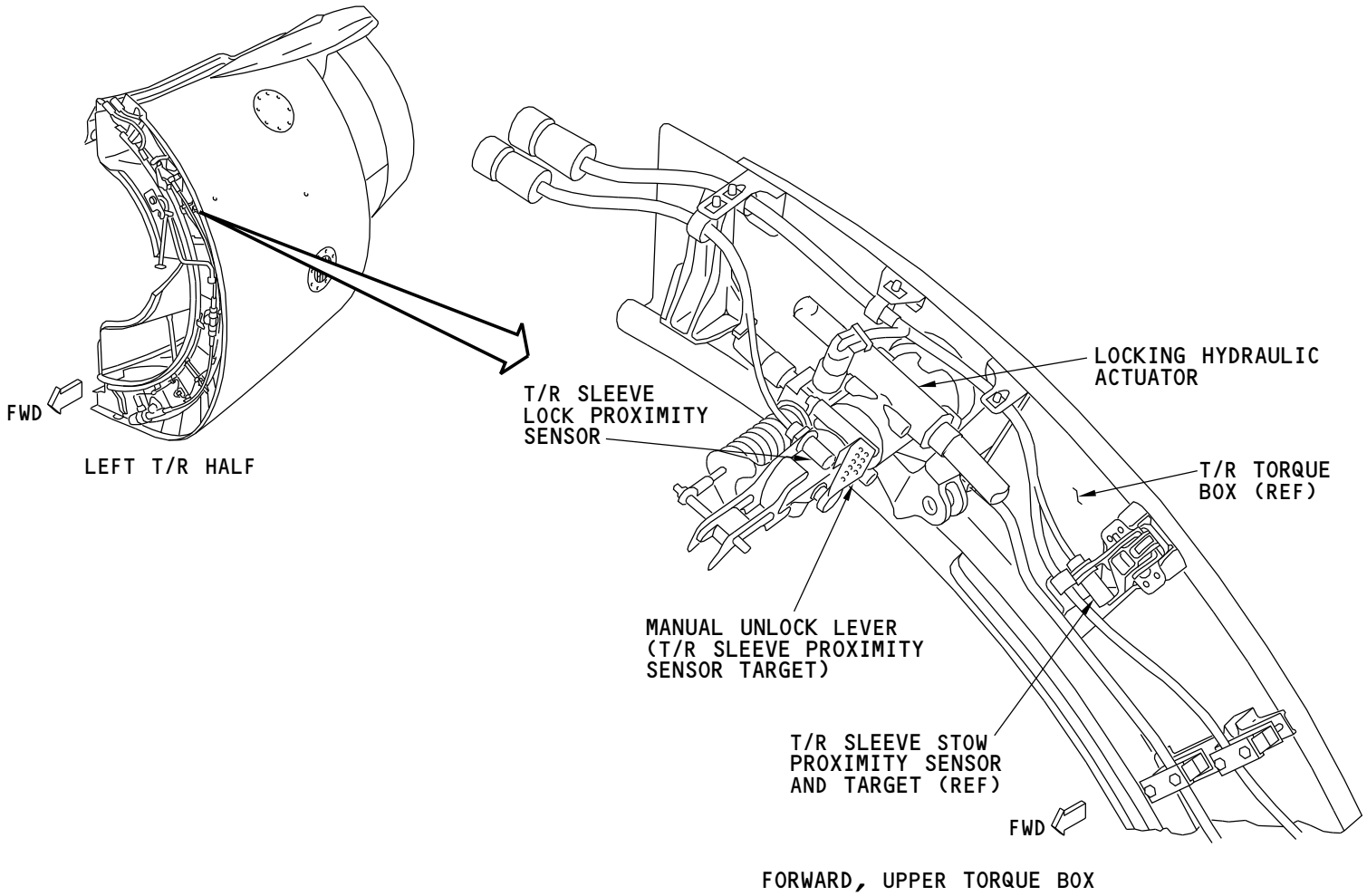
Each sensor has two output levels. One level for the lock position, the other level for the unlock position.

The sensor is a proximity type sensor. The actuator's manual unlock lever is the target for the sensor. The sensor's output changes when target is close (near).

Functional Description

The EAU supplies excitation to the sensor. The EAU sees a large change in the sensor's output when the target is close (near).

The manual unlock lever (target) moves close to the sensor when the hydraulic actuator unlocks during a T/R deploy operation. The lever stays in this position until the sleeve comes back to the stow position and the hydraulic actuator locks.



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THRUST REVERSER CONTROL SYSTEM - THRUST REVERSER SLEEVE LOCK PROXIMITY SENSOR

THRUST REVERSER CONTROL SYSTEM - THRUST REVERSER SLEEVE STOW PROXIMITY SENSOR

Purpose

The thrust reverser sleeve stow proximity sensor supplies a stow/not stowed signal to the engine accessory unit (EAU).

The EAU uses this signal for these functions:

- Normal T/R stow control
- Auto-restow control
- Fault logic and fault indication
- Fault isolation.

Refer to the functional description in this section for more information about how the EAU uses this input.

See the thrust reverser indicating system section for more information about T/R fault indication. (SECTION 78-36)

Location

The sensor is on the forward face of the T/R torque box. The target crank assembly is also on the forward face of the T/R torque box. Each T/R sleeve has a sensor and a target. You open a fan cowl to get access to a sensor and its target.

General

Each sensor has two output levels. One level for the stow position, the other level for the not stowed position. The sensor's output changes when the sensor's target is close (near).

The target is part of a crank. Two small torsion springs put a force on the crank. A plunger, on the T/R translating sleeve, keeps the target away (far) from the sensor when the sleeve is in the stow position.

Functional Description

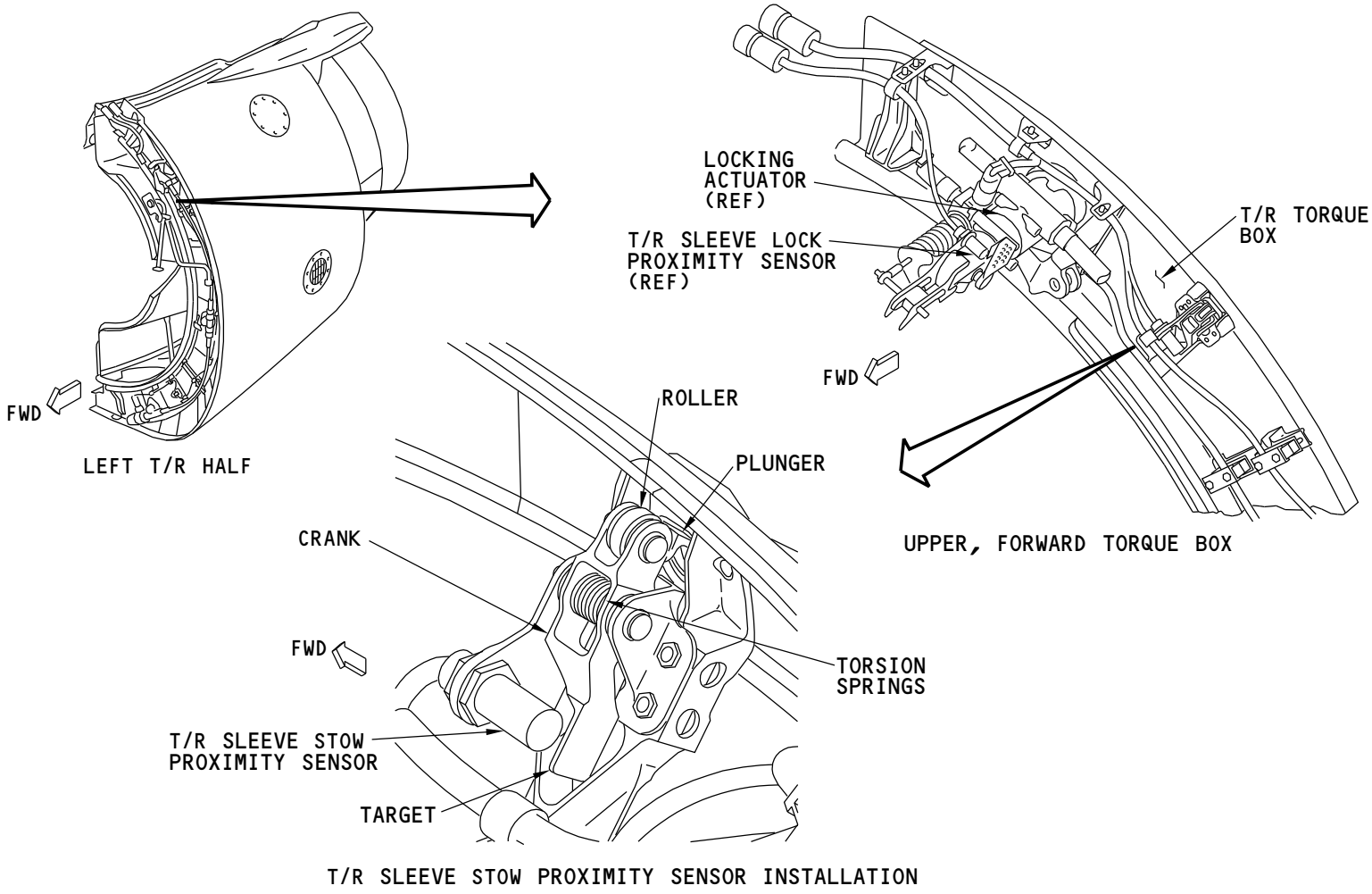
The EAU supplies excitation to the sensor. The EAU sees a large change in the sensor's output when the sensor's target is close (near).

The target moves close (near) to the sensor when the T/R sleeve moves out of the stow position during a T/R deploy operation. This is why the target moves:

- The plunger moves away from the crank's roller as the T/R translating sleeve moves aft
- The small torsion springs supply a force to the crank, opposite to the plunger's force
- The crank turns and the target moves close (near) to the sensor.

The target stays in the near position until the sleeve comes back to the stow position and the plunger turns the crank.

The output of the sensor stops changes because its target is away (far).



T/R SLEEVE STOW PROXIMITY SENSOR INSTALLATION

M88160 S0004632546_V1

THRUST REVERSER CONTROL SYSTEM - THRUST REVERSER SLEEVE STOW PROXIMITY SENSOR

THRUST REVERSER CONTROL SYSTEM - SYNC LOCK

Purpose

The sync lock has two purposes:

- Locks the sync shafts to prevent operation of the hydraulic actuators when there is no T/R deploy signal
- A manual drive for the hydraulic actuators.

Location

A sync lock attaches to the head end of the lower hydraulic actuator on each T/R half.

Physical Description

The sync lock is a mechanical lock which requires electrical power to operate during normal T/R operation. The sync lock has one electrical connector. The manual drive is on the bottom. You use the manual drive to disengage the lock mechanism. Electrical power is not always necessary when you use the manual drive.

Functional Description

Without electrical power, the sync lock is in the lock position, and the sync shafts cannot turn. The T/R hydraulic actuators cannot operate.

During a T/R deploy operation, the internal solenoid energizes and the sync lock clutch disengages (unlocks). The sync shafts are free to turn and the hydraulic actuators can operate.

The sync lock solenoid de-energizes 18 seconds after a stow command. This ensures that the translating sleeve has sufficient time go to the stow position.

Refer to the T/R control system functional description pages of this section for more information about the electrical operation of the sync locks.

