SECTION 6-8

FLIGHT CONTROLS

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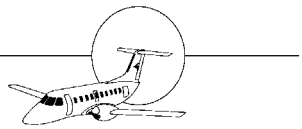
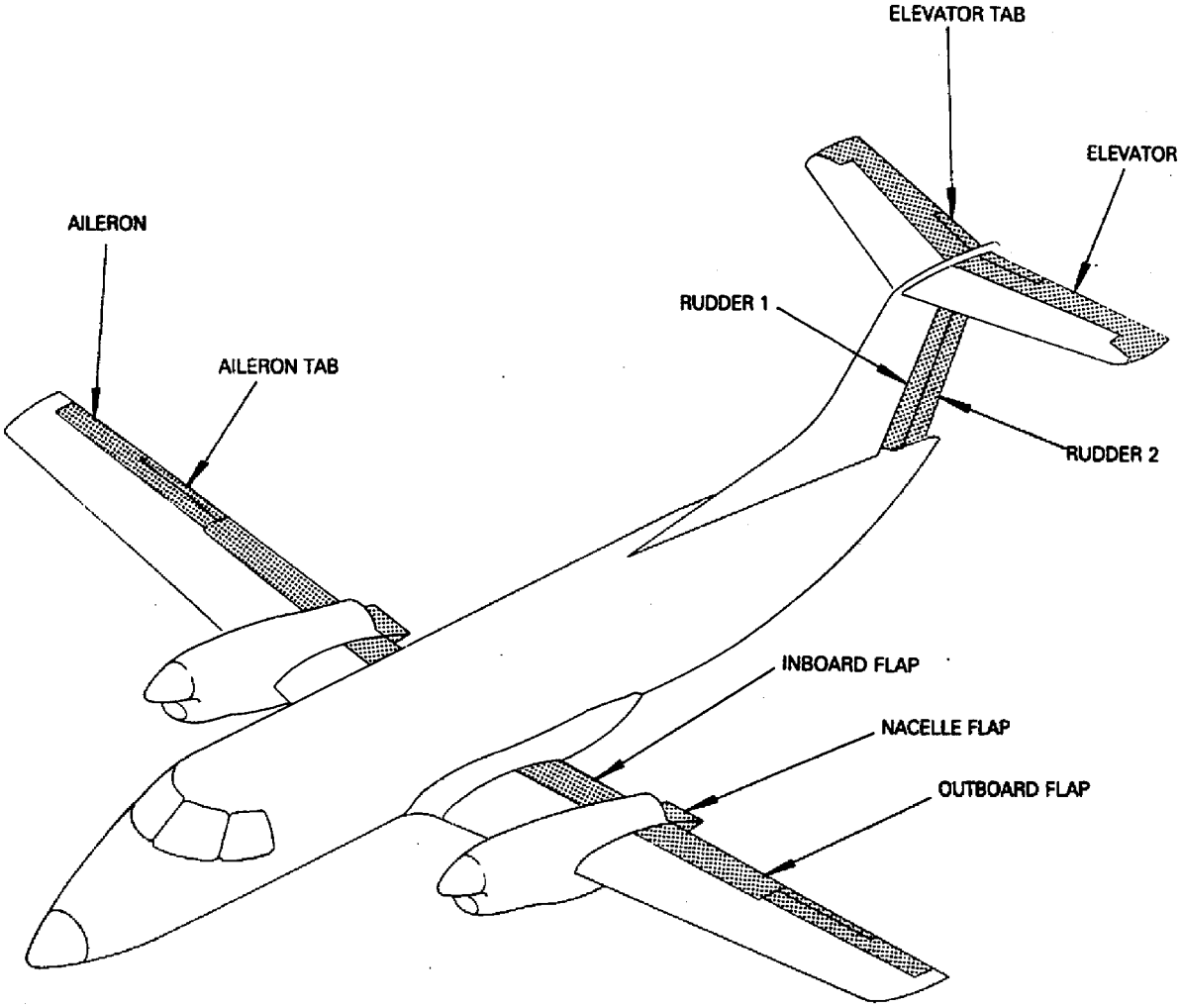
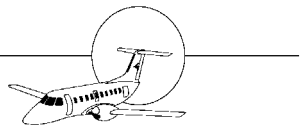


GENERAL DESCRIPTION

The primary flight control system consists of ailerons, elevators, and rudder. The ailerons and elevators are mechanically actuated. The rudder is hydraulically powered and may also be mechanically actuated in manual reversion mode in case of loss of both hydraulic systems.
The primary flight surfaces are operated by control wheels, columns and rudder pedals by the pilot and copilot.
The pilot's and copilot's controls are mechanically interconnected, and in case of one single system failure, the aileron and elevator control systems may be disconnected by the pilot and copilot, allowing operation by only one system.
The gust lock system protects the aileron and elevator control surfaces against gust condition on the ground. The rudder control surfaces are provided with hydraulic gust damping, when unpowered.
The flaps and trim tabs are considered secondary flight surfaces. The flap system is divided into three flap panels per wing, each panel being actuated by a hydraulic actuator.
The elevator and aileron tabs are adjusted by means of trim wheels installed respectively on the control stand and aft panel. The rudder trim is hydraulically powered and adjusted through of the trim wheel installed on the aft panel.



FLIGHT CONTROL SYSTEMS



RUDDER SYSTEM

GENERAL

Directional control is provided by a rudder, which consists of two panels, arranged in tandem. Two hydraulic actuators drive the forward panel, one of them powered by the green hydraulic system and another powered by the blue hydraulic system. The aft panel is hinged to the forward panel and linked to the fin through a rod at the top bottom.

Aft panel deflection is proportional to the forward panel.

The rudder's mechanical system is fully duplicated, consisting of cables, which connect the pedals in the cockpit to the forward panel. The left side pilot and the right side pilot rudder pedals are interconnected through a rod under the cockpit floor.

A Power Control Unit (PCU), installed in the vertical fin, is supplied by both hydraulic systems. It transforms pedal movements into rudder deflection. It also incorporates a device to trim the rudder and another to feed back the loads providing an artificial force increase proportional to rudder deflection.

In case of both hydraulic system failure, the PCU automatically reverts the rudder system to mechanical mode.

