CHAPTER 27 - FLIGHT CONTROLS

TABLE OF CONTENTS

LIST OF FIGURES

GENERAL

The flight control system comprises the flight surfaces and their trimming surfaces, the relevant control and actuation mechanisms, and the indicator/warning systems.

The aircraft has the following flight controls:

- ***Primary Flight Controls:*** reversible controls that allow three-axes manoeuvrability. Flight controls act on:
  - Ailerons
  - Elevators
  - Rudder
- ***Secondary Flight Controls:*** some of them trim the primary flight surfaces and others are intended to give additional lift at low airspeeds. They act on:
  - Aileron Trims (Trim Tabs and Servo Tabs)
  - Rudder Trims (Trim Tab and Servo Tab)
  - Elevator Trims (Trim Tabs and Servo Tabs)
  - Flaps

The system is completed with:

- Gust-Lock system, which allows the control surfaces to be locked in the neutral position to avoid damage by gusts while the aircraft is grounded.
- Automatic Stall Warning and Recovery System.
- Rudder Booster System
- Auto trim System on the Rudder and Elevators.
- Rudder Travel Control System.

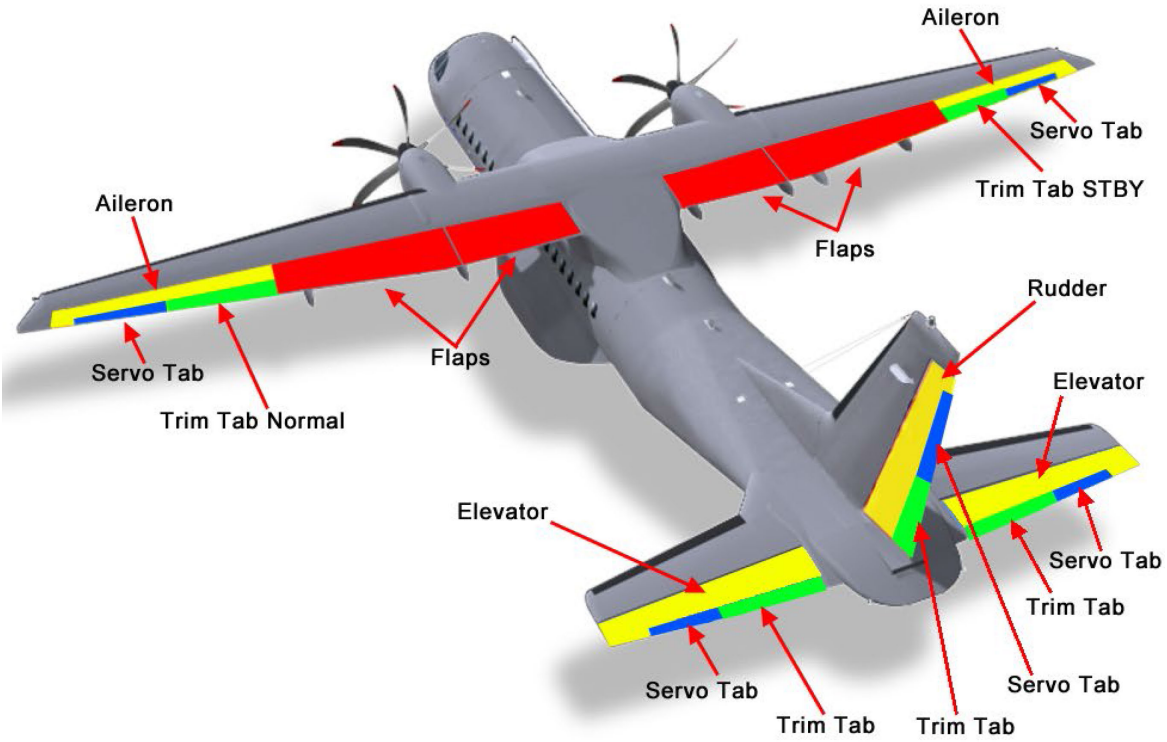

Figure 27-1 Control Surfaces

ROLL CONTROL

DESCRIPTION AND OPERATION

Roll control is performed by means of two control columns which transmit their movement through cables and rods to the ailerons.

The system has two separate channels: the left channel from the LH control column to the LH aileron, and the right channel from the RH control column to the RH aileron. Both channels are connected by two electrically-driven mechanical interconnection rods, one of which is located beneath the cockpit floor and the other in the central wing area. These interconnection rods allow the normal operation of both ailerons from either of the control column and enable the channels to be separated in case one of them jams. To separate the channels, both interconnection rods need to be disconnected. To operate the channels in synchronization only one of the interconnection rods needs to be connected.

Disconnecting the interconnection rods allows each channel to be operated separately. The interconnection rods are disconnected by raising the guard of the ROLL selector switch on the FLT CONT DISC panel (located on the pedestal) and moving it to the UNTIE position. The FWD and REAR lights show that the interconnection rods have been disconnected (by failure or by action of the ROLL selector).

Servo Tabs

To reduce the strain on the columns, each aileron incorporates a servo tab in its trailing edge which is actuated mechanically by the aileron deflection. The tabs work in such a way that when the aileron moves up or down the relevant tab is moved (by the control interconnection rods) in the opposite direction.

Trim Tabs

Each aileron has a trim tab on its trailing edge. Trim tabs are electrically operated to compensate the control movement. The trim tab is an aerodynamic surface attached to the aileron by a hinge. It is connected to the aileron by a pair of control interconnection rods linked to an actuator powered by a DC electric motor.

The aileron trimming system has two separate channels:

- Normal (operates the left-hand trim)
- Standby (STBY), which operates the right-hand trim

During normal operation, only the left aileron trim tab is used. This trim tab is controlled from either of the control columns using the ROLL TRIM selector switches. If the signals from the C/M-1 and C/M-2 selectors are different, the signal is inhibited and the trim tab stops moving.

When there is a fault on the normal trim channel (left-hand trim tab), the STBY channel can be used (right-hand trim tab) by raising the guard and operating the AILERON selector switch on the STBY TRIMS panel, located on the pedestal. As soon as the guard on the AILERON selector switch is removed the LH trim tab and the ROLL TRIM selectors on each of the control columns are inhibited.

OPERATION WITH INTERCONNECTION RODS DISCONNECTED:

If the control channels have been separated, the trim control is also affected:

- If the guard on the AILERON selector switch on the STBY TRIMS panel on the pedestal is not raised, the LH trim tab can be operated from the ROLL TRIM selector switch on the pilot control column and the RH trim tab (STBY) can be operated from the ROLL TRIM selector on the co-pilot control column.
- If the guard has been raised it will be only possible to operate the RH trim tab from the AILERON selector switch (the ROLL TRIM selectors on each of the control columns and the LH trim tab will be inhibited)

The position of each trim tab is shown continuously on the AILERON TRIM INDICATOR (NORMAL and STBY), located on the central instrument panel.

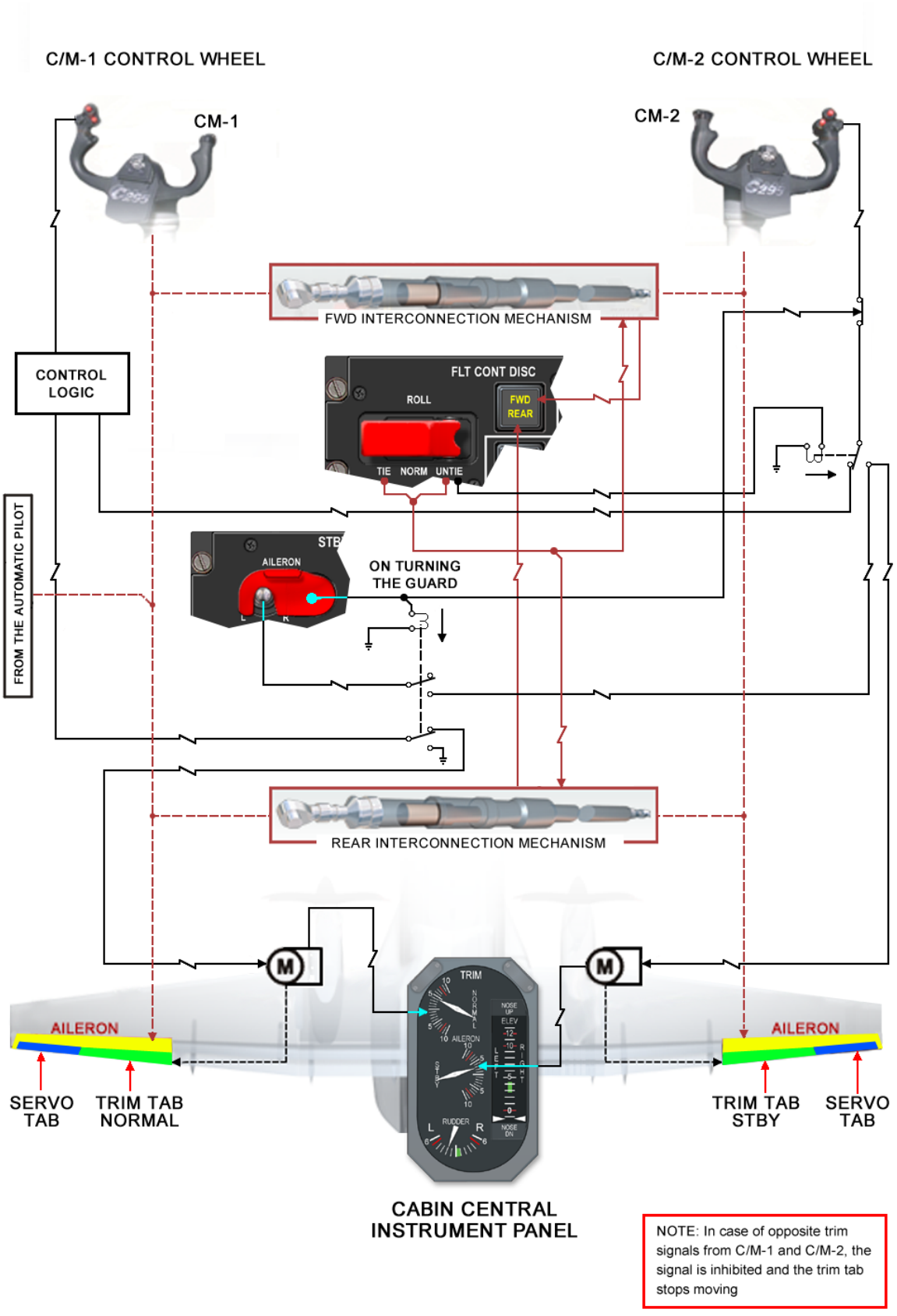

Figure 27-2 Aircraft Banking Control

CONTROLS AND INDICATORS

(1) ROLL TRIM Selector:

moves the trim tab on the LH aileron. When C/M-1 and C/M-2 selector switches send different signals, these are inhibited and the trim stops moving.

- *Pressed-in and moved to the right:* moves the trim tab on the LH aileron in such way the movement induced in the ailerons causes the aircraft to roll to the right.
- *Pressed-in and moved to the left:* moves the trim tab on the LH aileron in such way the movement induced in the ailerons causes the aircraft to roll to the left.

(2) Control Wheel

controls the movement of the ailerons mechanically.

(3) ROLL FWD & REAR Indicators:

- *FWD light on:* indicates disconnection of the front interconnection rod.
- *REAR light on:* indicates disconnection of the rear interconnection rod.

(4) FLT CONT DISC ROLL Selector (guarded):

- *UNTIE:* disconnects both interconnection rod, separating the channels. Disables control over the LH aileron trim tab from the C/M-2 ROLL TRIM selector switch and allows the control over the RH aileron trim tab from this selector.
- *TIE:* reconnects the two channels of the system through the two interconnection rods. Disables control over the right aileron trim tab from the C/M-2 ROLL TRIM selector switch and allows the control over the LH aileron trim tab from this selector.
- *NORM:* normal functioning of the system.

(5) STBY TRIMS AILERON Selector (guarded):

- *Guard Raised:* inhibits operation of the left aileron trim tab and enables operation of the right aileron trim tab from the STBY TRIMS AILERON selector switch.
- *L:* moves the trim tab on the right aileron, in such way the movement induced in the ailerons forces the aircraft to a left roll.
- *R:* moves the trim tab on the right aileron, such that the movement induced in the ailerons forces the aircraft to right roll.

(6) TRIM AILERON NORMAL & STBY Indicator:

- *NORMAL:* indicates (in degrees) the LH aileron trim tab deflection.
- *STBY:* indicates (in degrees) the RH aileron trim tab deflection.

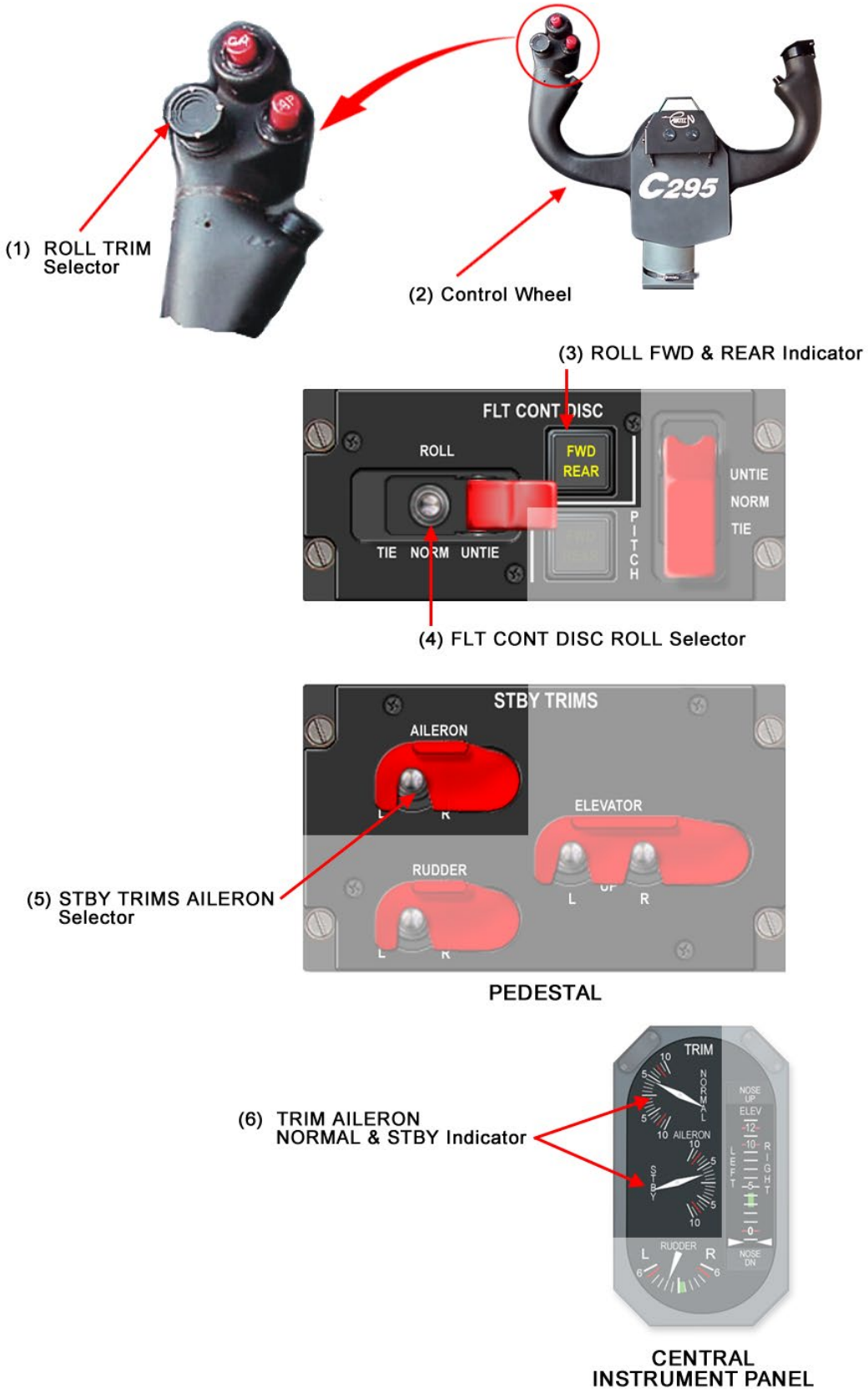

Figure 27-3 Aircraft Banking Control - Controls and Indicators

RUDDER CONTROL

DESCRIPTION AND OPERATION

Rudder control is got by means of two interconnected sets of pedals, which movements are transmitted along a series of cables and interconnection rods to the rudder. The pedals have a manually operated adjusting device, which allows their position, relative to the pilots seats, to be adjusted.

The system has a Rudder Booster system to reduce the effort the pilot needs to trim against the yaw caused by an engine failure. It also has a system that limits the maximum rudder deflection, according to the flight conditions.

Finally, the system has an Autotrim and Rudder Travel Control Unit (ARTCU), which controls the trim and autotrim (rudder and elevators) and the rudder travel control functions. The ARTCU gives the following rudder control functions:

- Manual Trimming
- Auto trim
- Rudder Travel Control

Rudder Boost Actuation

The system consists of a rudder booster (with two opposed chambers and a central piston), a by-pass valve (which connects both chambers) and two three-way valves.

Each chamber of the actuator receives compressed air from the relevant engine bleed through a pneumatic line and a three-way valve. Each valve is controlled by the relevant Electronic Engine Control system (EEC1 and EEC2). The valves have a solenoid, which is normally in the de-energized position (valve open), allowing air to flow free between the engine and the actuator. With both engines in normal operation, the pressure in each of the chambers is balanced. The system works in the following situations:

- In case of an engine failure, an over balance is created between the two chambers of the actuator, thus reduces the force on the pedals.
- If a power asymmetry is detected (by an angle of PL >65° and TQ <25% or PL >65º and NP <35%), the three-way valve relevant to the side on which there is a failure, closes. Thus interrupting air flowing from the engine and allowing the air in the actuator to discharge. The pressure difference between the two chambers of the actuator makes a deflection of the rudder, which is limited by the travel control system, and the power asymmetry is compensated.

The system operates when the two PLs are set above FI. When the PLs are set below FI (including reverse) the by-pass valve is energized to open. This connects the two chambers of the actuator and makes the system inoperative (the STBY light on the guarded ACTR pushbutton, on the FLIGHT CONTROL panel, will come on). At any time, the pilot has the option to cancel the system manually, by pushing the guarded ACTR pushbutton (OFF light on).

While on take-off with the rudder booster disconnected (OFF light on the ACTR pushbutton shows on), the UNSAFE TO warning will be displayed on the IEDS and the relevant warning bell will ring (LYRE warning bell. Refer to CHAPTER 31 - INDICATING AND RECORDING).