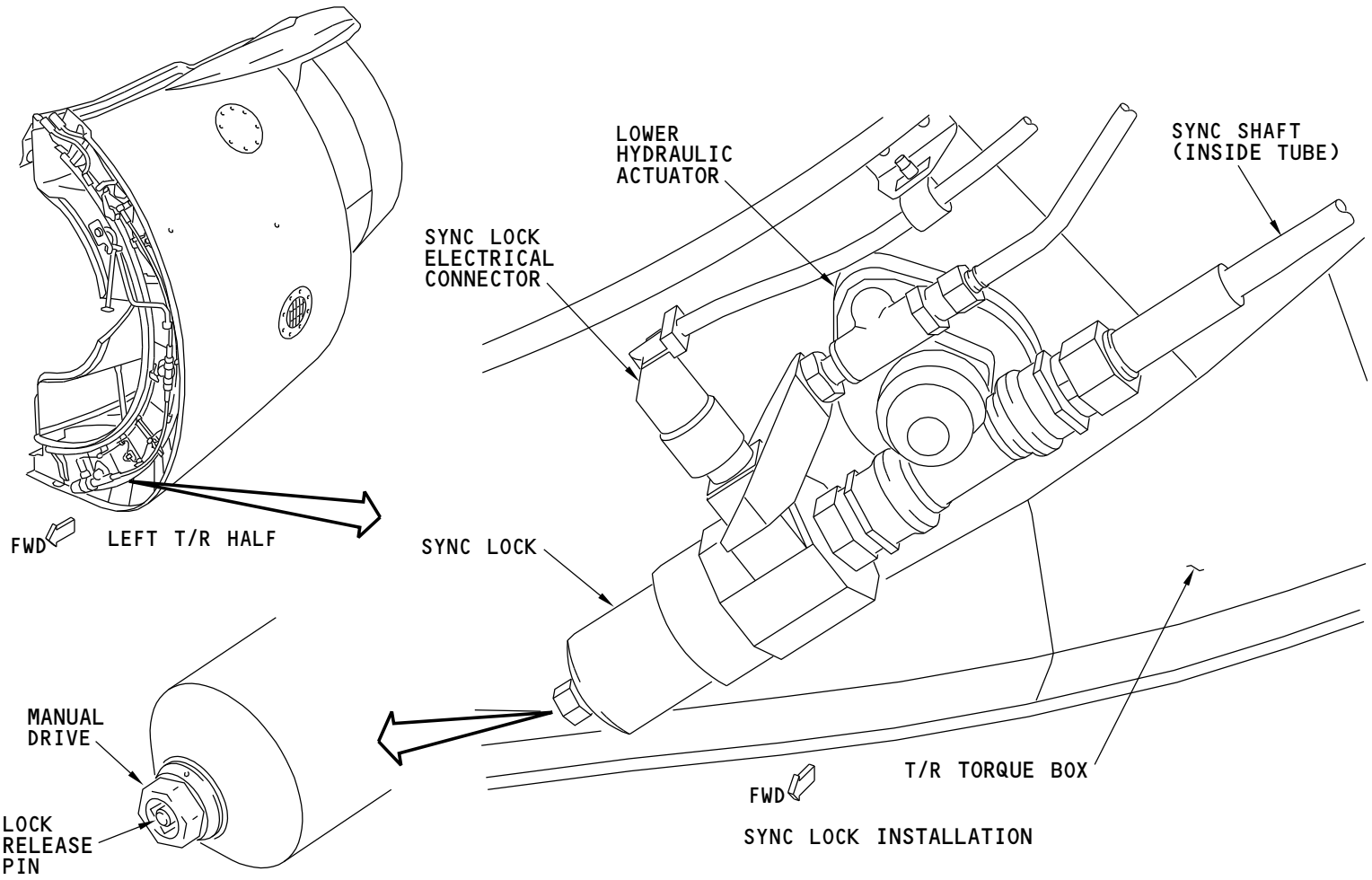
The manual drive portion of the sync lock engages internal mechanisms to turn the sync shafts.

Training Information Point

The sync lock unlocks when its solenoid energizes. However, you manually unlock the sync lock when you push a square drive tool into the manual drive connector. The square drive tool pushes in the lock release pin which is inside the drive connector. The sync lock unlocks when this pin is in.

You must energize the sync lock if you use a wrench on the manual drive. A wrench does not push the pin at the drive connector.

Always follow the procedures in the airplane maintenance manual (AMM) when you use the sync lock as a manual drive unit.



M88156 S0004632548_V1

THRUST REVERSER CONTROL SYSTEM - SYNC LOCK

THRUST REVERSER CONTROL SYSTEM - ENGINE ACCESSORY UNIT (EAU)

Purpose

The engine accessory unit (EAU) has these functions:

- Controls the thrust reverser (T/R) auto-restow operation
- Helps you do trouble-shooting of the T/R control system
- Controls the REVERSER lights on the P5 aft overhead panel in the flight compartment.

The EAU contains the auto-restow logic circuits. These circuits control the stow operation. See T/R CONTROL - FUNCTIONAL DESCRIPTION - STOW CONTROL in this section for more information.

The built-in test equipment (BITE) helps you do troubleshooting of the T/R control system. See the training information point page in this section for more information.

The EAU controls the REVERSER lights on the P5 aft overhead panel. These lights usually show that there is a T/R system problem.

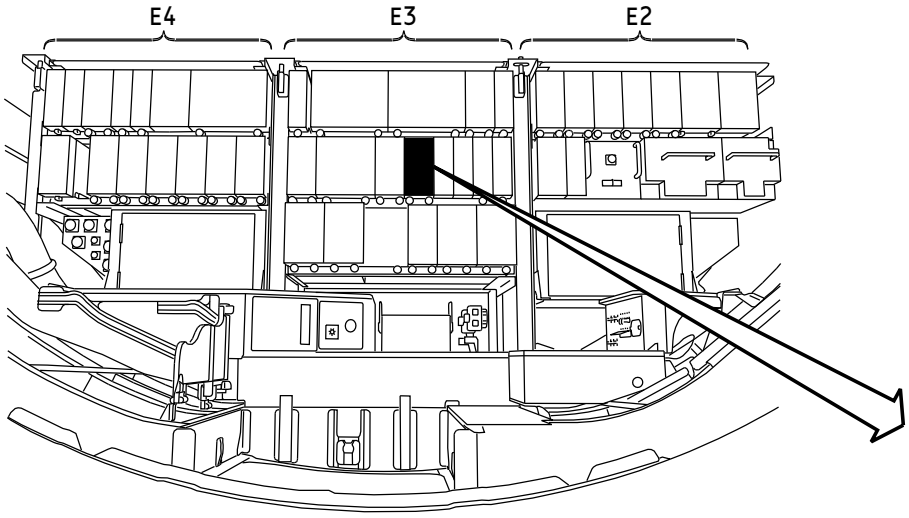
See the thrust reverser indicating system section for more information. (SECTION 78-36)

Component Location

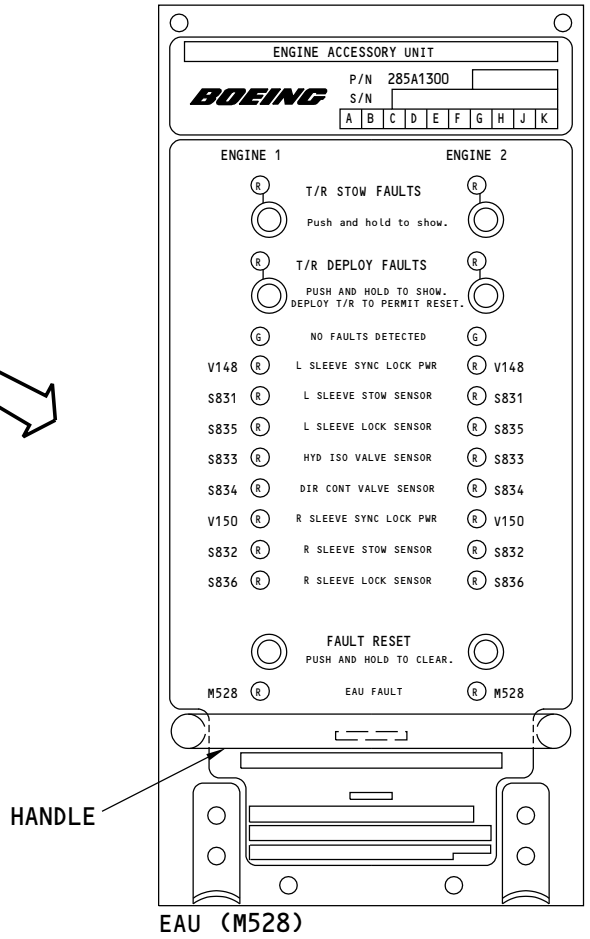
The EAU is on the E3 rack in the electrical equipment (EE) compartment.

Physical Description

The EAU face has a set of lights and switches for each T/R. A placard near the bottom, on the face of the EAU supplies BITE instructions.



EE COMPARTMENT
(LOOKING AFT)



EAU (M528)

M88157 S0004632550_V1

THRUST REVERSER CONTROL SYSTEM - ENGINE ACCESSORY UNIT (EAU)

THRUST REVERSER CONTROL SYSTEM - CONTROL VALVE MODULE

Purpose

The T/R control valve modules control hydraulic power to the T/R hydraulic actuators. Each module also has a handle that lets you deactivate the T/R for maintenance.

Physical Description

Each T/R control valve module has these internal components:

- Isolation valve
- Directional control valve
- Isolation valve proximity sensor
- Directional control valve proximity sensor
- Arm solenoid
- Stow solenoid
- Deploy solenoid
- Manual isolation (shutoff) valve.

See the functional description pages of this section for more information about how these components work in the T/R control system.

The manual isolation valve handle has a hole for the T/R maintenance deactivation pin.

Location

The T/R control valve modules are in the main gear wheel on the keel beam. The T/R 1 control valve module is on the left side. The T/R 2 control valve module is on the right side.

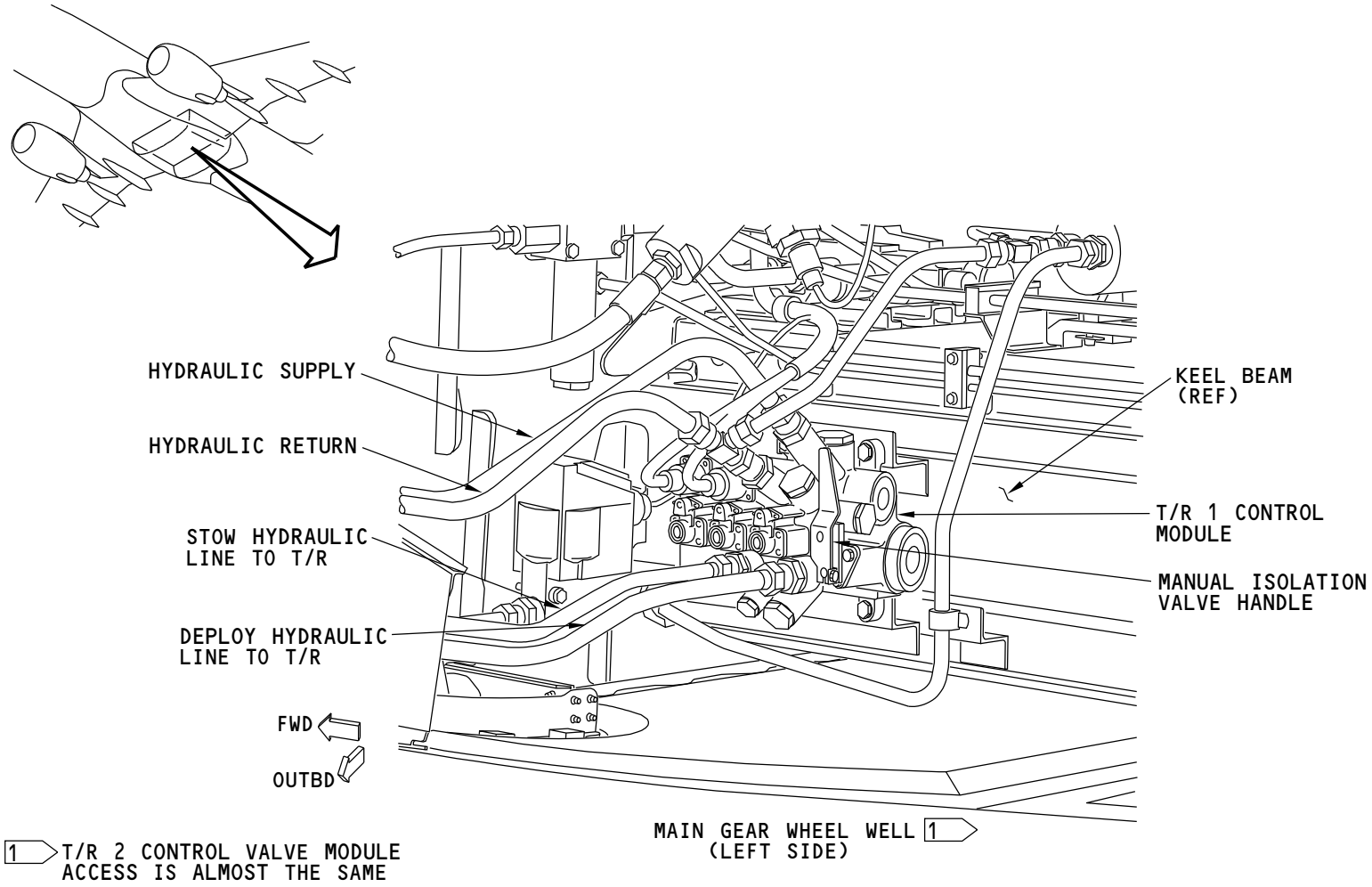
Training Information Point

You use the manual isolation valve handle to prevent accidental operation of T/Rs when persons or equipment are near the T/R. You put in a lock pin to keep the handle in the shutoff position.