The rudder control system incorporates an electrical control circuit, which receives both signals from pressure switches and airspeed indicator in order to provide proper system operation according to airplane airspeed.

SYSTEM OPERATION

Two valves installed at the PCU isolate the respective actuator. A switch located at the rudder control panel commands these valves and permits operations with one or both actuators powered by the green or blue hydraulic systems in any flight phase flight.

The rudder system may be operated by three modes:

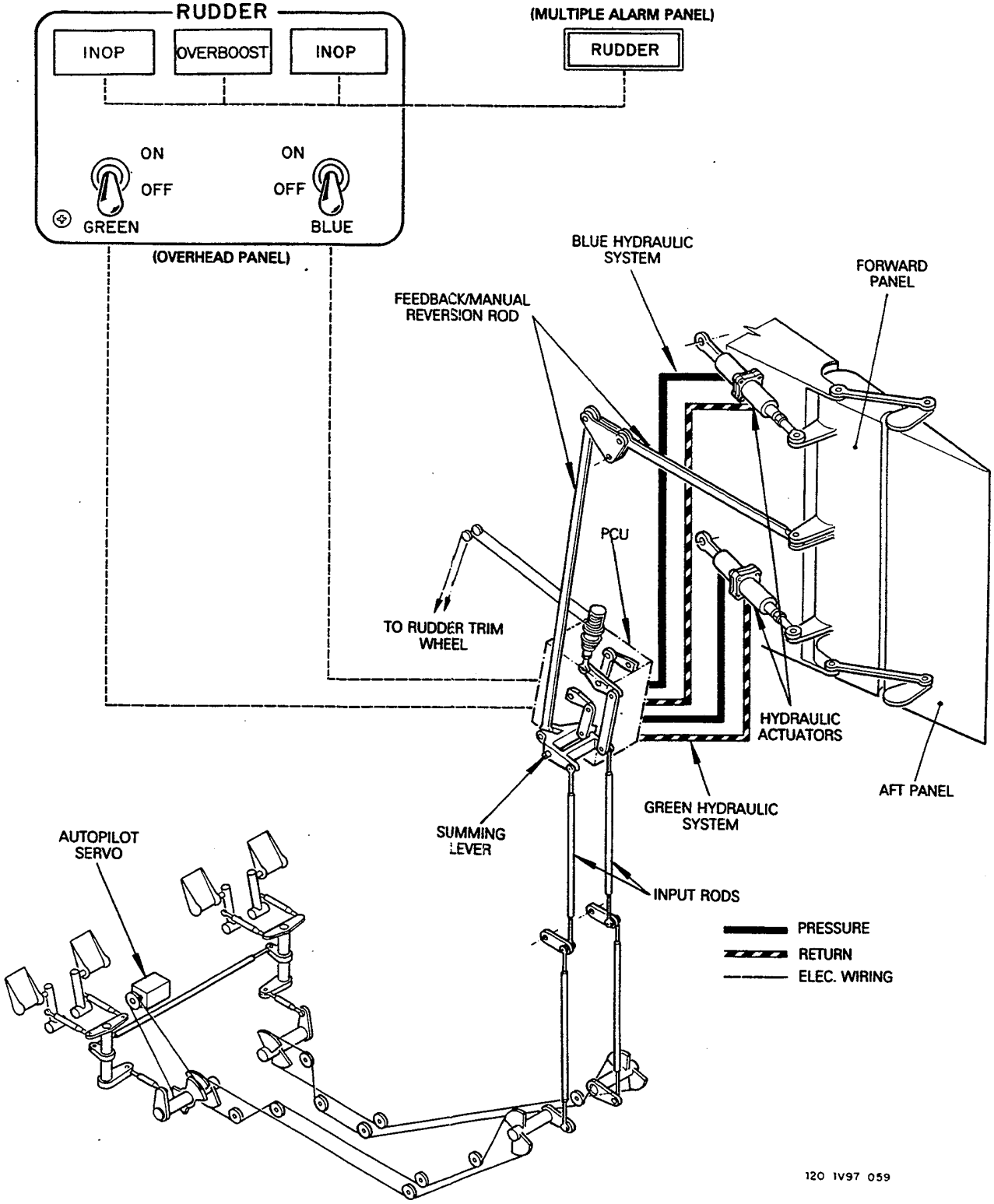
1. Powered by Both Hydraulic Systems

   When airspeed is below 120 KIAS, the rudder is powered by both hydraulic systems.

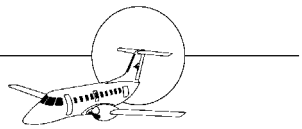
2. Powered by One Hydraulic System

   When airspeed is above 120 KIAS, the rudder is powered by the blue hydraulic system. The PCU automatically isolates the hydraulic fluid flow to the actuator powered by the green hydraulic system.

   In this case, no indication of this automatic selection is given to the pilots. A single actuator is enough to provide efficient rudder operation at all speeds.



RUDDER ACTUATION SYSTEM



3. Mechanical Reversion Mode

   The rudder system may be mechanically operated in case of loss of both hydraulic systems or by selecting both isolation switches to OFF. In this case, both INOP lights will be illuminated at the rudder control panel and the light RUDDER will illuminate at the multiple alarm panel. The pilot's effort is transmitted directly to the rudder surface through the feedback rod. For this reason, no trimming is available and the pilot has limited controllability since the external forces will limited the rudder deflection.

Above 120 KIAS, in the event of losing the blue hydraulic system, or the isolation switch of the actuator powered by the same hydraulic system is manually positioned to OFF, the actuator powered by the green hydraulic system takes over rudder power. No indication of this event will be shown to the pilot.
Failure of the blue hydraulic system will be indicated only when airspeed is reduced below 120 KIAS, by the illumination of the INOP light on the rudder control panel and RUDDER light on the multiple alarm panel. In case of automatic transfer from the blue to green hydraulic system occurs, and the blue recovers its normal function, it is recommended that the pilot reset the rudder system, positioning either isolation switch to OFF and afterwards the green to ON. Another way to reset the rudder system is reducing the airspeed below 120 KIAS and accelerating again.