To prevent the system from freezing, the pneumatic actuator is surrounded by a heater which heats the actuator cylinder and the by-pass valve. The heater has two (primary and secondary) separate electric heaters, controlled automatically by two separate electronic temperature controllers. These controllers set the heating elements within the preset maximum and minimum temperatures. During normal operation, the primary electric heater and its associated controller are in constant use and the secondary system is kept on standby. The secondary system operates when the HEATER STBY pushbutton is pushed after a primary system failure. A RUD HT caution displays on the IEDS in case of failure of any of them. The heating system has a test function which simulates a maximum temperature condition and de-energizes the heater.

Autotrim and Rudder Travel Control System (ARTCS)

The purpose of the system is to increase or decrease, the rudder travel limits according to the aircraft flight speeds and configurations.

The Autotrim and Rudder Travel Control Unit (ARTCU) controls the functions of the trim and auto trim systems (rudder and elevator) and the rudder travel control system.

The Rudder Travel Control System has two functions:

– Reduction of the Maximum Rudder Deflection limits (reduction function): Reduces the limits as the flight speed increases and, when the de-icing system is set to on, it limits the maximum deflection to preset default values.
– Increase of the Maximum Rudder Deflection limits (expansion function): This function, which is operative at speeds below 140 KIAS, expands the nominal maximum deflection values only under the following circumstances:

1. Engine failure during take-off, with:

   A. Engine failure

   B. Weight on columns

   C. Flaps not UP

2. At low flight speeds, with:

   A. Rudder deflections of more than 50% of nominal travel (due to strong crosswind)

   B. De-icing set to off

   C. Flaps in approach and landing configuration

   D. Position of PLs <55º

The RTCS EXP caution on the IEDS indicates that only the rudder travel expansion function has failed.

If the RTCS AUTO caution shows on the IEDS, both the rudder travel expansion function and rudder travel reduction function has failed (the ARTCS MAN light will flash). The reduction function is recovered by switching to manual mode by putting the AIRSPEED SEL selector in any of the following positions, depending on the speed of the aircraft (the ARTCS MAN will be on constantly):

– LOW (V < 140 KIAS)
– MED (140 KIAS ≤ V ≤ 200 KIAS)
– HIGH (V > 200 KIAS)

If manual mode fails, the RTCS MAN caution will display on the IEDS, indicating that the rudder travel reduction function has been lost. The rudder travel stops will remain in their last position. To return the stops to their nominal values, it is necessary to set the AIRSPEED SEL selector to the AUTO position.

Finally, while on take-off with the weight on columns (nose column) signal present and a PL position above 66.5º (close to MAXAUTO), if the AIRSPEED SEL selector is not in the AUTO position, the Unsafe Take-Off Configuration warning will be activated. That is, the UNSAFE TO warning will display on the IEDS and the associated LYRE warning bell will ring (refer to CHAPTER 31 - INDICATING AND RECORDING).

Servo Tab

To reduce the forces transmitted to the pedals, there is a servo tab in the top section of the trailing edge of the rudder. The servo tab is actuated mechanically by the deflection of the rudder, such that when the rudder moves, the servo tab is automatically moved in the opposite direction by the control interconnection rods.

Trim Tab

The trim tab is a moving aerodynamic surface attached to the lower part of the trailing edge of the rudder by a hinge. It is connected to the rudder by two control interconnection rods linked to an electrically-operated actuator. The actuator has two motors, one for normal operation and one (STBY) for emergency use. The motor used during normal operation is controlled by the ARTCU, which allows manual trimming and also gives an auto trim function. The normal and standby control channels are separate.

During normal operation, the trim tab is controlled by the RUDDER trim selector, located on the pedestal. This selector switch sends control signals to the ARTCU, which actuates the normal motor and operates the trim surfaces. The trim speed varies with the speed of the aircraft.

Also to reduce the pilots workload, the ARTCU sends autotrim commands when any of the following circumstances takes place:

- Change of speed
- Power change or asymmetry
- Engine failure.

The auto trim function is inhibited during manual trimming by the flight crew (using the RUDDER TRIM selector), or when the guard on the STBY TRIMS RUDDER selector switch is raised or when the stick shaker is activated.

If the RUD TRIM caution displays on the IEDS, the auto trim function has failed. If this happens, the normal trim function using the RUDDER TRIM selector, located on the pedestal may also have failed.

If there is a failure of the normal trim, the STBY trim is used by means of the STBY TRIMS RUDDER selector switch, located on the pedestal. This selector switch is protected by an active guard, which if raised, inhibits the auto trim function and disconnects power from the normal motor, thus permitting the standby motor to come into operation. The trim tab can now be operated from the STBY TRIMS RUDDER selector switch directly without the signal going through the ARTCU.

The operation of the trim tab is displayed on the TRIM RUDDER indicator, located on the central instrument panel.

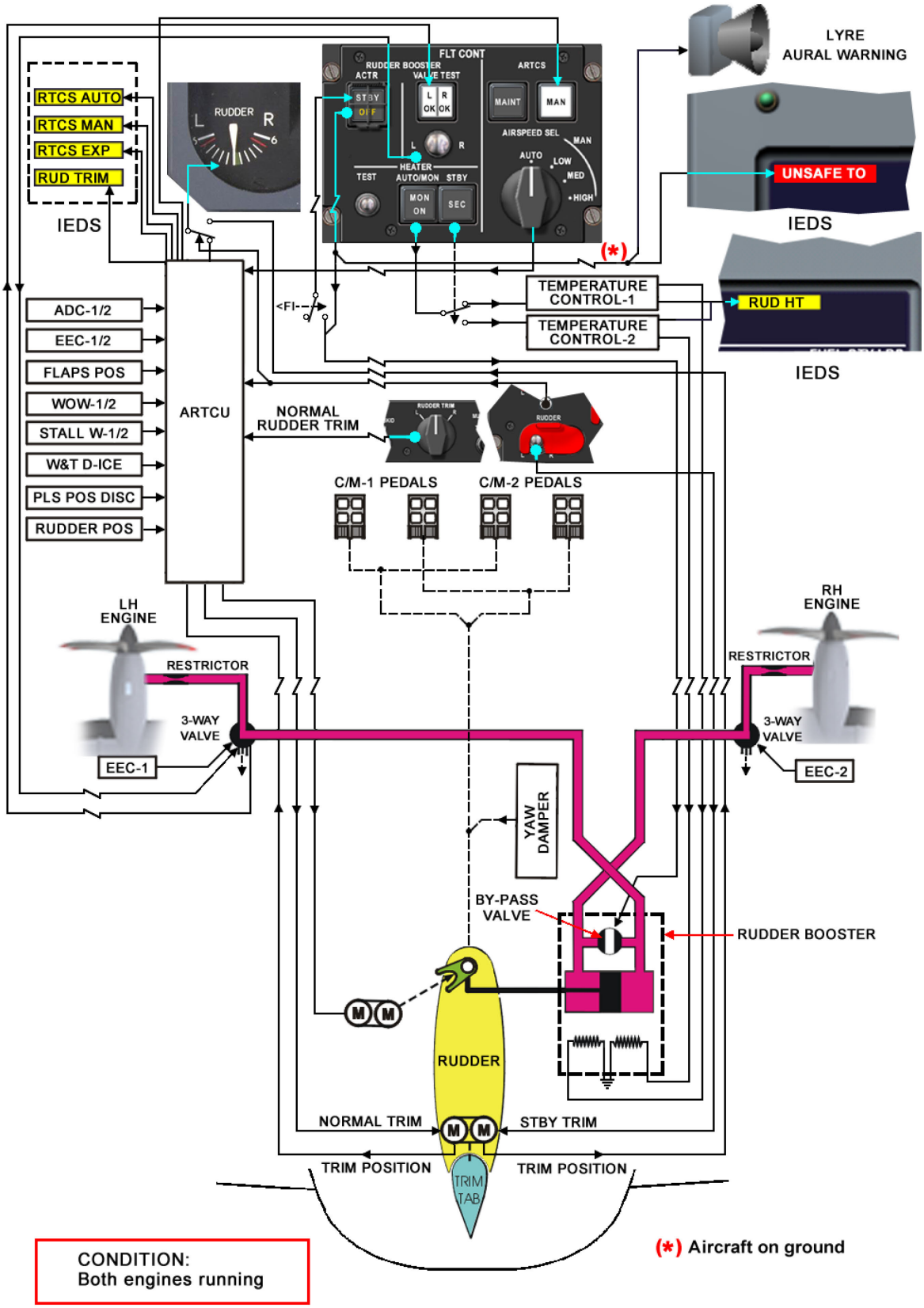

Figure 27-4 Aircraft Rudder Control

CONTROLS AND INDICATORS

(1) Pedal Unit (two):

to control the rudder operation.

(2) Pedal Adjustment Mechanism (two):

adjusts the distance between the yaw pedal assembly and the pilot's seat. To the right it brings them closer and to the left it moves them further away.

(3) VALVE TEST Indicator:

- *L OK* while at system test, indicates that the LH three-way valve is operative.
- *R OK* while at system test, indicates that the RH three-way valve is operative.

(4) MAINT Indicator:

- *On:* no failure in operation, but maintenance action is required.

(5) MAN Indicator:

- *Flashing:* loss of ARTCS automatic mode. Requires manual speed selection.
- *Fixed:* ARTCS manual mode selected.