The T/R deactivation for maintenance is different than the T/R deactivation for airplane dispatch. Be sure to follow the airplane maintenance manual (AMM) procedures.

WARNING: BEFORE YOU REMOVE THE LOCK PIN FROM THE T/R CONTROL VALVE MODULE FOR THE THRUST REVERSER, MAKE SURE THE THRUST REVERSER SLEEVES ARE IN THE CORRECT POSITION. IF THE THRUST REVERSER SLEEVES ARE IN THE STOWED POSITION, THE REVERSE THRUST LEVER MUST BE FULLY FORWARD. IF THE THRUST REVERSER SLEEVES ARE IN THE DEPLOYED POSITION, THE REVERSE THRUST LEVER MUST NOT BE IN THE STOWED POSITION. IF THE POSITION OF THE REVERSE THRUST LEVER DOES NOT AGREE WITH THE POSITION OF THE THRUST REVERSER SLEEVES, THE THRUST REVERSER SLEEVES COULD MOVE WHEN THE HYDRAULIC SYSTEM IS ACTIVATED. THIS COULD CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.

The T/R control valve module is a line replaceable unit (LRU). You should not replace the module's components on the line.



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THRUST REVERSER CONTROL SYSTEM - CONTROL VALVE MODULE

THRUST REVERSER CONTROL SYSTEM - VOLUMETRIC HYDRAULIC FUSES

General

There are three volumetric hydraulic fuses in the thrust reverser (T/R) control system.

Purpose

The volumetric fuses close and stop hydraulic fluid flow to prevent a complete loss of system hydraulic fluid if a leak occurs.

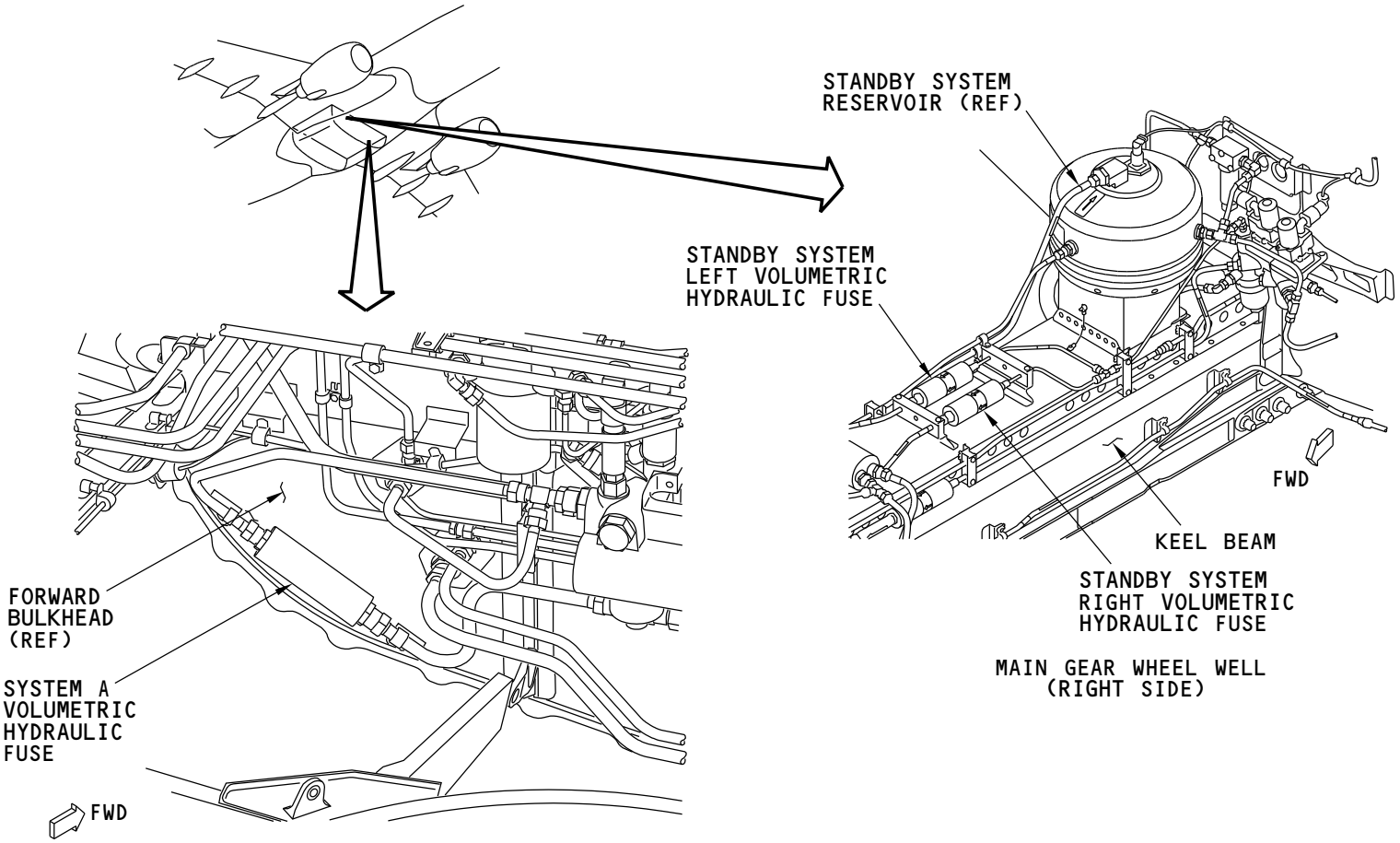
Component Location

The standby hydraulic system supply lines to the thrust reversers have two fuses. There is one fuse in the supply line to each T/R. These fuses are on the keel beam in the wheel well. The left fuse is in the supply line to T/R 1. The right fuse is in the supply line to T/R 2.

The third fuse is in the system A hydraulic supply line to T/R 1. This fuse is on main gear wheel well forward bulkhead, on the left side. System B does not have a fuse in its supply to T/R 2.

Functional Description

A volumetric fuse lets approximately 175 cubic inches of fluid flow through before it closes. The fuse opens when the hydraulic pressure on the two sides of the fuse are approximately the same.



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THRUST REVERSER CONTROL SYSTEM - VOLUMETRIC HYDRAULIC FUSES

THRUST REVERSER CONTROL SYSTEM - SHUTTLE VALVES

Purpose

The shuttle valve selects the hydraulic source for T/R operation.

Component Location

The two shuttle valves are on the main landing gear wheel well forward bulkhead.

General

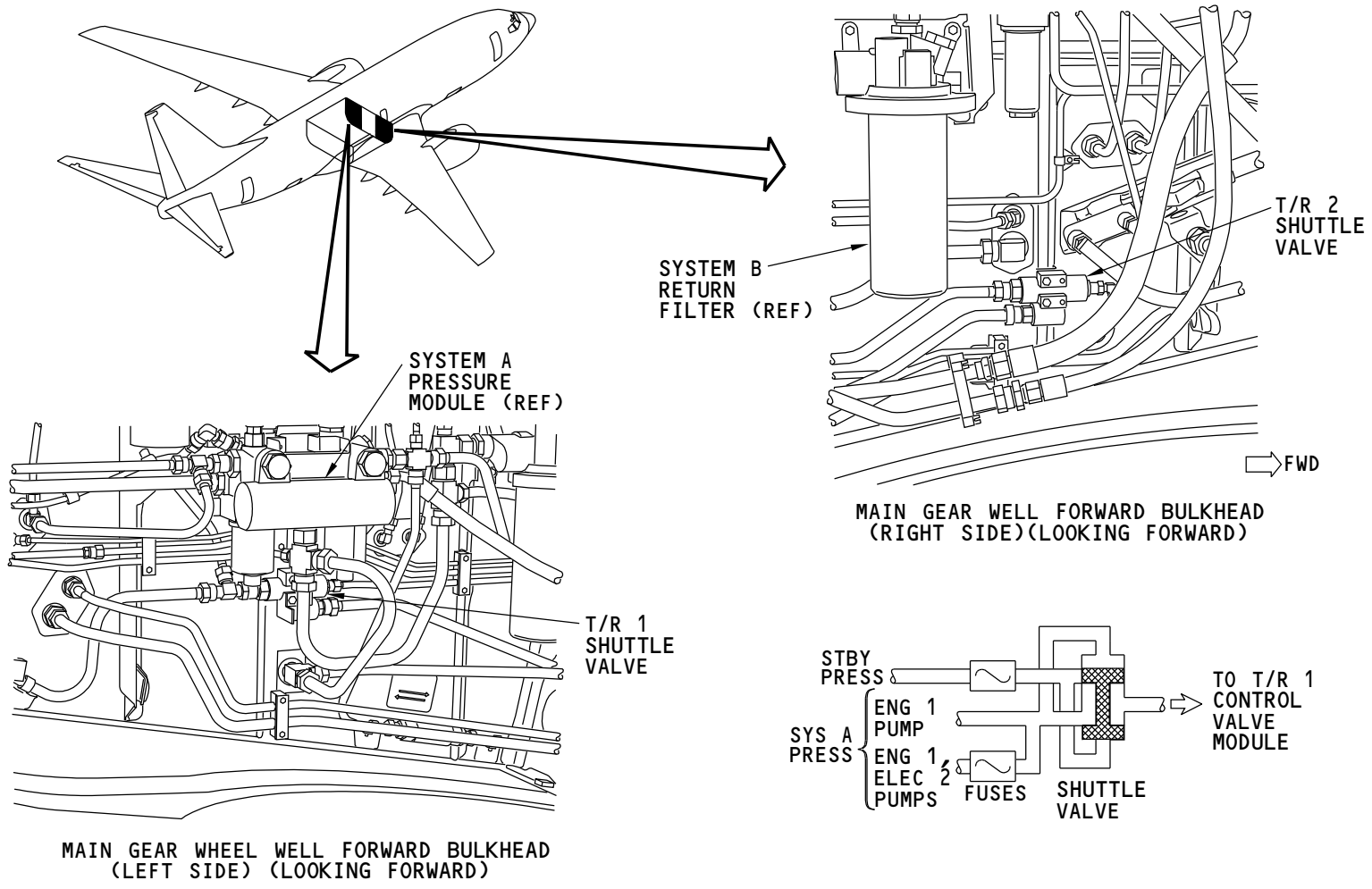
There are two shuttle valves in the T/R reverser control system.

Functional Description

The shuttle valves move whenever the pressure difference between the primary hydraulic system and the standby system exceeds 125 psi.

For example, hydraulic system A usually powers T/R 1. The left shuttle valve will move if system A pressure goes 125 psi below the standby system pressure. The standby hydraulic system then supplies hydraulic power to the T/R 1 hydraulic control module. The shuttle valve moves back when system A pressure goes 125 psi above the standby system pressure.

The right shuttle valve selects the hydraulic power source for T/R 2. Hydraulic system B is the normal source. Like T/R 1, the standby system is the alternate source for T/R 2.



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THRUST REVERSER CONTROL SYSTEM - SHUTTLE VALVES

THRUST REVERSER CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - DEPLOY CONTROL

General

A deploy signal goes to the T/R control system when you raise the reverse thrust levers. Electrical power controls the T/R control valve module.

The T/R control system logic prevents a T/R deploy operation when the airplane is more than 10 feet (3 meters) from the ground.