NOTE: In case one engine is shut down, and the respective electrical hydraulic pump is turned OFF or has failed, residual pressure on the hydraulic line caused by windmilling can disturb the automatic transfer. In case of no transferring, the pilot must turn the switch on the proper side (respective shut down engine) to OFF, to allow the system transfer.

In the event of airspeed signal disagreement, the RUDDER SPEED SW light, on the multiple alarm panel, will illuminate and the pilot must turn the GREEN switch at the rudder control panel to OFF. It will inhibit the actuator powered by the green hydraulic system.
If, for any reason, both actuators remain pressurized above 120 KIAS, the OVERBOOST light will illuminate at the rudder control panel and the light RUDDER will illuminate at the multiple alarm panel. In this case the GREEN switch must be positioned to OFF at the rudder control panel to avoid system damage.

GREEN SYSTEM INOPERATIVE LIGHT (AMBER)

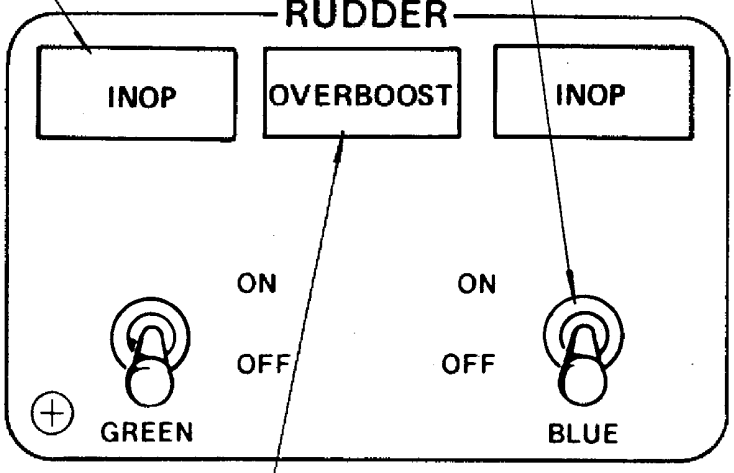
ILLUMINATED – When corresponding switch is in OFF position or when the system is depressurized below 120 KIAS, it illuminates in conjunction with the RUDDER light in the multiple alarm panel.

NOTE: Both INOP lights will only be illuminated above 120 KIAS if both rudder systems become depressurized.

BLUE SYSTEM ISOLATION SWITCH

ON – Blue hydraulic system pressure is supplied to the rudder powered system.

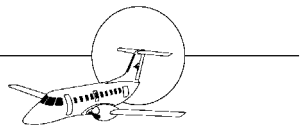
OFF – Hydraulic pressure is shut off.



OVERBOOST CAUTION LIGHT (AMBER)

ILLUMINATED – If, for any reason, both hydraulic actuators remain pressurized above 120 KIAS, it illuminates in conjunction with the RUDDER light on the multiple alarme panel.

RUDDER PANEL
(OVERHEAD PANEL)



AILERON SYSTEM

The rolling movement is performed by two ailerons, one installed in each half-wing. The ailerons are mechanically actuated through a duplicated actuation system subdivided into two subsystems (pilot's and copilot's).

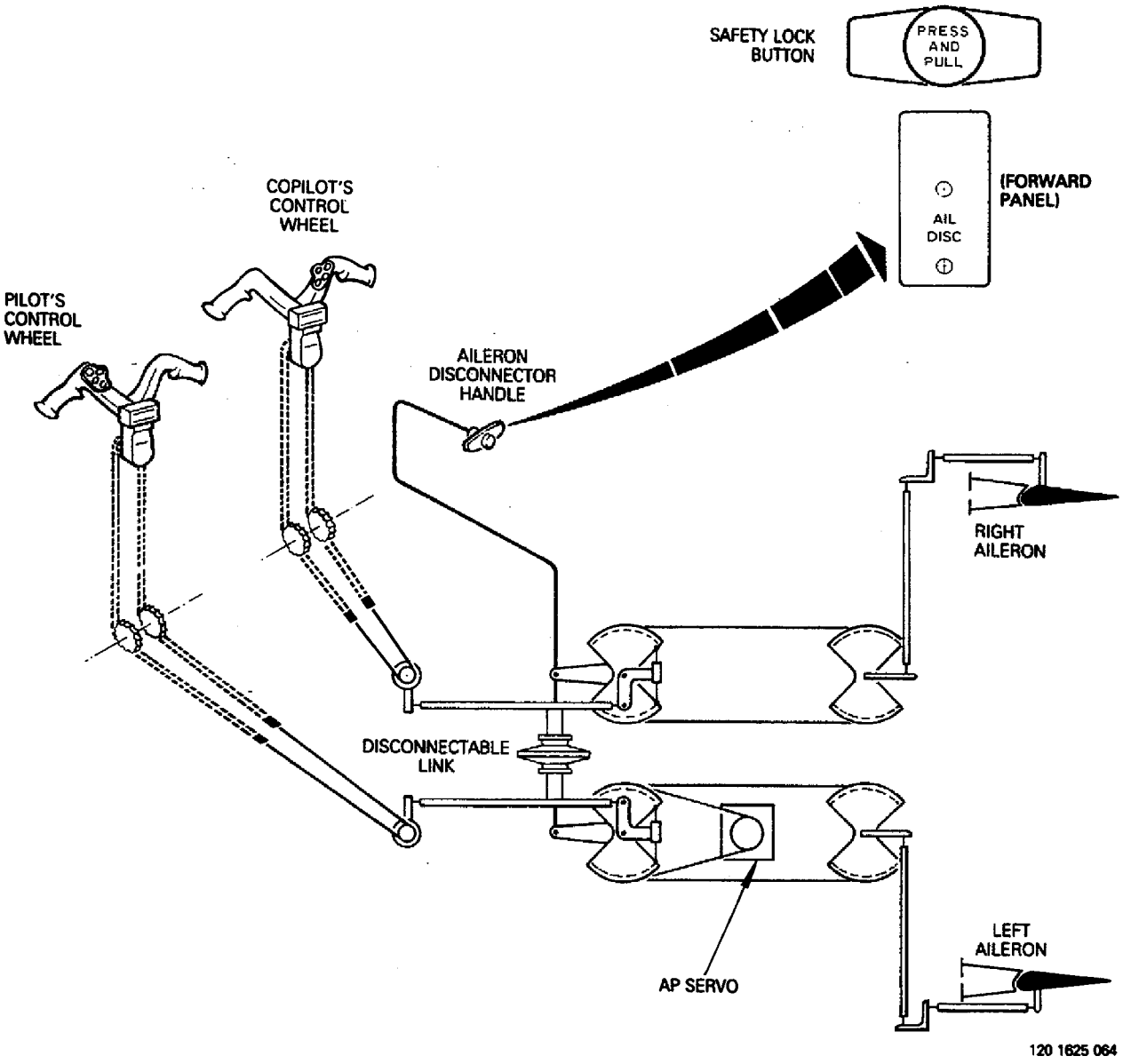
The aileron control subsystems are interconnected through an interconnection shaft. This shaft has a disconnection device installed at its mid length which allows the control subsystems to be disconnected.