(6) AIRSPEED SEL Selector:

selects automatic or manual operation (low, med, high) of the ARTCS.

- *AUTO* Automatic functioning of the ARTCS.
- *LOW* For flight speeds below 140 KIAS.
- *MED* For flight speeds between 140 KIAS and 200 KIAS.
- *HIGH* For flight speeds above 200 KIAS.

(7) HEATER STBY Pushbutton:

- *Pushed-in (SEC light to on)* The secondary heater for the Rudder Booster and the associated by-pass valve have been selected.

(8) HEATER AUTO/MON Pushbutton:

- *Pushed-in (MON light on)* allows the functioning of the selected electric heater to be monitored (by means of the ON light).
- *ON* Temperature controller supplying power to its relevant heater.

(9) HEATER TEST Switch:

- *Held:* with electric heaters on, tests the ability of the electronic temperature controller to cut-off the power to the electric heaters. The ON light, which indicates the heaters are powered, will go off. If held in the TEST position, the RUD HT caution is displayed on the IEDS.

(10) VALVE TEST Switch:

- *L* tests the LH three way valve. With both engines running right pedal will moves forward.
- *R* tests the RH three way valve. With both engines running left pedal will moves forward.

(11) ACTR Pushbutton (guarded):

- *STBY:* at least one PL is below 55º, making the by-pass valve to open, thus connecting the two chambers of the rudder actuator and taking the system out of operation.

- *Pushed-in (OFF light show):* the by-pass valve opens, connecting the two chambers of the rudder actuator and taking the system out of operation.

(12) RUDDER TRIM Selector:

- operates on the actuator used under normal conditions (through the ARTCU).
- *L:* moves the trim tab in such way the movement induced in the rudder makes the aircraft to a left yaw.
- *R:* moves the trim tab in such way the movement induced in the rudder makes the aircraft to a right yaw.

(13) STBY TRIM RUDDER Guard:

- *Raised:* inhibits normal control from the RUDDER TRIM selector switch.

(14) STBY TRIM RUDDER Selector (guarded):

- operates directly on the actuator motor, when used under emergency conditions.
- *L:* moves the trim tab in such way the movement induced in the rudder makes the aircraft to a left yaw.
- *R:* moves the trim tab in such way the movement induced in the rudder makes the aircraft to a right yaw.

(15) TRIM RUDDER Indicator:

indicates the rudder trim tab deflection (in degrees). A green band, from 0º to 1º to the right indicates the normal rudder trim range for take-off.

(16) (IEDS) RTCS AUTO Caution:

loss of ARTCS automatic mode. Use manual mode. The limit expansion function is not available.

(17) (IEDS) RTCS MAN Caution:

loss of ARTCS manual mode. The limit reduction function will not be available. The rudder travel stops will be at their last values.

(18) (IEDS) RTCS EXP Caution:

the limit function has failed.

(19) (IEDS) RUD HT Caution:

failure of the selected heating system of the Rudder Booster.

(20) (IEDS) RUD TRIM Caution:

the rudder auto trim function has been lost. The normal trim function (by means of the RUDDER TRIM selector, located on the pedestal) may also have failed.

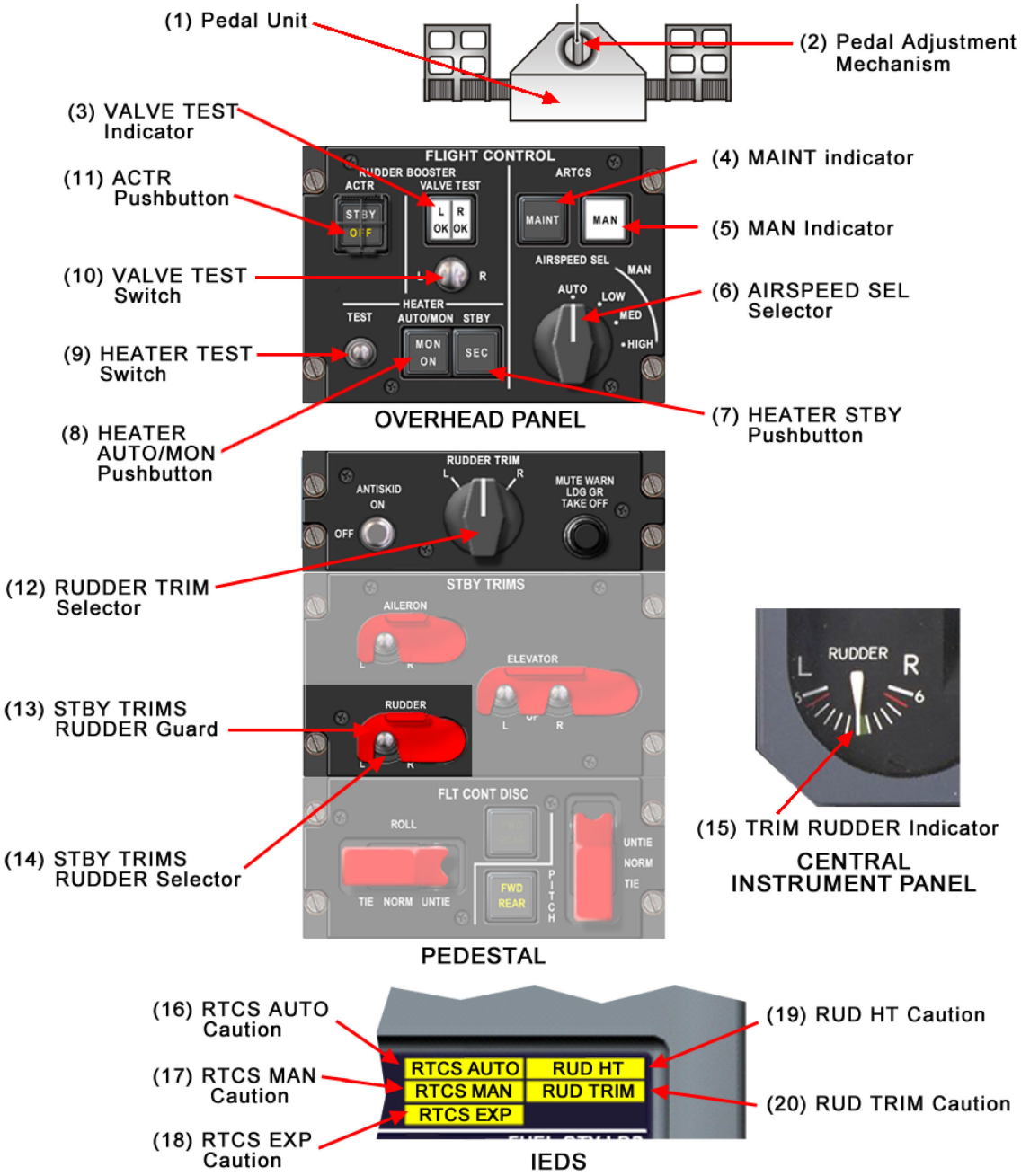

Figure 27-5 Aircraft Rudder Control - Controls and Indicators

PITCH CONTROL

DESCRIPTION AND OPERATION

The elevator control system is a manually operated mechanical system which uses interconnection rods, pulleys and cables to transmit the movement of the control columns through to the control surfaces.

The system has two separate channels: the left channel, from the LH column to the LH elevator surface and the right channel from the RH column to the RH elevator surface. Both channels are connected together by two electro-mechanical interconnection rods. These rods permit the normal operation of both elevators from either of the control columns and enable the channels to be separated if one of them fail. To separate the channels, both interconnection rods need to be disconnected. To operate the channels in synchronization only one of the interconnection rods needs to be connected.

Disconnecting the interconnecting rods allows each channel to be operated independently. The mechanism is disconnected by raising the guard on the PITCH selector switch (on the FLT CONT DISC panel located on the pedestal) and moving it to the UNTIE position. The FWD and REAR lights indicate that the interconnection rods are disconnected (by failure or by action of the PITCH SELECTOR).

Servo Tab

To reduce the strain on the columns, each elevator surface incorporates a servo tab in its trailing edge which is actuated mechanically by the elevator deflection. These tabs work in such way that when the elevator moves up or down, the relevant servo tab is moved in the opposite direction by the control interconnection rods.

Trim Tab

Each elevator surface has a trim tab located in its trailing edge. Trim tabs are operated electrically to compensate the control movement as required. The trim tab is an aerodynamic surface which is attached to the elevator by a hinge. It is connected to the elevator by a pair of control interconnection rods linked to an electrically operated actuator. Each actuator has two motors, one for normal operation and one (STBY) for emergency use. The normal and STBY control channels are separate. The trim speed varies with the speed of the aircraft.

The motor used for normal operation is controlled by the ARTCU. The ARTCU gives the following pitch control functions and prioresses as described:

– Manual Trimming (from any of the PITCH TRIM selector switches on the control column).
– Automatic Pilot Trimming
– Autotrim

If manual trimming is selected (from the PITCH TRIM selector switches, located on the control column) when the automatic pilot is engaged, the automatic pilot will disengage automatically.

During normal operation, both trim tabs are controlled from either of the PITCH TRIM selector switches, located on the control column. If signals from the C/M-1 and C/M-2 selector switches are different, the signals are inhibited and the trim tab stops moving. These selectors send control signals to the ARTCU, which actuate the normal motors. Also in order to reduce the pilots workload, the ARTCU sends autotrim commands when any of the following circumstances take place while airborne:

– Changes in flap configuration
– Changes of speed
– Power asymmetry or change
– Engine failure on ground.