This is a brief summary of what happens when you move the left reverse thrust lever to the deploy position:

- The T/R control switch moves to the deploy position
- The switches in the autothrottle (A/T) switch pack move to the deploy position
- The T/R sync lock (sl) latch relay energizes
- The sync locks energize and unlock
- The T/R sequence (seq) relay energizes through the T/R time delay module, 0.1 seconds after the sync locks unlock
- The arm and deploy solenoids energize
- The T/R control valve module sends hydraulic fluid to the actuators to deploy the translating sleeves.

T/R 2 operates almost the same.

Sync Locks

The sync locks must unlock for the T/R hydraulic actuators to operate. The sync locks energize to unlock. They receive dc standby bus power through the T/R SL latch relay (RLY) after it energizes to the deploy position.

T/R Control Valve Module

Each T/R control valve module has a deploy solenoid and arm solenoid. Both solenoids must energize to send hydraulic power to deploy its T/R. See T/R CONTROL - FUNCTIONAL DESCRIPTION - HYDRAULIC FLOW for more information.

The deploy solenoid receives power from the dc standby bus through the engine fire switch, and the control switch (SW). The deploy solenoid finds an electrical ground through these components:

- Sequence relay (SEQ RLY), and
- Flight control computer A (FCC A), or
- The air sensing relay (R584), or
- The radio altimeter (R/A) less than 10 ft B relay.

The arm solenoid receives power from the dc standby bus through the fire switch. The arm solenoid finds an electrical ground through these components:

- Arm SW
- Sequence relay (SEQ RLY), and
- Flight control computer A (FCC A), or
- The air sensing relay (R584), or
- The radio altimeter (R/A) less than 10 ft B relay.

T/R Sequence Relay and T/R Time Delay Module

The T/R sequence relay (SEQ RLY) is energized through the T/R time delay module, 0.1 seconds after the sync locks energize and unlock. This time delay gives the sync locks time to unlock before the arm solenoid and deploy solenoid energize and sends hydraulic power to the T/R. The T/R sequence relay finds an electrical ground through the T/R time delay module.

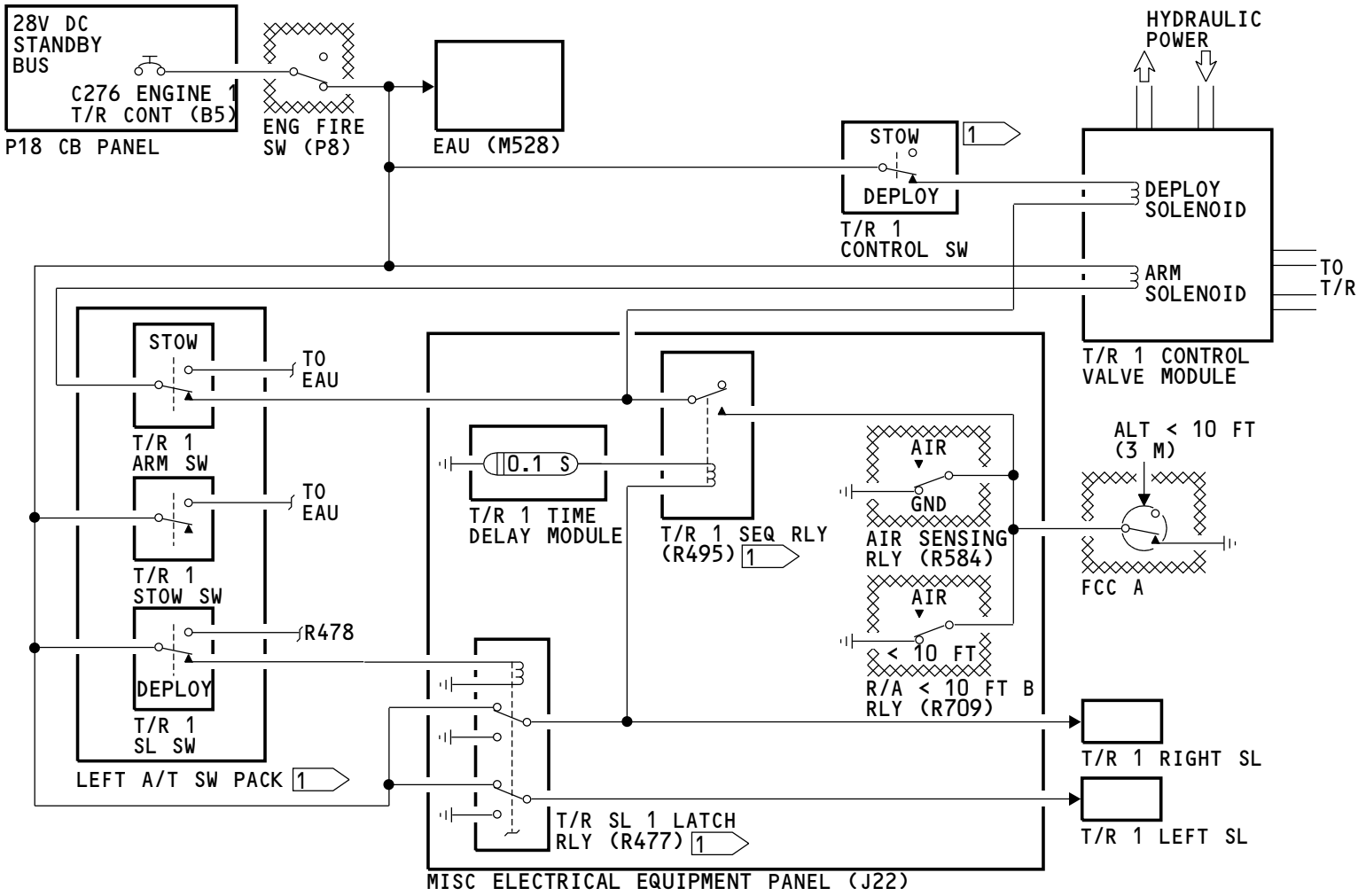
Flight Control Computer (FCC)

The FCC's supply an electrical ground when the altitude of the airplane is ten feet (3 meters) or less. FCC A supplies the ground for T/R 1. FCC B supplies a ground for T/R 2.

Miscellaneous Electrical Equipment Panels (J22 and J24)

The miscellaneous electrical equipment panel (J22) is in the fuselage, left of the nose gear wheel well.

The equivalent T/R 2 control system components are in the miscellaneous electrical equipment panel (J24). The J24 is in the fuselage, right of the nose gear wheel well.



1 CONTACTS IN DEPLOY POSITION

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THRUST REVERSER CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - DEPLOY CONTROL

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THRUST REVERSER CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - STOW CONTROL

General

A stow signal goes to the T/R control system when you lower the reverse thrust lever. Electrical power controls the T/R control valve module.

This section shows T/R 1 operation. T/R 2 operation is this same.

This is a brief summary of what happens when you return the reverse thrust lever to the stow position after a T/R deploy operation:

- The switches in the autothrottle (A/T) switch pack move to the stow position
- A stow signal goes to the EAU through the stow switch
- The stow solenoid energizes
- The deploy solenoid de-energizes
- The arm solenoid finds an electrical ground inside the EAU to stay energized
- The T/R control valve module sends hydraulic fluid to the actuators to stow the translating sleeves
- The arm and stow solenoid de-energize after 10.5 seconds
- The sync locks go to the lock position after 18 seconds.

Sync Locks

The sync locks must unlock for the T/R hydraulic actuators to operate. The sync locks energize to unlock. The sync locks should have electrical power when the reverse thrust levers are up.

Power at the sync locks stays on temporarily during the stow operation. The T/R SL time delay relay (RLY) energizes 18 seconds after the T/R 1 SL switch moves to the stow position. This supplies a ground for the T/R 1 SL latch RLY's to energize. This removes power from the sync locks. The sync locks de-energize and lock.

T/R Control Valve Module

Each T/R control valve module has a stow solenoid and an arm solenoid. Both solenoids must energize for the hydraulic power to stow the T/R. See T/R CONTROL FUNCTIONAL DESCRIPTION - HYDRAULIC FLOW for more information.

The stow solenoid receives power from the dc standby bus through the T/R 1 stow switch and EAU logic circuits. EAU logic completes the electrical circuit with one of these conditions:

- One or two translating sleeves on a T/R are not in the stow position
- One or two translating sleeves on a T/R are out of the lock position.

The output of the EAU logic also supplies an electrical ground for the arm solenoid circuit.

The arm solenoid receives power from the dc standby bus through the engine fire switch. The T/R arm switch and the EAU logic complete the electrical circuit to ground.

EAU Logic Circuit Output (Auto-Restow)

The EAU circuit logic output controls the operation of the arm and stow solenoids for a T/R stow operation.

The stow logic output usually goes away when the EAU receives a reset signal. Under normal operation, this happens 10.5 seconds after you lower the reverse thrust lever to the stow position. With no logic output, the arm and stow solenoids de-energize and hydraulic flow to the T/R's actuators stop.

A logic output stays if the EAU has a sleeve unlocked or not stowed signal 10.5 seconds after you command T/R stow. Electrical power stays on at the arm and stow solenoids. This keeps hydraulic pressure at the actuators to stow the T/R. The output stays until one of these two sets of conditions happen:

- The EAU sees the sleeves stowed and locked and you push the reset switch on the face of the EAU, or

- You operate the T/R and the EAU sees the sleeves stowed and locked in less than 10.5 seconds after you command stow.

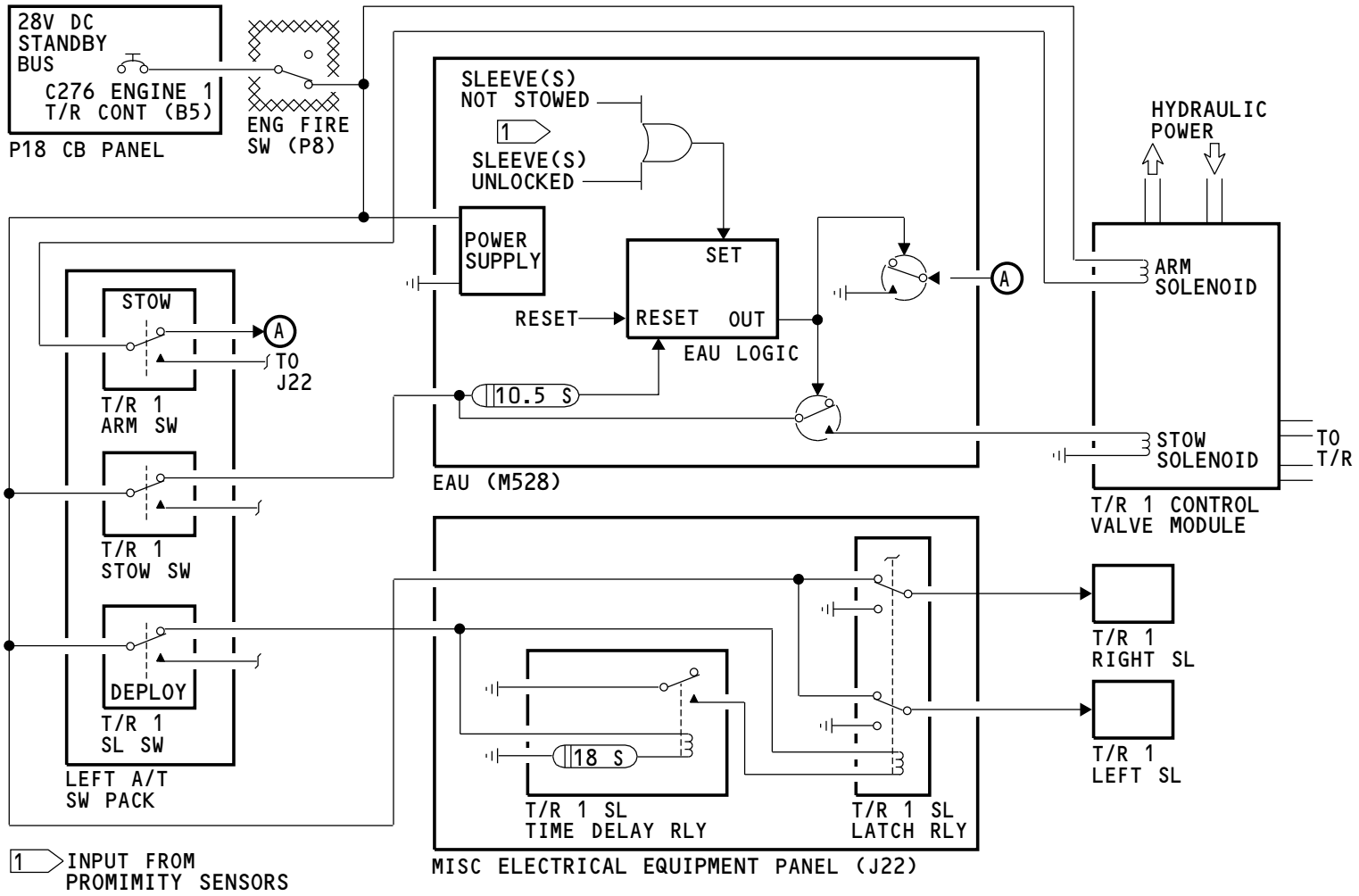
The reset signal from the EAU reset switch will not remove the logic output if the T/R sleeve proximity sensors still show an unlocked or not stowed condition.