The disconnection device is operated by a handle located on the forward panel. To disconnect, it is necessary to press the safety lock button, and pull the handle. Once disconnected, the CONTR DISENG light will be illuminated in the multiple alarm panel, and the controls cannot be reconnected during flight, requiring a maintenance action.

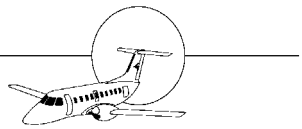
In the event of operating the disconnection, each pilot has authority upon each aileron surface of the associated side.

The ailerons may also be actuated by the autopilot. With the disconnection device actuated, the autopilot will actuate only upon the left aileron control surface.

In the event of aileron failure, the pilots must disconnect the aileron controls. It the copilot's aileron is failed, no trim is available. In this case, greater aileron control forces are expected. Aileron trim is still available if the pilot's aileron control is failed.

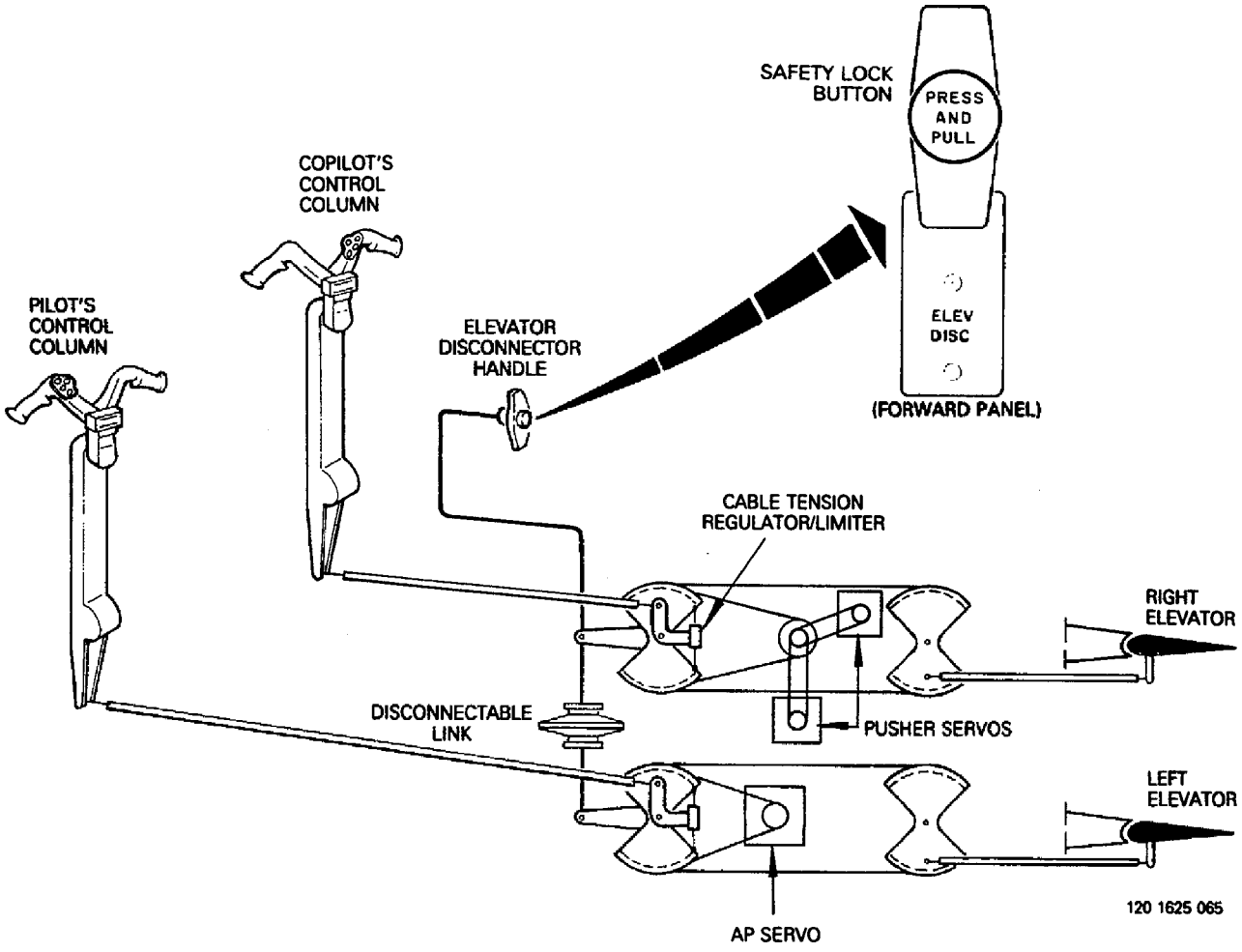


AILERON ACTUATION SYSTEM

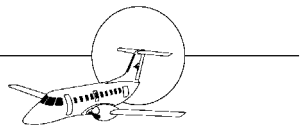


ELEVATOR SYSTEM

The primary pitch control is performed by an elevator which is constituted by two panels (left and right) linked to the horizontal stabilizer through a joint.
The elevators are mechanically actuated through a duplicated actuation system subdivided into two subsystems (pilot's and copilot's).
The elevator control subsystems are interconnected through an interconnection shaft. This shaft has a disconnection device installed at its mid length.
The disconnection device is operated by a handle located on the forward panel. To disconnect, it is necessary to press the safety lock button and pull the disconnection handle. Once disconnected, the CONTR DISENG light will be illuminated in the multiple alarm panel, and the controls cannot be reconnected during flight, requiring maintenance action.
In the event of operating the disconnection device, each pilot has authority upon the elevator surface of the associated side.
The autopilot servo is connected to the left elevator control shaft, and the pusher servos are connected to the right elevator control column. Should the disconnection device be actuated, the servos will actuate only upon the elevator panel of respective side.