The auto trim function is inhibited during manual trimming by the flight crew (using the PITCH TRIM selector switches located on the control column), by the automatic pilot or if the guard on the STBY TRIMS ELEVATOR L, R is raised when the stick-shaker is activated. The ARTCU synchronizes the operation of the LH and RH trim tabs.

The ELEV TRIM caution on the IEDS indicates that the auto trim function has not operated. If this happens, normal trim function from the PITCH TRIM selectors, located on the control column, might also have failed.

If there is a failure of the normal channel, trim tabs can be actuated by the standby motors (STBY) and controlled directly by the ELEVATOR L, R selector switches, located on the STBY TRIMS control unit. Both selectors are protected by means of an active guard, which disables the ARTCU and consequently the auto trim function. This enables each selector switch to operate the standby motor of its relevant trim tab. None of the motors are synchronized, therefore it is necessary to synchronize them manually (in order to increase controls effectiveness) by means of the ELEVATOR L, R selector switches, which can be operated either together or separately.

The position of each of the trim tabs is displayed on the TRIM ELEV (LEFT, RIGHT) indicator.

If the control channels have been separated, the trim control stays on.

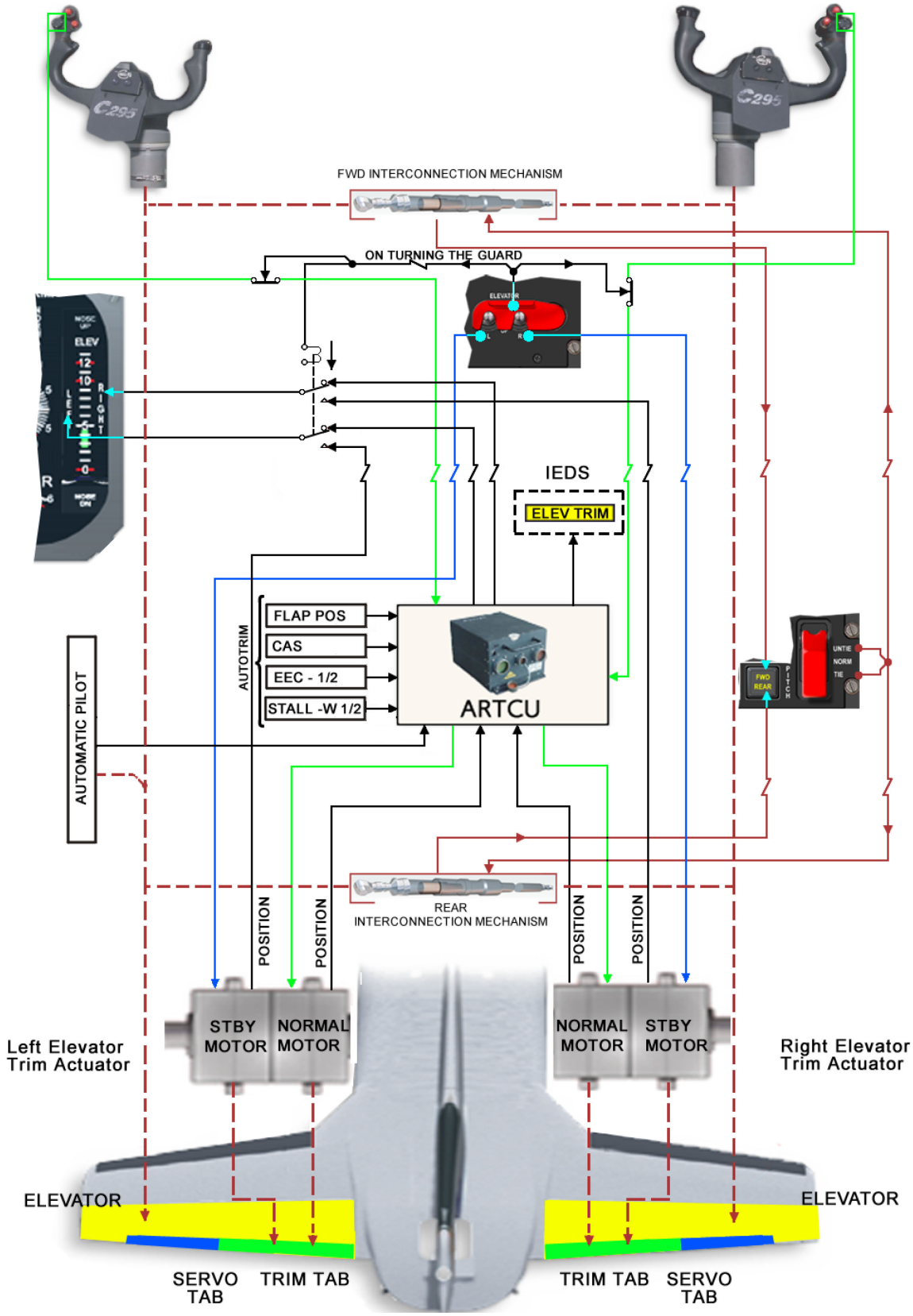

Figure 27-6 Aircraft Pitch Control

Stall Warning and Recovery System (SWRS)

The angle of attack is displayed on two indicators, located on both sides of the instrument panel. The reading is based on the information given by the two angle of attack sensors (each of them has its own built-in computer), located on the outside of the aircraft. From the angle of attack and its rate of change, flap configuration and the wing and tail de-icing boots activating status, the system calculates the angle of attack and activates the stall acoustic warning and the stick-shaker, if exceeded during flight.

The stick-shaker is a device attached to the control column, which warns the pilot that the aircraft is close to stalling by vibrating the control columns. Activation of the system, disengages the automatic pilot.

If, the angle of attack continues to increase after the stall warning, the Stick-Pusher is activated.

The stick-pusher acts on the elevator to pitch the aircraft nose down and thus reducing its angle of attack. The action of the stick-pusher can be overcome mechanically by acting a given force on the control column of 75 lbs, but the system does not disconnect. Once the stick-pusher has come into operation, it does not stop until the angle of attack is below a given value. The system is disengaged automatically (PSHR OFF light on) on the ground or above 215 KIAS if airborne. It comes back, when the aircraft slows to below 210 KIAS. It can only be disconnected with the PSHR DSARM pushbutton (PSHR DSARM light on).

When the wing and tail de-icing boots are selected, the angle of attack at which the stick-shaker and stick-pusher come into operation are reduced (ON light on the SHIFT pushbutton displays). However, after wing and tail de-icing boots are disconnected, the system continues taking this effect into account (in case there is an ice built-up). It is necessary to press-in the SHIFT pushbutton, after checking the aircraft is free of ice (ON light on the SHIFT pushbutton off).

When the 1, 2 SWRS caution displays on the IEDS, the PSHR OFF light comes on (on both SWRS panels, located on both sides of the instrument panel) to indicate that both the stick-shaker on the relevant side, and the stick pusher have not operated.

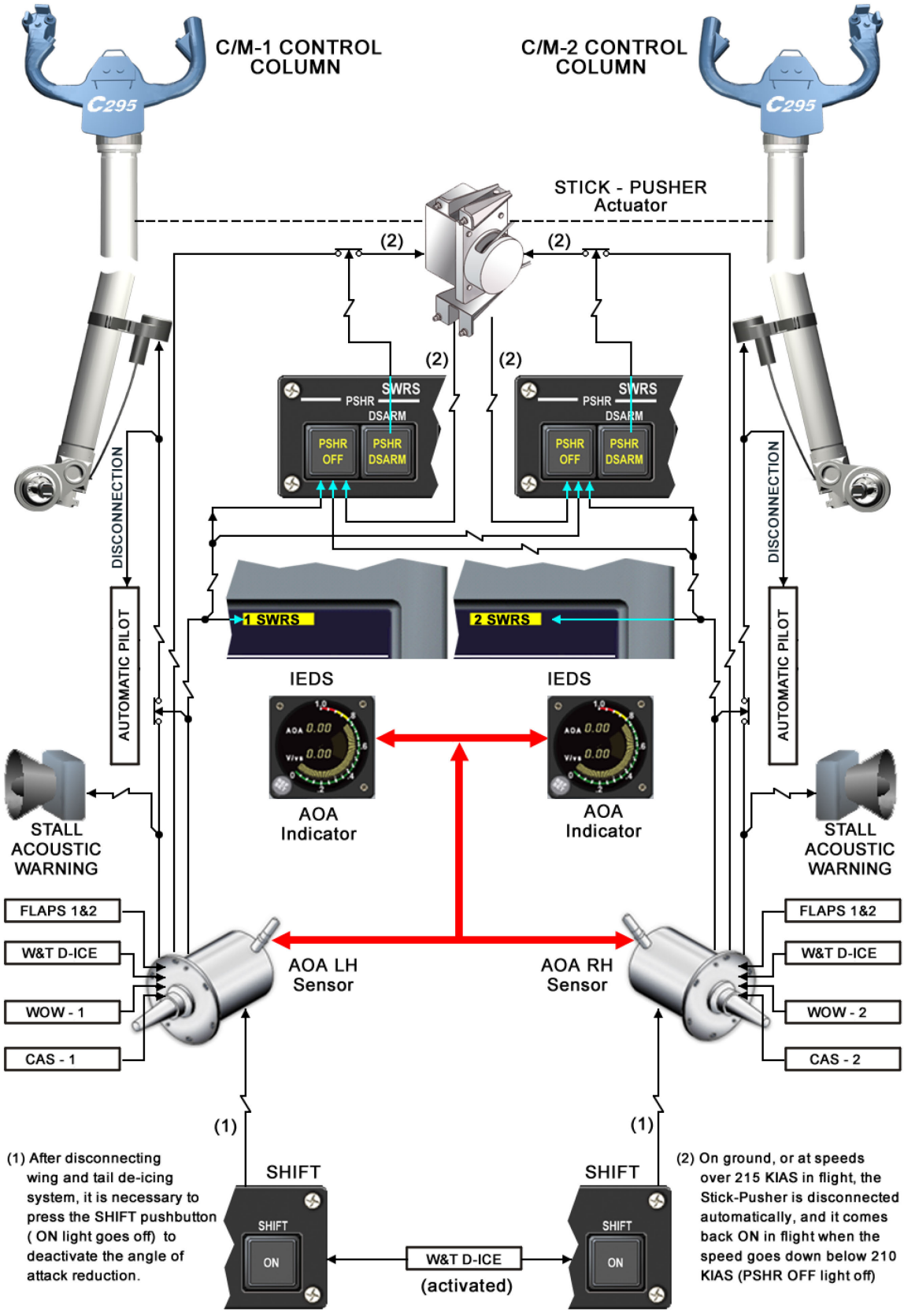

Figure 27-7 Stall Warning and Recovery System.