A logic output will happen under these conditions:

- The reverse thrust levers have been in the stow position for more than 10.5 seconds
- The EAU receives a sleeve not stowed or sleeve not locked signal.

The arm and stow solenoids energize and the T/R control valve module sends hydraulic power to stow the T/R. The output stays until one of these two sets of conditions happen:

- The EAU sees the sleeves stowed and locked and you push the reset switch on the face of the EAU, or
- You operate the T/R and the EAU sees the sleeves stowed and locked in less than 10.5 seconds after you command a stow operation.



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THRUST REVERSER CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - STOW CONTROL

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THRUST REVERSER CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - DEPLOY/STOW HYDRAULIC FLOW

General

The T/R control valve modules control hydraulic power to the hydraulic actuators for T/R deploy and stow operations.

Hydraulic system A supplies hydraulic power for T/R 1. System B supplies hydraulic power for T/R 2. The standby system supplies backup hydraulic power through the shuttle valves if system A or system B fails. See the shuttle valve page in this section for more information.

The graphic shows T/R 1 operation. T/R 2 operation is almost the same.

Deploy

The arm and deploy solenoids energize when you raise the reverse thrust lever. See T/R CONTROL - FUNCTIONAL DESCRIPTION - DEPLOY CONTROL in this section for more information about the electrical circuit.

This happens when the arm solenoid energizes and hydraulic power is available to the T/R control valve module:

- The hydraulic control valve adjacent to the arm solenoid moves against its spring and hydraulic fluid flows through the valve to the hydraulic isolation valve (HIV)
- The HIV moves to the arm position (up)
- Hydraulic power is made available at the directional control valve (DCV)
- Hydraulic fluid goes through the open manual shutoff valve to the rod side of the T/R actuators.

The deploy solenoid energizes after the sync lock receives a signal to unlock. See the deploy control functional description for more information.

This happens when the deploy solenoid energizes and hydraulic power is available to the T/R control valve module:

- The hydraulic control valve adjacent to the deploy solenoid moves against its spring and hydraulic fluid flows through the valve to the DCV
- The DCV moves to the deploy position (up)
- Hydraulic fluid flows through the DCV to the head side and the rod side of the T/R actuator pistons
- Each locking actuator's mechanism disengages.

The hydraulic pressure on both sides of each actuator piston are equal but the surface area of the head side is larger than the rod side. The larger force on the head side causes the actuator pistons to extend.

As the actuators extend, the fluid on the rod side of the actuators goes to the manual shutoff valve and mixes with the fluid which goes to the head side.

Stow

The arm and stow solenoids temporarily energize when you return the reverse thrust lever to the stow position. The deploy solenoid de-energizes and the hydraulic control valve adjacent to it returns to its normal position. See T/R CONTROL - FUNCTIONAL DESCRIPTION - STOW CONTROL for more information about the electrical circuit.

These are the effects when the arm solenoid remains energized and hydraulic power is available to the T/R control valve module:

- The hydraulic control valve adjacent to the arm solenoid stays against its spring
- Hydraulic fluid keeps the HIV in the arm position
- Hydraulic power stays available at the directional control valve (DCV)
- Hydraulic system pressure stays high at the rod side of the T/R actuators.

This happens when the stow solenoid energizes:

- The hydraulic control valve adjacent to the stow solenoid moves against its spring and hydraulic fluid flows through the valve to the DCV
- The DCV moves from the deploy position to the stow position (down)
- Hydraulic pressure at the head side goes low as the fluid returns to the airplane hydraulic systems through the manual shutoff valve and the DCV
- The hydraulic pressure at the rod side cause the actuators to retract and stow the T/R.

Manual Shutoff Valve

The manual shutoff valve is normally open. You close it whenever you do maintenance on or around the T/Rs.

See CONTROL VALVE MODULE, in this section for more information about the T/R control valve module and the manual shutoff valve handle.

One Way Flow Restrictors

The one-way restrictors restrict the mass flow rate of hydraulic fluid to the T/R hydraulic actuators. They permit free hydraulic flow from the T/R hydraulic actuators. This prevents a possible hydraulic pressure build up across the head of the actuators when the T/Rs are not in operation.

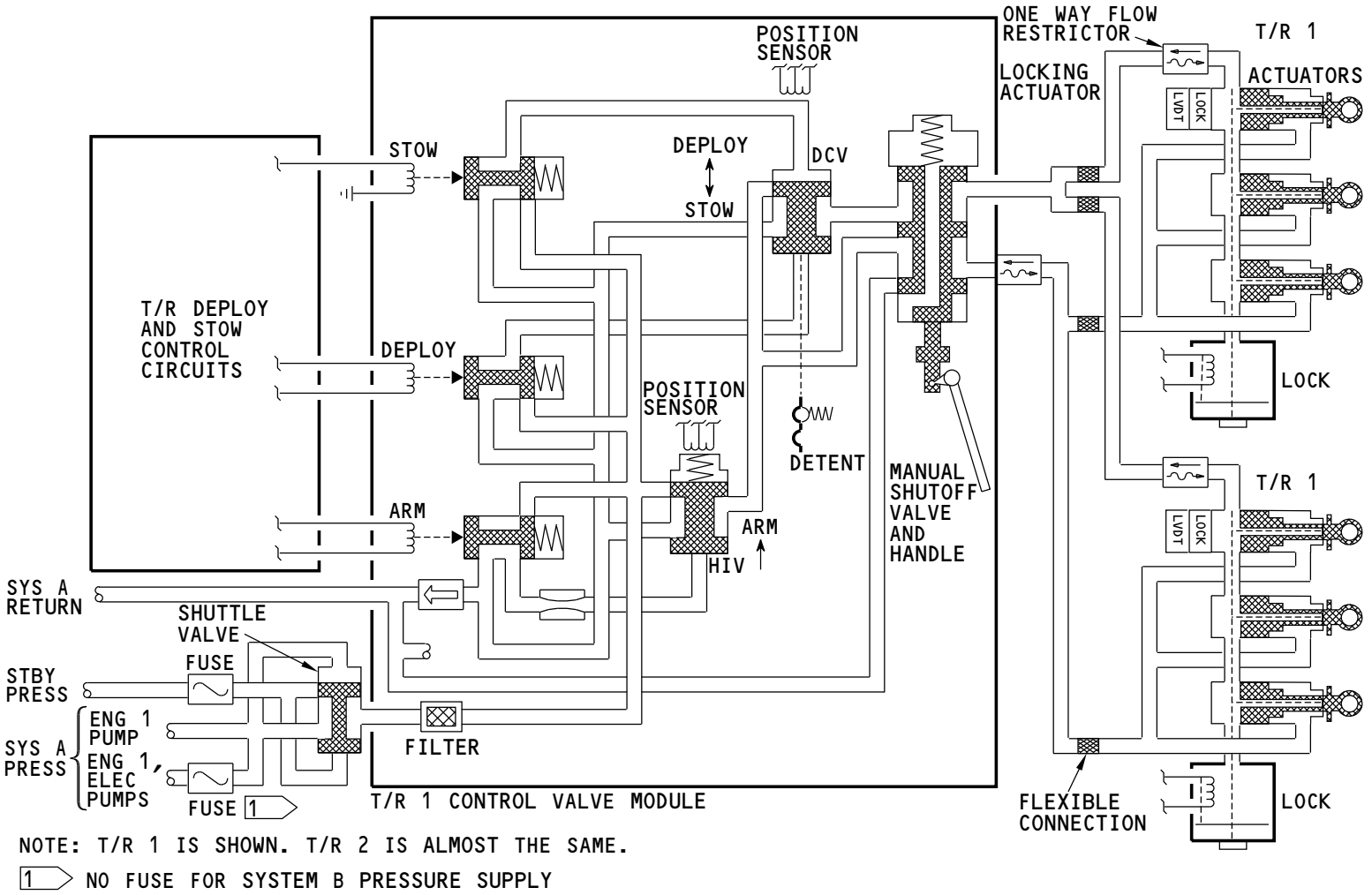
Internal Valve Position Sensors

The EAU uses the position sensors on the DCV and The HIV for fault detection. See the EAU page in this section for more information.

Training Information Point

There is no hydraulic return to the standby system for T/R 1. There is a transfer of hydraulic fluid from the standby system to system A during stow if the standby system deploys the T/R.

There is no similar transfer of hydraulic fluid for T/R 2 operation.



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THRUST REVERSER CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - DEPLOY/STOW HYDRAULIC FLOW

THRUST REVERSER CONTROL SYSTEM - EAU - TRAINING INFORMATION POINT

General

The EAU face has a set of lights and switches for each T/R. A placard near the bottom the EAU supplies BITE instructions.

T/R Control System Troubleshooting

The EAU BITE helps you do trouble-shooting of the T/R control system. The EAU monitors these component inputs from each T/R:

- Left and right sleeve stow proximity sensors
- Left and right sleeve lock proximity sensors
- Hydraulic isolation valve (HIV) position (inside the T/R control valve module)
- Directional control valve (DCV) position (inside the T/R control valve module)
- Voltage at both sync locks.

The EAU identifies a fault if an input is incorrect for the thrust reverser command. For example, a sync lock may not receive electrical power after the pilot commands a deploy operation.

The T/R DEPLOY FAULTS light comes on if a fault happens during a deploy operation. The T/R STOW FAULTS light comes on if a fault happens during a stow operation or after a stow operation. Both lights are red.

The EAU also has a light for each component input. If a component has a failure, then its light will stay on at the end of the BITE. These lights are red.