ELEVATOR ACTUATION SYSTEM



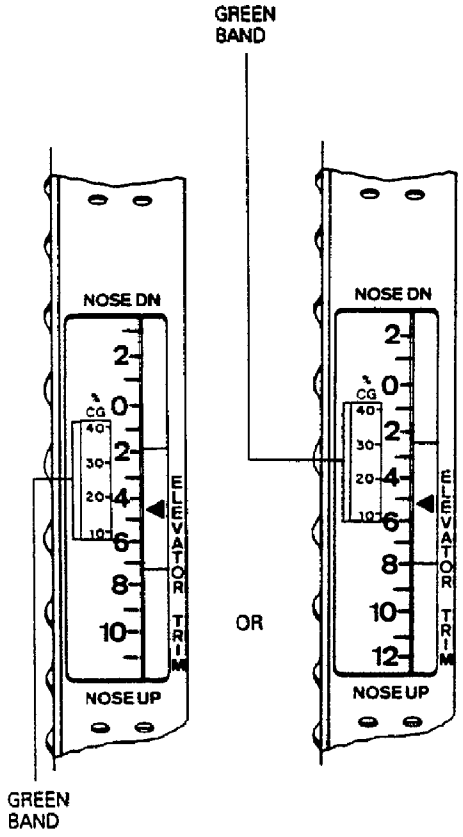
TRIM SYSTEMS

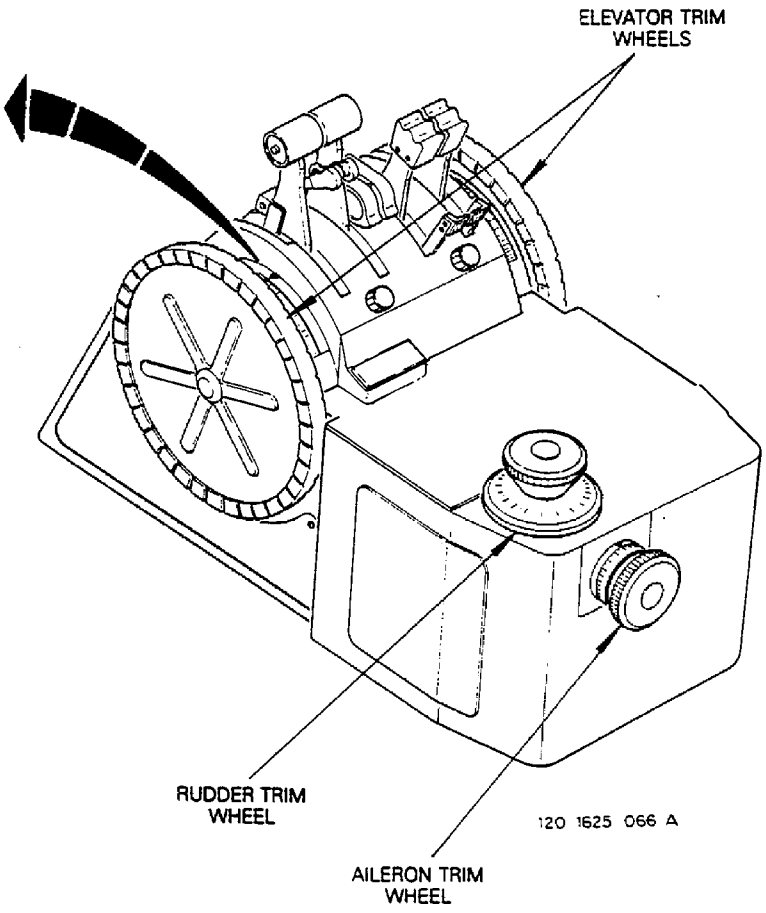
Roll and pitch trimming is accomplished by the aileron and elevator tabs, actuated by irreversible mechanical actuators installed inside each aerodynamic surface.

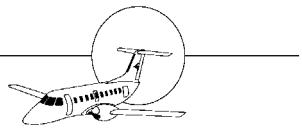
Directional trimming is accomplished through the feel and centering device of the PCU, only when the rudder system is in powered mode.

Roll, pitch and directional trimming are manually controlled from the cockpit, with tab position being displayed at the tab control wheel base.

NOTE: THE GREEN BAND REPRESENTS C.G. LIMITS.
IF, DURING TAKEOFF, THE TRIM IS SET OUT OF GREEN BAND, THE "TAKEOFF TRIM" AURAL WARNING WILL SOUND.







FLAP SYSTEM

SYSTEM DESCRIPTION

The airplane is equipped with three flap panels in each wing, designated as inboard, nacelle and outboard flaps.
All flaps are actuated through hydraulic actuators, one for each flap panel, and their displacement is electronically controlled.
The green hydraulic system supplies the outboard pair, and the blue hydraulic system supplies the inboard and nacelle pair. A selector located at the aft panel commands flap setting. Mechanical detents are provided for the levers at 0°, 15°, 25°, and 45° positions, with a gate stop at the 15° position.