CONTROLS AND INDICATORS (PITCH CONTROL)

(1) PITCH TRIM Selector:

acts on the ARTCU to control the normal operation motors that are responsible for the trim tab actuators. If the signal from the C/M-1 and C/M-2 selector switches is different, the signal is inhibited and trim stops.

- *Pressing-in and moving-up:* moves the trim tabs so that the movement induced in the elevators pitches the aircraft nose down.
- *Pressing-in and moving-down:* moves the trim tabs so that the movement induced in the elevators pitches the aircraft nose up.

NOTE

If the automatic pilot is engaged, it will disengage when this selector switch is operated.

(2) Control Column:

controls the elevators mechanically.

(3) STBY TRIMS ELEVATOR Guard:

- *Raised:* normal control from the PITCH TRIM selector switches (located on the control column) is disabled as well as the autotrim function.

(4) STBY TRIMS ELEVATOR L, R Selectors:

- *DN:* moves the relevant trim tab (left or right) so that the movement induced in the elevators pitches down the aircraft nose.
- *UP:* moves the relevant trim tab (left or right) so that the movement induced in the elevators pitches aircraft the nose up.

(5) FLT CONT DISC PITCH Selector (guarded):

- *UNTIE:* disconnects the interconnection rods, separating the channels.
- *TIE:* re-connects the two channels of the system through the two interconnection rods.
- *NORM:* normal functioning of the system.

(6) PITCH FWD & REAR Indicator:

- *FWD light on:* indicates disconnection of the front interconnection rod.
- *REAR light on:* indicates disconnection of the rear mechanism rod.

(7) TRIM ELEV Indicator:

indicates trim tabs deflection (in degrees). The limit values are 12.5º NOSE UP and -0.5º NOSE DOWN. A green band, from 2.5° to 4.5° NOSE UP, indicates the normal longitudinal trim range for take-off (beyond this green band the UNSAFE TAKE OFF condition will displays).

- *LEFT:* indicates left trim tab deflection.
- *RIGHT:* indicates right trim tab deflection.

(8) (IEDS) ELEV TRIM Caution:

the elevator autotrim function has been lost. Normal trimming (by means of the PITCH TRIM selector, located on the control column) may also have failed.

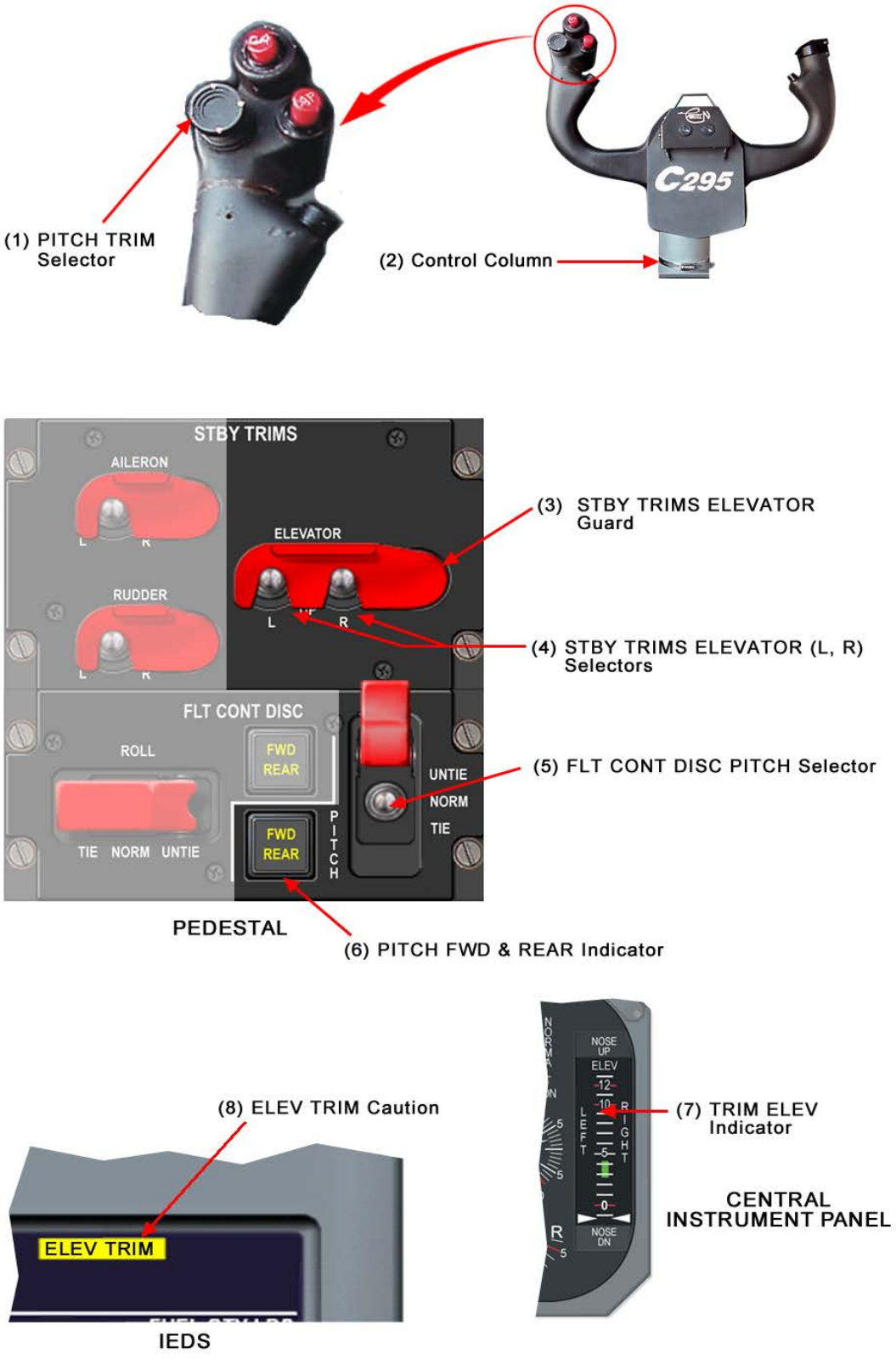

Figure 27-8 Aircraft Pitch Control - Controls and Indicators

CONTROLS AND INDICATORS (SWRS)

(1) PSHR OFF Indicator (two):

- *ON:* stall recovery system is inhibited while aircraft is grounded, or airborne above a 215 KIAS, or due to a system failure.

(2) PSHR DSARM Pushbutton (two):

- When either pushbutton is pushed-in, the stall recovery system is inhibited and both PSHR DSARM lights come on.

(3) SHIFT Pushbutton (two):

- *ON light on:* the angles of attack at which the stall warning (stall acoustic warning and stick-shaker) and stall recovery (stick-pusher) systems are activated, have been reduced. Because the wing and tail de-icing boots have been set to on. Switching the wing and tail de-icing boots off do not make the light going off.
- *Pressed-in (ON light off):* the angles of attack at which the stall warning (stall acoustic warning and stick-shaker) and stall recovery (stick-pusher) systems are activated will have been returned to their normal values, if the de-icing system has previously been switched to off.

(4) SWRS MAINT Indicator (#1, #2):

- *ON:* no failure in operation, but maintenance is required.

(5) SWRS MAINT (TEST) Switch:

- *TEST:* test the SWRS system (bell, AOAs, stick-shaker and stick-pusher). Only available on ground.

(6) (IEDS) 1, 2 SWRS Caution:

stick-pusher has failed (PSHR OFF light on).