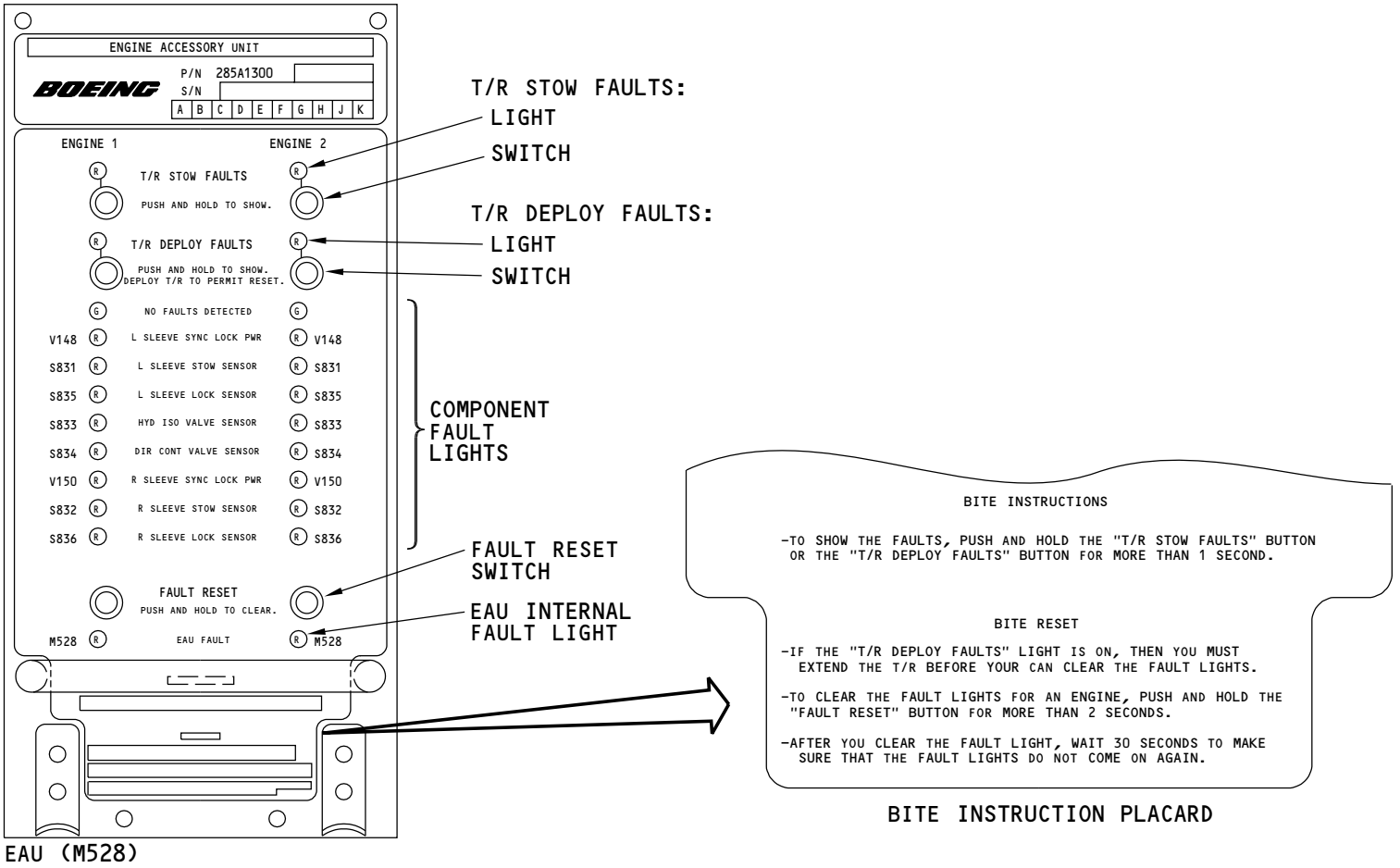
This is a brief summary of the BITE procedure:

- You push and hold the T/R DEPLOY FAULTS button (switch) to see deploy faults or
- Push and hold the T/R STOW FAULTS button (switch) to see stow faults
- All lights come on for a test
- Lights which stay on show faults
- The green NO FAULTS DETECTED light comes on if there are no faults found
- You release the button (switch)
- Lights that stayed on to show faults go out.

You use the FAULT RESET buttons (switches) to erase the EAU fault memory. Deploy faults are reset only when the T/R is in the deploy position. Refer to the procedures in chapter 78, part two of the airplane maintenance manual (AMM) when you use the EAU BITE.

The fault memory will erase when the T/R operates 5 times with no faults.

The EAU FAULT light comes on if there is an internal EAU failure.



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THRUST REVERSER CONTROL SYSTEM - EAU - TRAINING INFORMATION POINT

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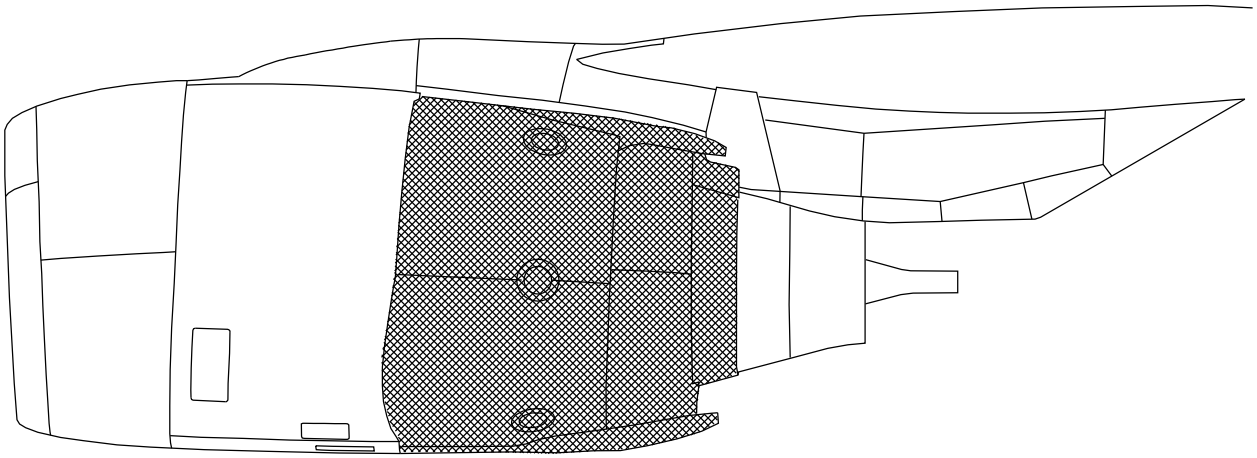
THRUST REVERSER INDICATING SYSTEM - INTRODUCTION

Purpose

The thrust reverser (T/R) indicating system supplies this indication data in the flight compartment:

- REV message on common display system (CDS)
- REVERSER fault light (aft P5)
- Linear variable differential transformer (LVDT) real time data and failure data to the control display units (CDU)
- ENGINE CONTROL light (aft P5).



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THRUST REVERSER INDICATING SYSTEM - INTRODUCTION

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THRUST REVERSER INDICATING SYSTEM - GENERAL DESCRIPTION

General

The thrust reverser (T/R) indicating system supplies T/R translating sleeve position data to the common display system (CDS). The REV message comes on as an indication of translating sleeve position.

The T/R indicating system uses the REVERSER lights to show T/R control system component failure.

The T/R indicating system can also bring on the ENGINE CONTROL light to show T/R indicating system component failure.

You use the control display unit (CDU) to see T/R indicating system component failure data.

REV Messages

The REV messages show just above the engine N1 indicators on the CDS. One message shows for each T/R.

The message shows in amber when one or both sleeves of a T/R are between 10 to 90 percent of the travel to the deploy position.

The message shows in green anytime both sleeves of a T/R are more than 90 percent of the travel to the deploy position.

Each T/R translating sleeve has one linear variable differential transformer (LVDT). The LVDT gives sleeve position data to the engine electronic control (EEC).

The EEC and the display electronics units (DEUs) contain the logic necessary to operate the REV message. The EEC supplies a signal on an ARINC 429 bus to each display electronics unit (DEU). The DEUs then show the message on the correct display unit.

REVERSER Lights

Each T/R has an amber REVERSER light on the engine panel. There is one light for each T/R. Master caution comes on after a time delay whenever a REVERSER light comes on. The REVERSER light can come on in flight.

The REVERSER lights come on for 10.5 seconds during a normal T/R stow operation. A REVERSER light stays on if a T/R control system component fails during the stow. The light stays on until the stow failure goes away.

The REVERSER light comes on immediately during a deploy if a T/R control system component fails. The light stays on until you fix the deploy problem and reset the engine accessory unit (EAU).

The REVERSER light comes on when any of these T/R control system component's do not operate correctly for a stow or deploy operation:

- Proximity sensor (2 each T/R sleeve)
- Sync lock
- Directional control valve (DCV) inside the T/R control valve module
- Hydraulic isolation valve (HIV) inside the T/R control valve module.

The engine accessory unit (EAU) contains the logic necessary to identify T/R control system component failures. The EAU controls the REVERSER lights.

ENGINE CONTROL Light

Each engine has an amber ENGINE CONTROL light on the engine panel. This light comes on when a serious failure of an engine or a failure of the T/R LVDT happens. You should not dispatch the airplane with an ENGINE CONTROL light on. Master caution also comes on with this light.

The T/R indicating system uses input from the LVDTs to control the ENGINE CONTROL light.

The ENGINE CONTROL light will not illuminate with the airplane in air mode, even with faults related to the thrust reverser translating sleeve position. The EEC will send a fault signal to the control display unit (CDU) when the translating sleeve position signals occur. The CDU will inhibit the ENGINE CONTROL light if the airplane is in the air.

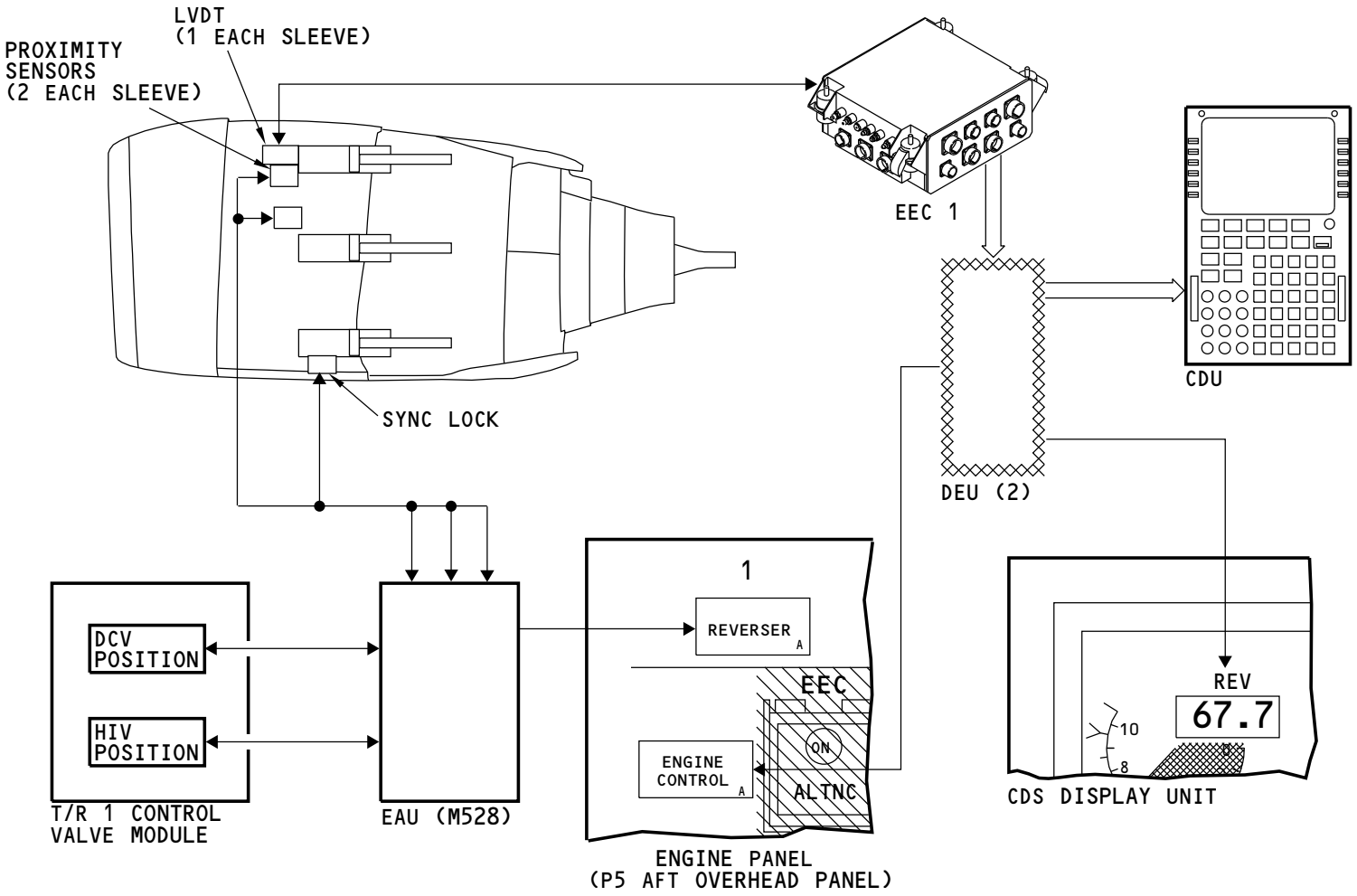
There are no conditions that would cause the ENGINE CONTROL light to illuminate while the airplane is in air mode. The EEC has no air/ground input in its fault logic. The ENGINE CONTROL light is controlled by the CDU with this logic; the ENGINE CONTROL light is enabled after 30 seconds when increasing ground speed is less than 80 knots, or ground speed is less than 30 knots, or ground speed is invalid and the airplane is in ground mode. The ENGINE CONTROL light can only illuminate when the EEC provides an appropriate input to the CDU and the CDU enables the light.