ELECTRONIC SYSTEM CONTROL

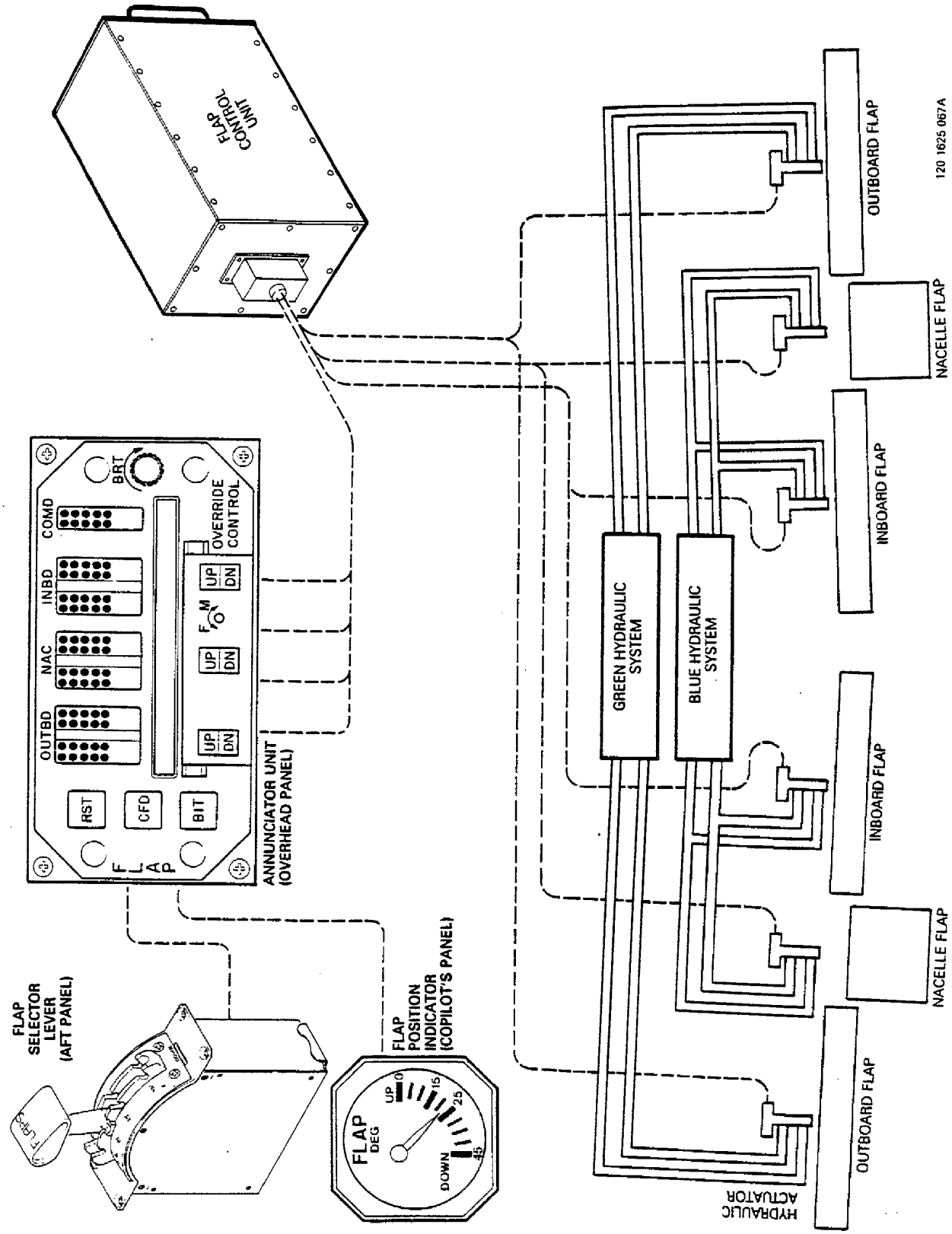
The flaps electronic control system comprises the following main components:

– Flap Position Indication (FPI);

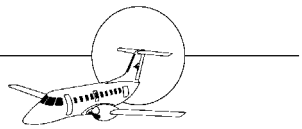
– Flap Annunciator Unit (FAU).

Once the pilot selects the desired flap position on the Flap Selector Lever, the information is transmitted to the Annunciator Unit through three independents control channels. The flap position setting is transmitted to the Flap Control Unit (FCU) that commands the proper actuators. The Annunciator Unit display information about the system's operation by means of light bars, which individually dysplay the position of each flap panel and the selected flap position. This unit is continuously monitoring each flap panel displacement, and also may disengage the normal actuators control.
The Flap Position Indicator is an analog, single pointer instrument that shows the weighted flap displacement average.

NOTE:
- If during takeoff the flap position is not consistent with the approved takeoff setting, the TAKEOFF FLAPS voice message will sound.
- For airplanes equipped with alphanumeric display on the annunciator panel, in case of flap position indicator failure, the alphanumeric display will present the INVALID ANLG IND message.
- On Post-Mod. SB 120-31-0009 aircraft or airframes S/N 120.058, 120.064, 120.066 and on are equipped with the Flap Warning Indication Panel (FWIP), installed on the overhead panel, just below the Flap Annunciator Panel.
  In this case, the faults are also indicated by the ASYMMETRY, DISAGREEMENT or CONTROL FAULT lights.



FLAP ACTUATION SYSTEM



SYSTEM FAULTS

CONTROL FAULT

The control fault is characterized by a failure in any of the Flap Control Unit channels of the Flap Annunciator Unit or in the Flap Selector Lever.
Once a control fault occurs, disagreement output is inhibited to prevent one failure triggering two alarms simultaneously.

Indication:
- FLAP and ADVANCED SWS lights flashing on the Multiple Alarm Panel;
- CONTROL FAULT light illuminated on the Flap Warning Indication Panel;
- CONTROL FAULT indication on the Annunciator Panel's alphanumeric display (if applicable);
- Lights bar of the respective pair flashing on the Annunciator Panel.

When a control fault is detected in any control channels, the respective pair is disengaged. In case of detecting a control fault in the Annunciator Panel or in the Flap Selector Lever, all three pairs will be disengaged.