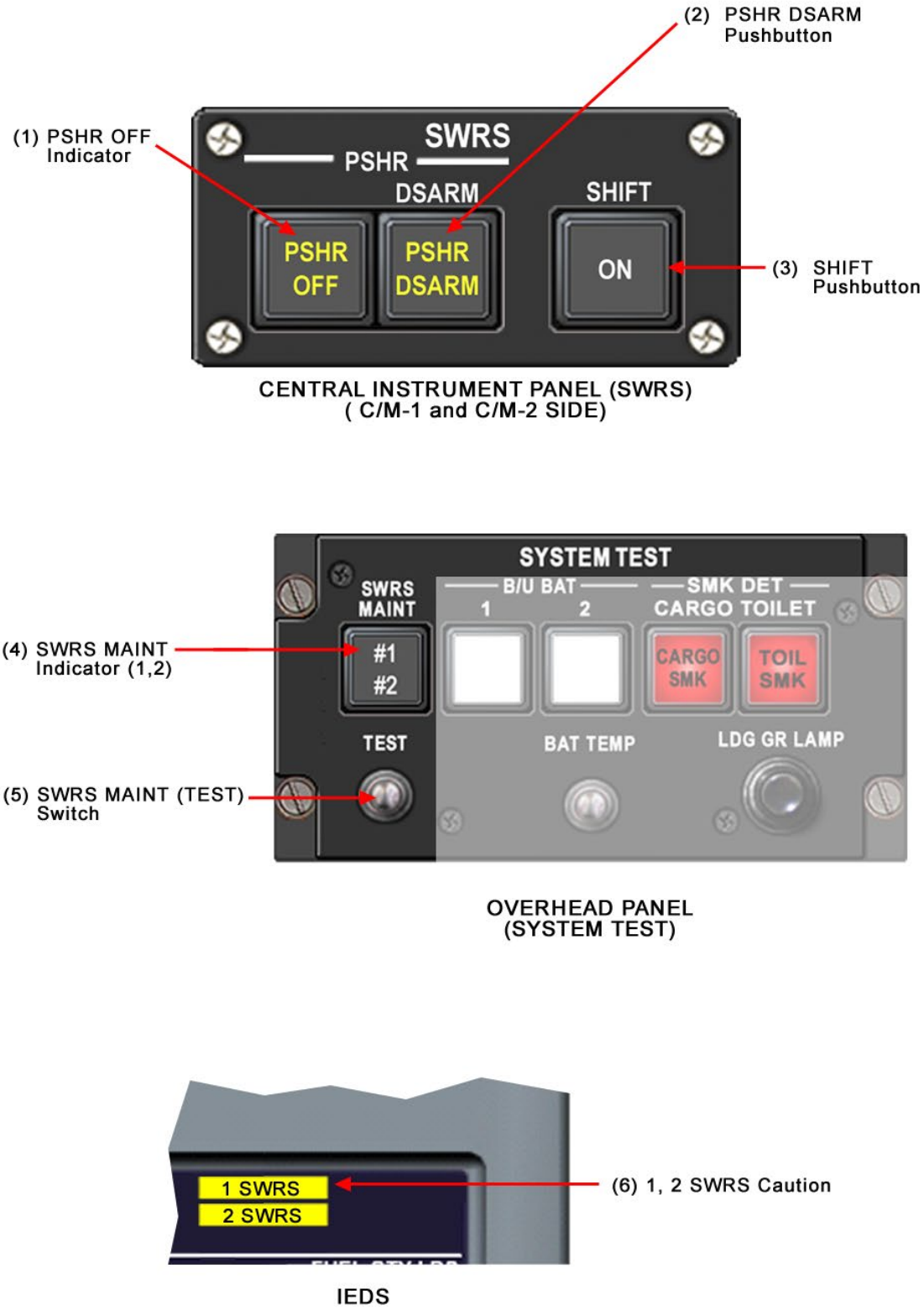

Figure 27-9 Stall Warning and Recovery System (SWRS) - Controls and Indicators

FLAPS

DESCRIPTION AND OPERATION

The flap system has two inner flap surfaces and two outer flap surfaces. Both of them mounted symmetrically on the trailing edge of the wings.

When the pilot moves the FLAPS lever to the desired position, an electrical signal is sent to the Flap Validating Unit (FVU). This signal is valid when:

- At least one hydraulic pump is running
- Pressure at the hydraulic system is over 1000 PSI.

If the signal validating conditions are met, the FVU will send the electrical signal to the Flaps Electronic Control Unit (FECU). if the validating conditions are not met:

- FECU signal will be the flap selection prior signal
- FLAPS SEQ light comes on.

The FLAPS SEQ light will go off when the FLAPS lever is positioned according to the flap position indicator.

The signal received by the FECU is sent to the Flap Power Unit (FPU) to extend or retract the flaps by means of eight mechanical actuators.

At each wing, actuators are driven by a shaft, the final section of which incorporates a brake and a potentiometer. Each potentiometer sends an electrical signal (feedback) to the FECU. The signal gives the true position of the flaps and indicates direction and rotation speed of each shaft. A part of the FECU (Comparison Module) compares the signals received from the two potentiometers with one another and with the signal received from the FLAPS lever to produce the following actions:

- If the position requested by the FLAPS lever differs from that indicated by its potentiometers (flap change request), signals will be sent to the FPU hydraulic motor in order to move it in the appropriate direction until the control and feedback signals are the same.
- The signal sent to the flaps indicator is the average signal of both potentiometers

The FECU will also activate the FLAP ASYM warnings on the IEDS, cut off the movement of the FPU and brake the shaft if:

- Signals from the potentiometers indicate a significant difference between position of the flaps on one wing and the other (flap asymmetry), or:
- Drive shafts move incorrectly (either incorrect direction of turn or excess velocity), or:
- Drive shafts turn without being ordered to do so, or:
- Shafts fail to move when ordered.

In case of any of these failures (FLAP ASYM warning activated), it will not be possible to re-connect the system using the RESET switch on the FLAPS panel.

The potentiometers send the flap position signal to the ARTCU which compares it with the speed signal, in such that if the aircraft speed is greater than the flap extension speed (V_{FE}) relevant to the real flap position, the V_{FE}, light will come on, but flap actuation will not be inhibited.

The FECU will also activate the FLAP FAIL caution on the IEDS if there is a failure different from those described before. If only the FLAP FAIL caution is displayed, it will be possible to re-connect the system using the RESET switch on the FLAPS panel.

A self-test device enables the correct functioning of the system to be checked by means of the FLAPS BITE pushbutton with the aircraft grounded and flaps at 10º (FLAPS lever in the T/OFF position and FLAPS indicator in the TO position) or at 15º (FLAPS lever in APPR and FLAPS indicator in APP).

Finally, the FECU comparison module also activates the UNSAFE TO and GEAR UP warnings on the IEDS when the relevant conditions are met (Refer to CHAPTER 31 - INDICATING AND RECORDING, and CHAPTER 32 - LANDING GEAR, respectively).

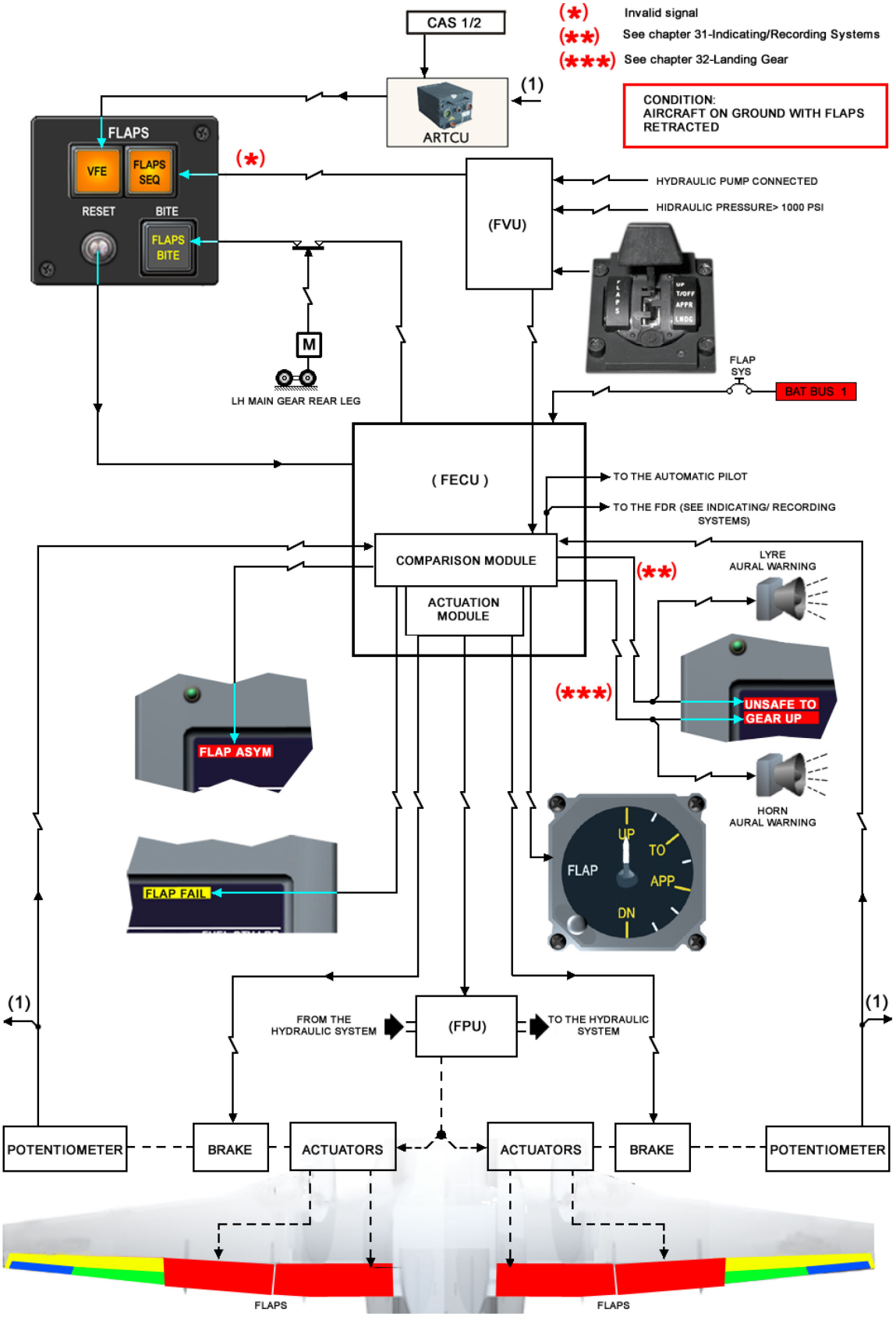

Figure 27-10 Flaps

CONTROLS AND INDICATORS

(1) FLAPS Lever:

moves the flaps to the selected position, if hydraulic pressure is available. The flap position is validated in the FVU. It has four slotted positions to stop the lever travel and check the speed according to the flap position:

- UP
- T/OFF
- APPR
- LNDG

(2) V_{FE} Indicator:

- On: flap selection has been made at a speed higher than the recommended one.