An ENGINE CONTROL light comes on when any two of these conditions are true for a T/R:

- The left translating sleeve position signal (from the LVDT) is not in range
- The right translating sleeve position signal (from the LVDT) is not in range
- The left translating sleeve position signals (from the LVDT) do not agree
- The right translating sleeve position signals (from the LVDT) do not agree.

Control Display Unit (CDU)

You can see LVDT real time data and failure messages on the control display unit (CDU). See the engine indicating chapter for more information about how the CDU helps you do trouble-shooting. (CHAPTER 77)



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THRUST REVERSER INDICATING SYSTEM - GENERAL DESCRIPTION

THRUST REVERSER INDICATING SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT

REVERSER Lights

The amber REVERSER lights are on the engine panel. This panel is on the P5 aft overhead panel in the flight compartment.

ENGINE CONTROL Lights

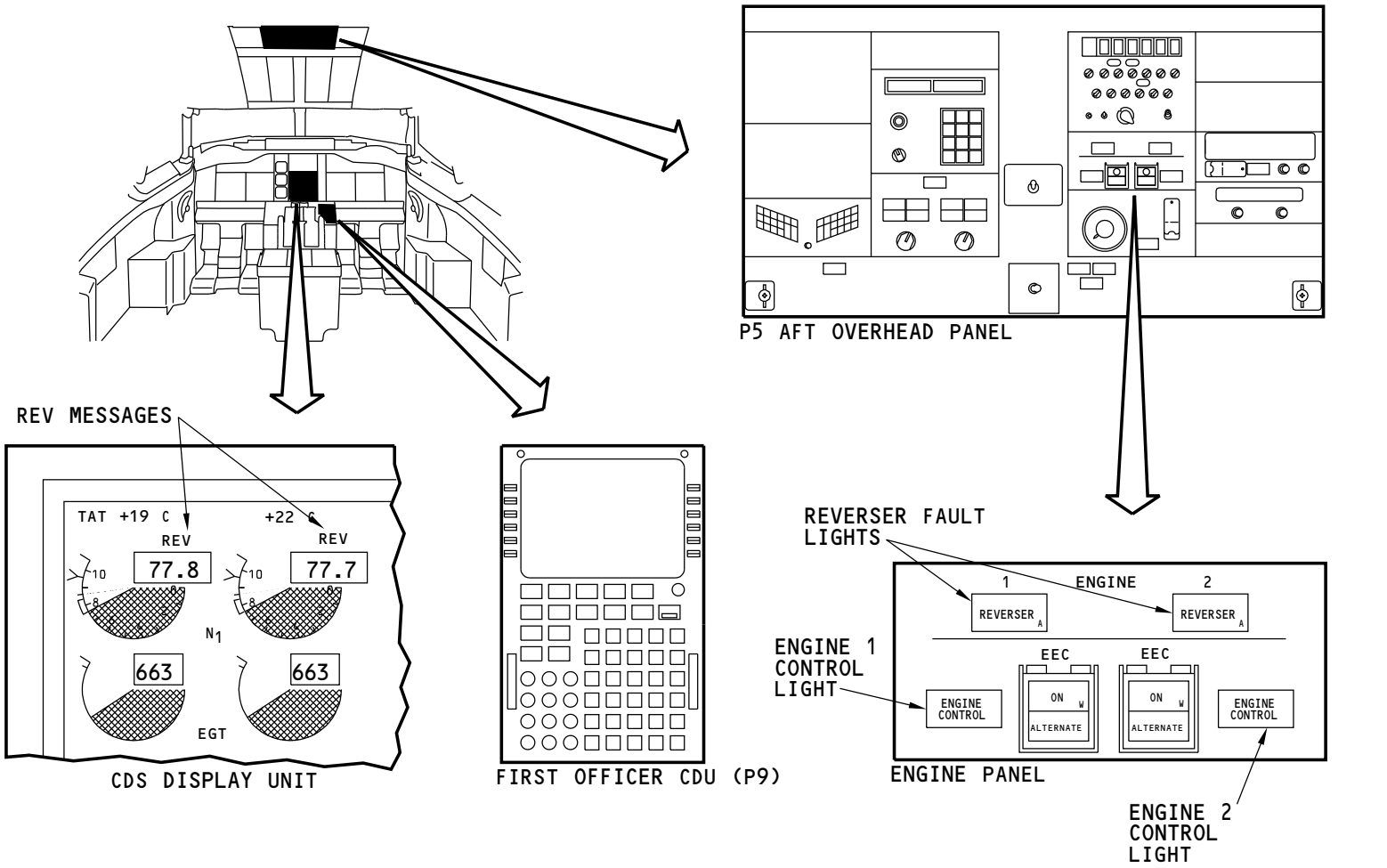
The amber ENGINE CONTROL lights are on the engine panel.

REV Messages

The REV messages show on the common display system (CDS). The message shows just above the engine N1 indicator.

Control Display Units

The control display units (CDUs) are on the P9 panel in the flight compartment. The CDUs are on the left and right side of the lower center display unit.



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THRUST REVERSER INDICATING SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT

THRUST REVERSER INDICATING SYSTEM - LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

Purpose

The linear variable differential transformer (LVDT) supplies T/R sleeve position data to the electronic engine control (EEC).

The EEC uses the LVDT signal for these functions:

- Control the REV message on the common display system (CDS)
- Control the ENGINE CONTROL light (aft P5)
- LVDT failure isolation through the control display units (CDUs).
- Reverse thrust interlock control
- Engine forward and reverse thrust control.

See the functional description in this section for more information about the REV message.

See the engine controls chapter for more information about the reverse thrust interlock. (CHAPTER 76)

See the engine controls chapter for more information about how the EEC controls engine thrust. (CHAPTER 76)

Physical Description

The LVDT is a dual channel transducer with separate armatures. The LVDT has two electrical connectors for EEC channel A and channel B wiring. The locking hydraulic actuator feedback control rod connects to the LVDT's armature assembly.

Location

The LVDT is on the head end of the locking actuator. You open the fan cowl to get access to the head of the locking actuator.

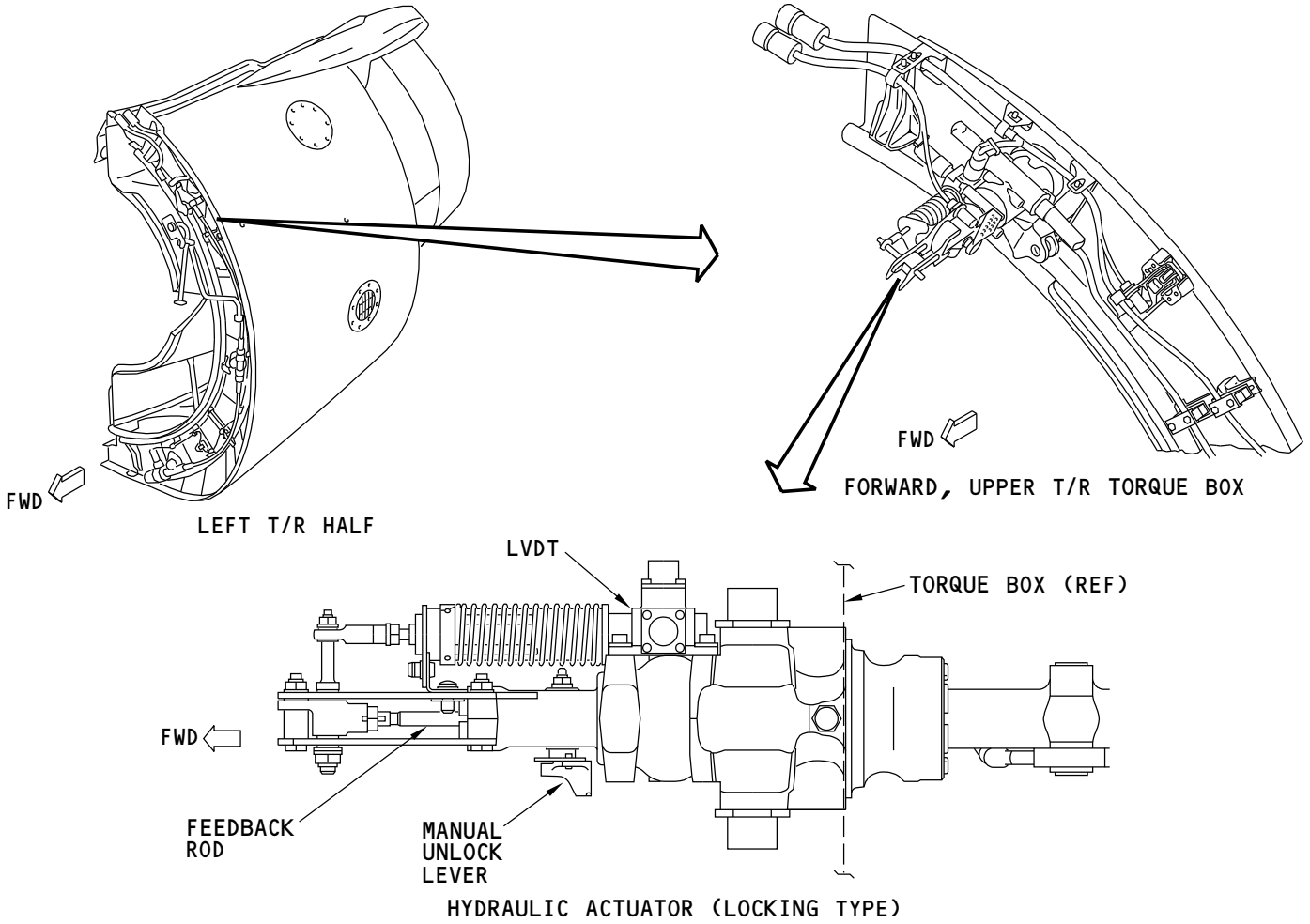
Functional Description

The feedback rod of the locking actuators moves the LVDT's armature assembly as the T/R sleeve deploys or stows.

The EEC supplies excitation to the LVDT. The LVDT's output voltage is proportional to its armature position. The LVDT's output is proportional to the sleeve position.

Troubleshooting

You use the control display unit (CDU) to help do troubleshooting of the LVDT. Refer to the troubleshooting page of this section for more information.



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THRUST REVERSER INDICATING SYSTEM - LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

THRUST REVERSER INDICATING SYSTEM - REVERSER LIGHT - FUNCTIONAL DESCRIPTION

General

A REVERSER light comes on when any of these conditions happen:

- For 10.5 seconds after T/R stow command
- T/R stow control system component fault (except during a deploy operation)
- T/R deploy control system component fault during deploy operation.

The engine accessory unit (EAU) contains the logic necessary to identify T/R control system component faults. The EAU controls the REVERSER lights.

Stow Operation

The reverser lights usually comes on for 10.5 seconds after you command a stow operation. This is because the hydraulic isolation valves (HIV) temporarily stay in the arm position to supply hydraulic power to the actuators for the stow operation. This condition usually ends 10.5 seconds after the stow command.

See the thrust reverser control system section for more information. (SECTION 78-34)

Stow Fault Logic

The EAU identifies any of these conditions as a stow fault:

- Any sleeve stow sensor is near (10s after stow command)
- Any sleeve lock sensor is near (10s after stow command)
- Left or right sync lock voltage (26s after stow command)
- Directional control valve (DCV) sensor near (15s after stow command)
- HIV sensor near (15s after stow command).

For any of these conditions the REVERSER light comes on. The light goes out when the stow fault goes away. The master caution and the ENG annunciator come on if the fault stays for more than 13 seconds.

The REVERSER light will come on and stay on (latch) if the EAU sees the arm switch fail to the deploy position. This is the only stow fault that keeps the REVERSER light on. You must replace the switch, deploy the T/R and reset the EAU to make the REVERSER light go out.