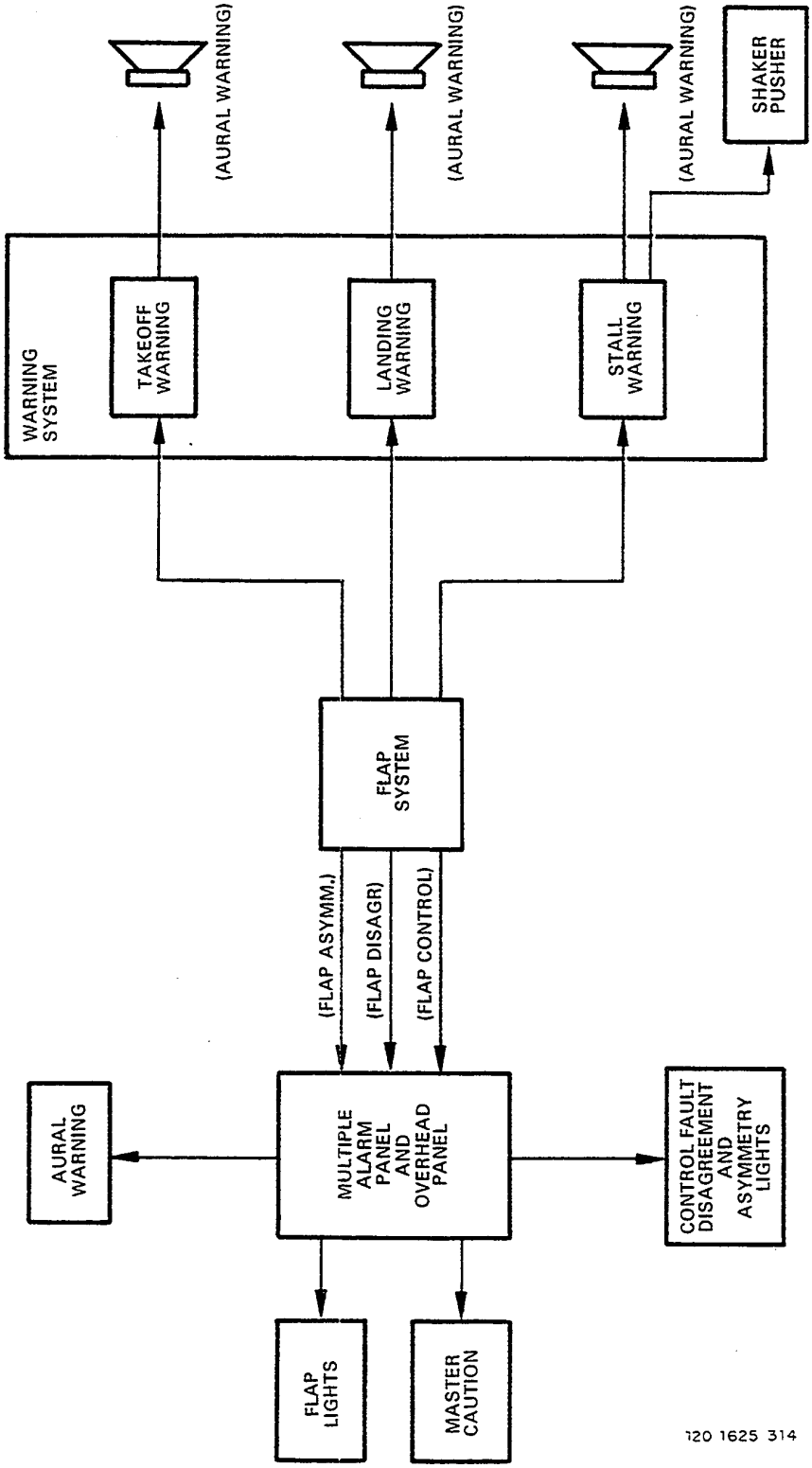
NOTE: In case of flap control fault, the shaker will actuate as if the flaps were set at 45° and the pusher will actuate as if flap were set at 0°.

DISAGREEMENT

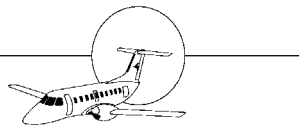
A disagreement is characterized when the difference between two or more pairs is more than 7 degrees.

Indication:
- FLAP and ADVANCED SWS lights flashing on the Multiple Alarm Panel;
- DISAGREEMENT light illuminated on the Flap Warning Indication Panel;
- DISAGREEMENT indication on the Annunciator Panel's alphanumeric display (if applicable);
- All channels lights bars flashing on the Annunciator Panel.

NOTE: In the event of a disagreement failure on aircraft equipped with an alphanumeric display on the annunciator panel, the message DON'T OVRD will also be shown on the alphanumeric display, associated with a flap pair in disagreement. Should more than one message be requires to be shown, they are alternately indicated on the alphanumeric display.