(3) FLAPS SEQ Indicator:

- On: flap selection has been made with no hydraulic pump on, or with a hydraulic pressure below 1000 PSI.

(4) FLAPS BITE Pushbutton:

- Pressed-in momentarily (FLAPS BITE light on): With the aircraft grounded and flaps at 10º (FLAPS lever in the T/OFF position and the FLAPS indicator in the TO position) or at 15º (FLAPS lever in the APPR position and the FLAPS indicator in the APPR position), it checks the FECU circuits, displays the FLAP FAIL caution and the FLAP ASYM warning on the IEDS, sets to On the FLAPS SEQ, and FLAPS BITE lights. The pointer of the FLAPS indicator will also jump.

(5) Flaps RESET Switch:

- RESET: allows the FECU to be re-activated after it has been locked by a signal failure (FLAP FAIL caution). If the failure also caused the FLAP ASYM warning, the system cannot be Re-activated.

(6) FLAPS Indicator:

shows the position of the flaps. Indicator marks are:

- UP (0º)
- TO (10º)
- APP (15º)
- DN (23º)

This indication is the arithmetic mean of the signals as received by the FECU from the potentiometers. DN position corresponds to LNDG on the FLAPS lever.

(7) (IEDS) FLAP ASYM Warning:

there is an asymmetry between the flaps on one wing and the other, or there has been an unrequired movement of the drive shafts, or the shaft did not move when it is required to. It also displays if the turning direction is not correct, or if the drive shafts turn too fast.

(8) (IEDS) FLAP FAIL Caution:

failure of Flap System.

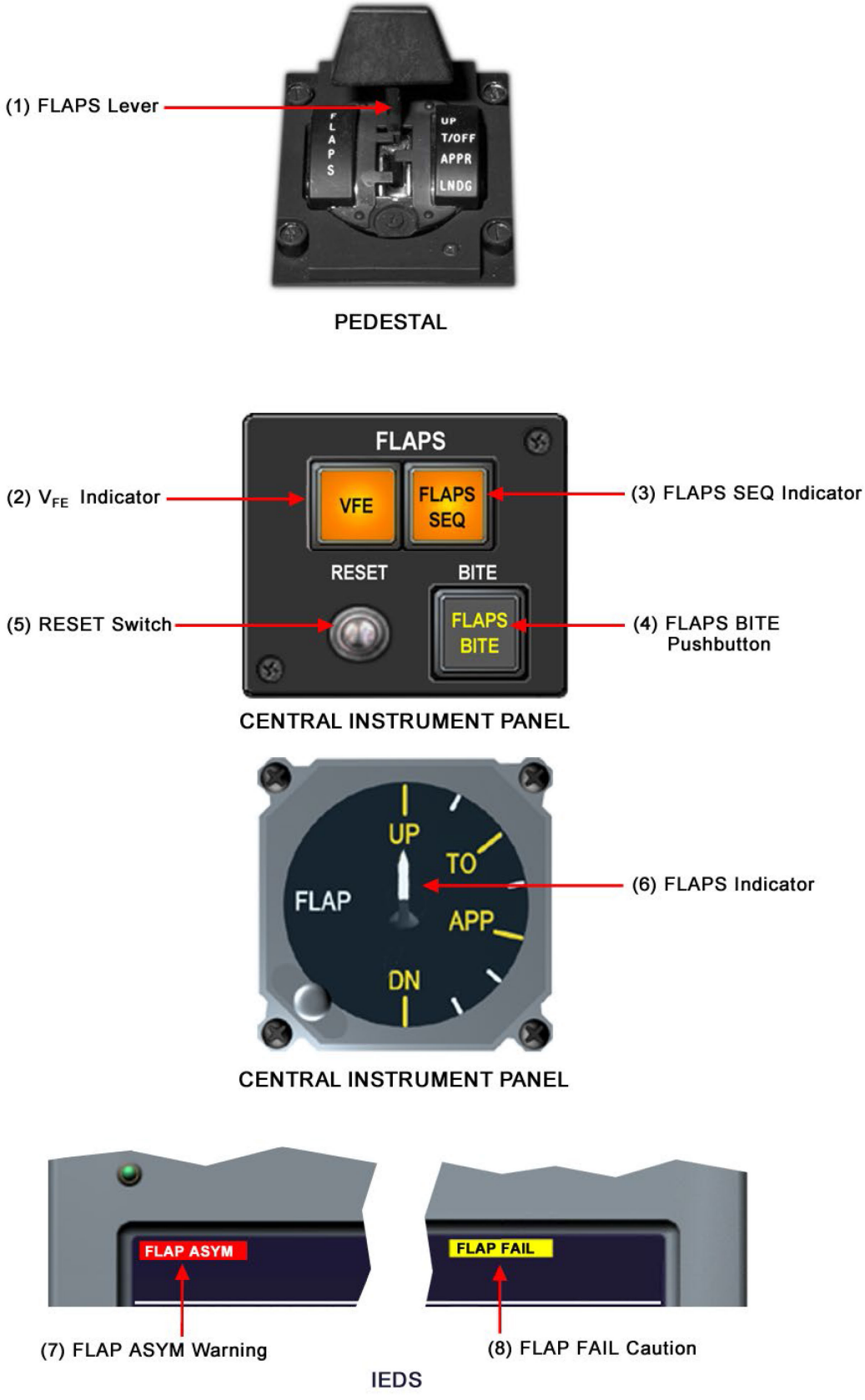

Figure 27-11 Flaps - Controls and Indicators

GUST-LOCK SYSTEM

The purpose of this system is to lock the flight controls in a neutral position to avoid damage by sudden movements caused by gusts while the aircraft is grounded.

DESCRIPTION

Primary flight surfaces are locked by pins which lock particular quadrants of the actuation circuits to prevent movement of the control surfaces. These pins are operated mechanically from the gust-lock lever on the pedestal.

Pins are spring-loaded to prevent the control channels from being locked if the transmission cable from the lever breaks.

In the vertical position the gust-lock lever also restricts the throttle levers from being moved forward to a position that prevents the propeller brake from working fully (refer to CHAPTER 71 - POWER PLANT). Once the lever has been lowered in order to initiate flight, it prevents the cross-feed valve from being opened and thus avoids both air-conditioning packs being powered from just one engine (refer to CHAPTER 36 - PNEUMATIC). In the vertical position, it also allows the propeller brake to be activated (refer to CHAPTER 71 - POWER PLANT).

CONTROLS AND INDICATORS

(1) Unlock pushbutton:

releases the gust-lock lever (from its vertical position).

(2) Gust Lock Lever:

putting the flight controls in the neutral position and moving the gust-lock lever to the vertical position, locks the primary flight controls (ailerons, elevators and rudder). In the vertical position, restricts the movement of the throttle levers and allows operation of both the cross-feed valve and the propeller brake.

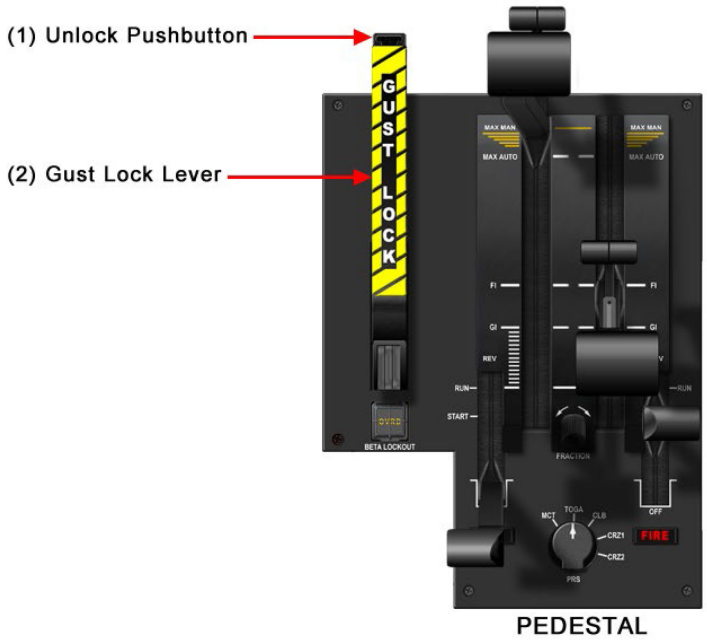

Figure 27-12 Gust-Lock System - Controls and Indicators

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