Deploy Fault Logic

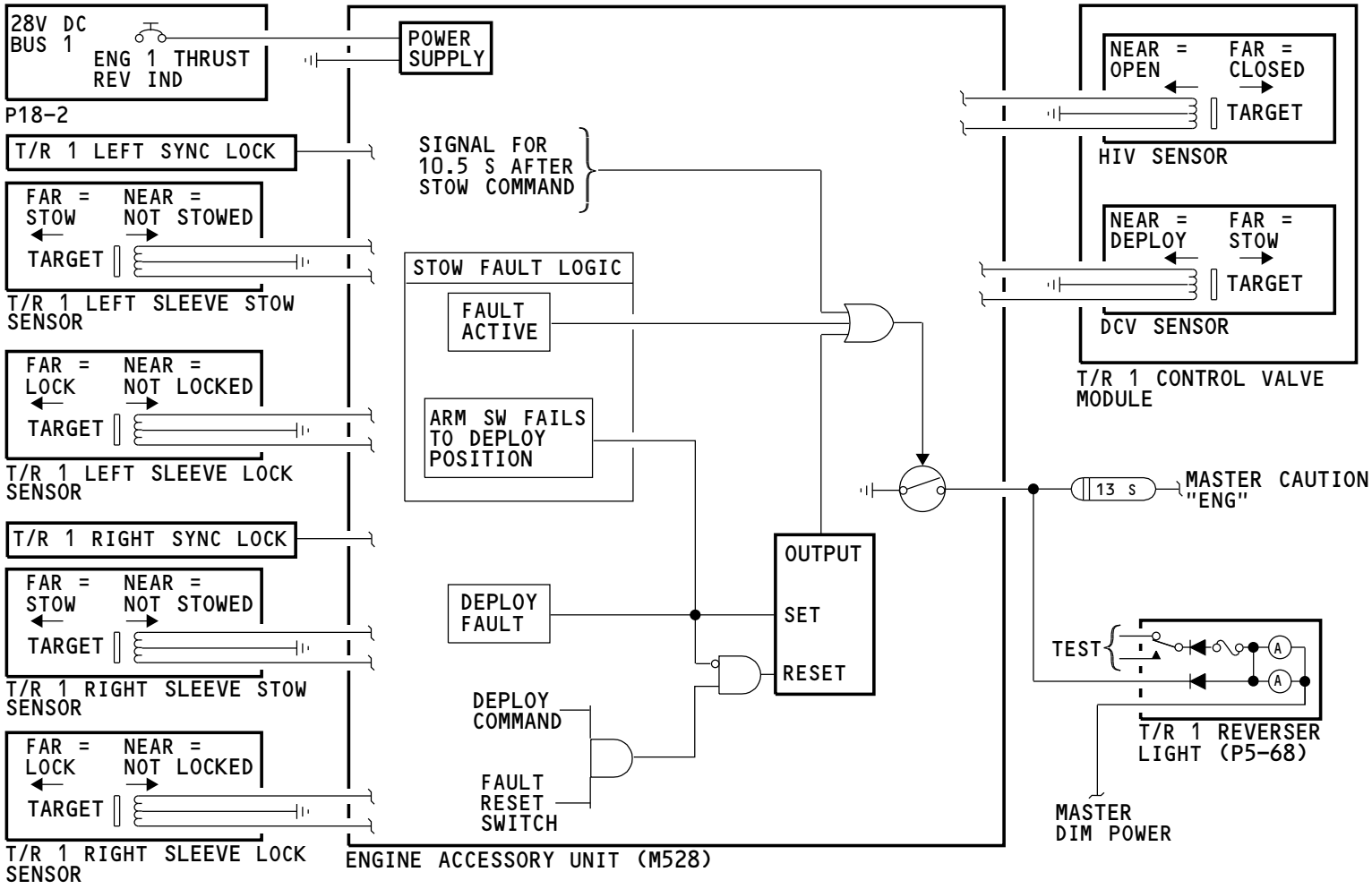
The EAU identifies any of these conditions as a deploy fault:

- Any sleeve stow sensor far (6s after deploy command)
- Any sleeve lock sensor far (6s after deploy command)
- No left or right sync lock voltage (2s after deploy command)
- Directional control valve (DCV) sensor far (6s after deploy command)
- HIV sensor far (6s after deploy command).

For any of these conditions the REVERSER light comes on. The master caution and the ENG annunciator comes on if the fault stays for more than 13 seconds.

A deploy fault keeps the reverser light on. You must fix the problem which causes the fault, deploy the T/R, and clear (reset) the EAU deploy fault memory before the reverser light can go out.

Procedures in part two of the airplane maintenance manual (AMM) show how to clear the EAU fault memory.



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THRUST REVERSER INDICATING SYSTEM - REVERSER LIGHT - FUNCTIONAL DESCRIPTION

THRUST REVERSER INDICATING SYSTEM - REV MESSAGE - FUNCTIONAL DESCRIPTION

General

An amber REV message shows when one or both sleeves of a T/R are more than 10 percent, but less than 90 percent to the deploy position. The REV message changes to green when both sleeves are more than 90 percent to the deploy position.

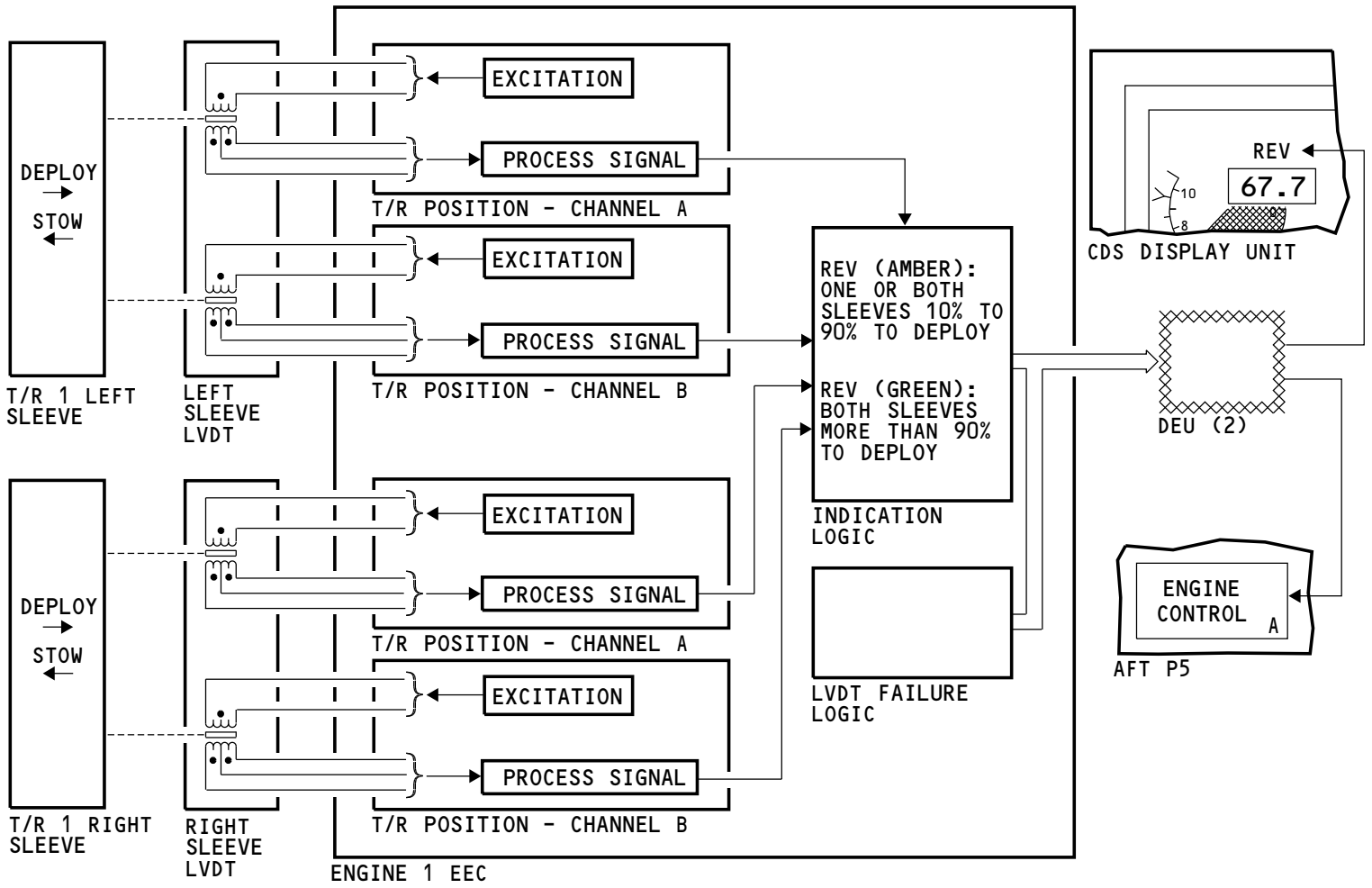
The electronic engine control (EEC) contains the logic which processes the input from each LVDT.

EEC

The EEC changes the LVDT analog signal to a digital signal. The EEC and DEUs contain the REV message indication logic. The EEC sends a signal on an ARINC 429 bus to each display electronics unit (DEU). The DEUs show the REV message on the common display system (CDS).

Channel A and channel B calculate sleeve position from the LVDT input. The EEC usually uses an average of the two values in its logic to show the message.

The EEC also has the LVDT failure logic. When conditions are met, the amber ENGINE CONTROL light and master caution come on with the airplane is on the ground.



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THRUST REVERSER INDICATING SYSTEM - REV MESSAGE - FUNCTIONAL DESCRIPTION

THRUST REVERSER INDICATING SYSTEM - TRAINING INFORMATION POINT

General

You use the control display units (CDUs) to do trouble-shooting of the linear variable differential transformer (LVDT). The CDU shows real time data or failure codes.

See the engine indicating chapter for more information about other engine maintenance messages that the CDU shows. (CHAPTER 77)

Failure Data

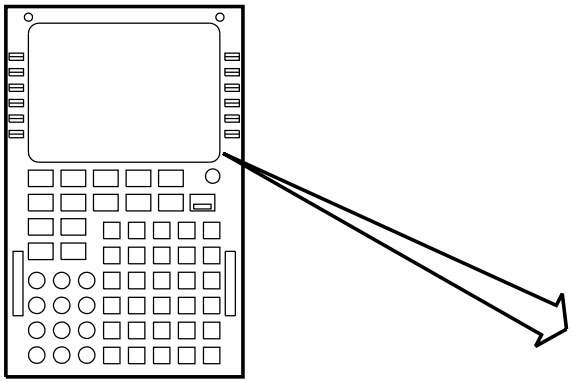
The EEC records a LVDT failure when any of these happen for more than 5 seconds:

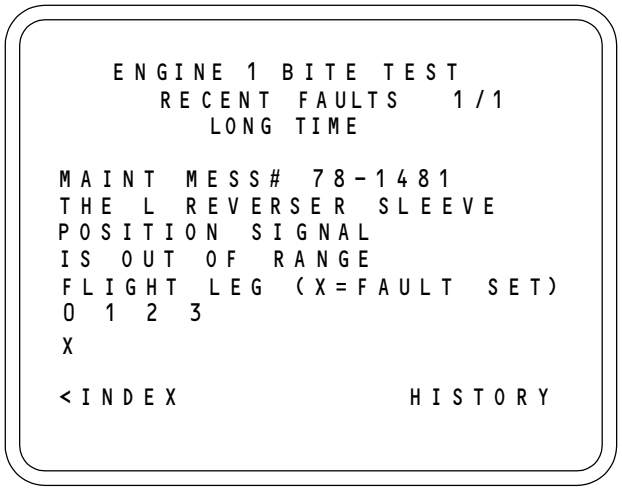
- LVDT input to EEC is out of range
- EEC channel A and B see that sleeve is 10 percent to the deploy position and forward thrust levers are forward of the idle position.
- The value of the difference between the T/R sleeve's position signals on EEC channel A and B is greater than 12 percent.

Real Time Data

You use the CDU to see this real time data for any LVDT:

- Sleeve position in percent travel to deploy position (usually average of channel A and channel B)
- Sleeve position in percent travel to the deploy position for the EEC channel you select
- EEC channel A and B LVDT voltage data.





CDU - LVDT BITE

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THRUST REVERSER INDICATING SYSTEM - TRAINING INFORMATION POINT