FLAP SYSTEM INTERFACES – SCHEMATIC

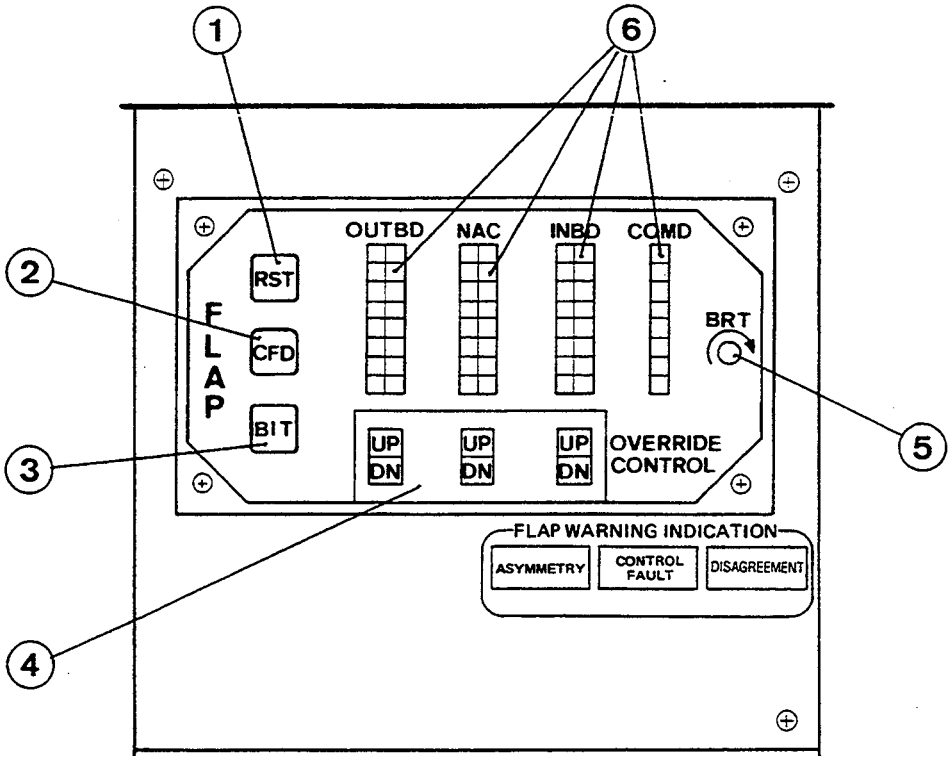


ASYMMETRY

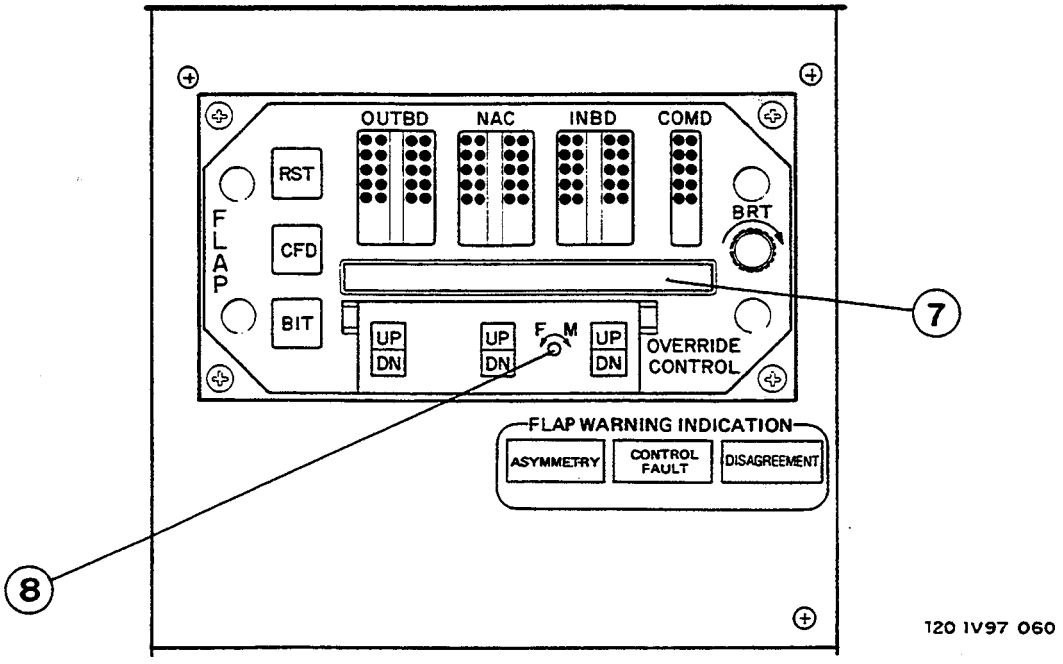
An asymmetrical condition occurs when two flap panel in the same pair differ in position by more than 7 degrees. Once the asymmetry fault has been detected, the system will disengage the affected pair and the disagreement output is inhibited to prevent one failure from triggering two alarms simultaneously.

Indication:
- FLAP light flashing on the multiple alarm panel;
- Light illuminated on the Flap Warning Indication Panel;
- ASYMMETRY indication on the Annunciator Panel's alphanumeric display (if applicable);
- Affected channel light bars flashing.

NOTE: If necessary, the pilot should operate the override switch in order to eliminate the asymmetrical condition. This operation consists in driving the good flap panel toward the malfunctioning flap panel.



FLAP ANNUNCIATOR PANEL VERSION I
(OVERHEAD PANEL)



FLAP ANNUNCIATOR PANEL VERSION II
(OVERHEAD PANEL)

1. RESET (RST) PUSHBUTTON

Pressing the RST pushbutton clears all memories and fault indications, initializes all systems and restarts automatic control.
If the RST pushbutton is pressed after a control fault, the last valid indication will be deleted.
The reset is automatic on application of power.

NOTE:
- The pilots must verify the flap position indicator before pressing the RST pushbutton. The flap position indication may not be valid after the RST pushbutton is pressed.
- The RST pushbutton must be pressed only momentarily, because, if it is pressed continuously, it may lead to an asymmetrical condition, as the flap control unit computer may be controlling a flap system fault.

2. CANCEL FAULT DISPLAY (CFD) PUSHBUTTON

Pressing the CFD pushbutton inhibits bar flashing only.

NOTE: The CFD pushbutton is not functional during BIT (built-in test).

3. BUILT-IN TEST (BIT) PUSHBUTTON

By pressing BIT pushbutton, the built-in test is performed within 3 seconds. The selector lever must be at 0° position. A successfully completed test will be indicated by illumination of all light bars (flashing of the bars is a fault indication) and CONTROL FAULT light, by flashing of the FLAP light on the multiple alarm panel and by END OF BIT message displayed on the Annunciator Panel Alphanumeric Display (if applicable). During the test, the pointer of the flap position indicator moves out of its operational range.

4. OVERRIDE SWITCHES

Three override switches are incorporated to the annunciator panel to individually command each of the flap pairs, bypassing the electronic control. The switches are spring centered, enabling extension or retraction to be overridden.
Override operation in either direction causes power disengagement of automatic control, without losing the true flap position indication in the indicator and light bars.

NOTE:
- A transient fault which does not lead the affected channel to disengage is automatically corrected by the system as soon as its cause ceases. A fault which leads the affected channel to disengage is correctable only by using manual override.
- If necessary, the override switches must be used only to correct an asymmetry fault. The correct action is to drive the good flap panel toward the malfunctioning flap panel.

5. BRT ROTARY SWITCH

This switch is used to control the brightness of the light bars.

NOTE: The Flap Position Indicator and the Flap Selector Lever lighting are controlled through their relevant lighting rotary switch installed on the instrument panel.

6. LIGHT BARS

The Annunciator Panel has 7 green light bar columns which individually display the position of each flap panel and the flap selected position.

7. ALPHANUMERIC DISPLAY (IF APPLICABLE)

The Annunciator Panel has a 16 character alphanumeric display. The purpose for this display is to manage the maintenance mode operation and provide pilot advisory messages in flight.

8. FLIGHT MAINTENANCE MODE ENABLE SWITCH (IF APPLICABLE)

The M position enables the access to maintenance mode.
The F position must be selected for the airplane operation.

NOTE: The annunciator panel alphanumeric display will show the MAINT MODE ENABLE message just after the switch has been selected to M position.