Boeing 707

Flight Controls Introduction

Training manual

For training purposes only
LEVEL 3

ATA 27

Contact address for

course registrations
course schedule information

Aviation Competence Centre
info@aviationcompetencecentre.nl

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ABBREVIATIONS AND ACRONYMS

1. GENERAL.

The primary flight controls are ailerons, elevators, and a rudder.The ailerons and elevators are operated by control tabs and assisted by aerodynamic balance panels. The rudder is normally hydraulically powered and automatically returns to manual operation (through control tabs) with reduced travel if hydraulic pressure is lost.

Spoilers on the upper wing surfaces operate as speed brakes and with the inboard ailerons to augment lateral control. Outboard ailerons, which are locked in the faired position with the flaps retracted, operate with increasing travel as the flaps are extended. Double slotted inboard and outboard flaps, single slotted fillet flaps, and leading edge flaps and slats provide lift and drag control for slow-speed flight. Trim is accomplished through the aileron and rudder control systems and through a variable-incidence stabilizer. The airplane autopilot operates the elevators and ailerons, spoilers, and the stabilizer in the same manner as the pilot.

A stall warning system (stick shaker) is incorporated to shake the control column if the airplane approaches a stall condition in flight.

A takeoff warning system sounds a horn if stabilizer trim, flaps/leading edge devices, or speedbrakes are not in safe condition for takeoff when the No. 3 throttle is advanced.

Gust snubbers, attached to the inboard ailerons and elevators, provide protection against tail winds and gusts eliminating the need for control locks. The rudder power control unit acts as a snubber for the rudder. To prevent gust damage to the outboard ailerons, they should be locked faired by retracting the flaps.

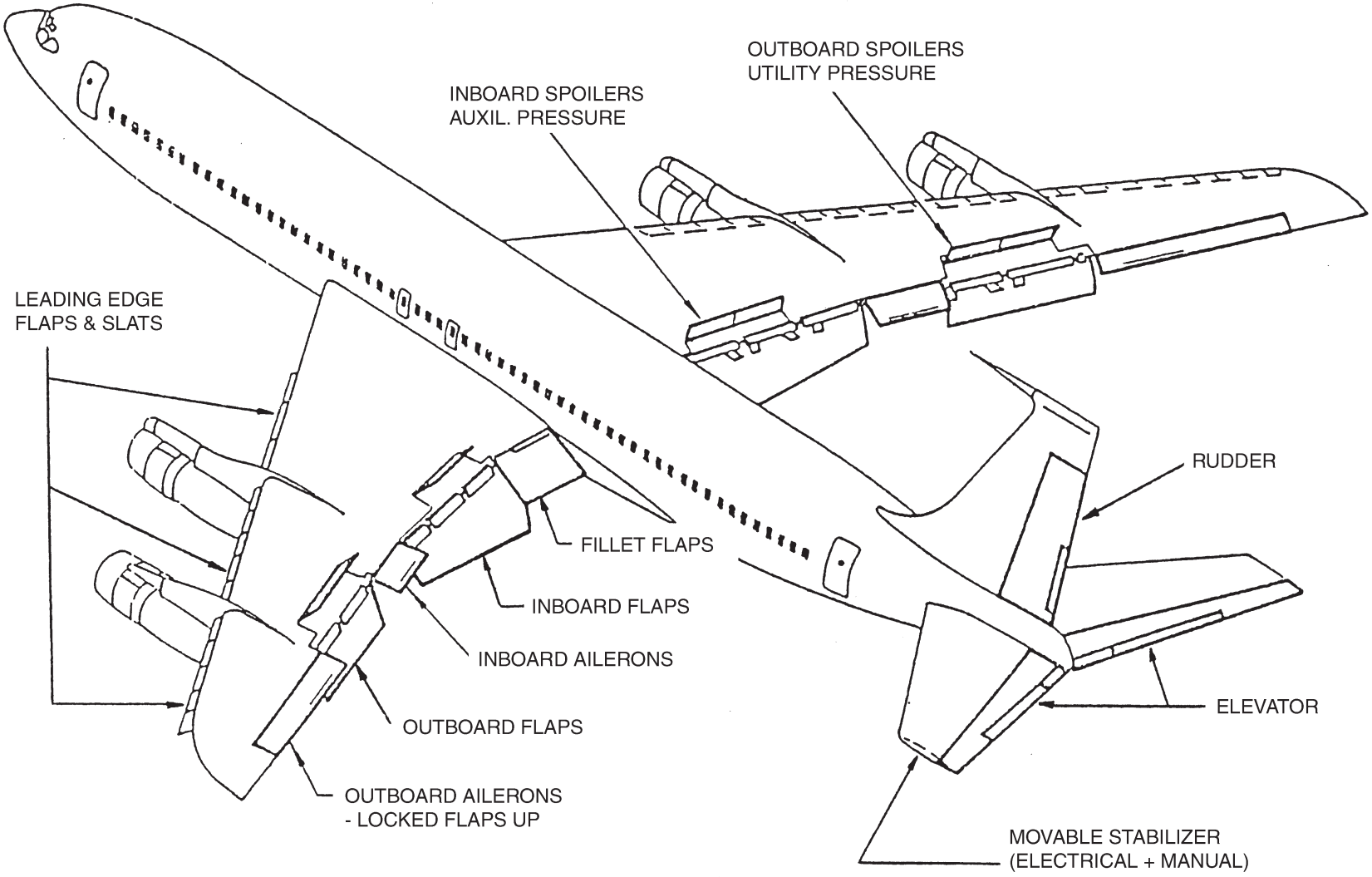
Tab-operated aileron and elevator control surfaces can be checked for full deflection on the ground by stops in the tab control linkages which contact and move the control surfaces after full tab travel. The rudder travel is 13° with boost OFF and 26,5° with boost ON. The rudder tab acts as an antibalance tab when the rudder boost is ON and as a control tab when the rudder boost is OFF.

NOTE: Tailwinds or crosswinds can "load up" the control surfaces so that it becomes difficult to make the normal ground check. This condition is indicated by a partial travel requiring high forces on the control wheel, or rudder pedal (boost OFF). Refer to FLIGHT CONTROLS ABNORMAL OPERATION.

All hydraulically powered flight controls (spoilers, rudder, flaps) can be depressurized by electric motor driven hydraulic bypass valves. This allows isolation of a malfunctioning control and split flap and spoiler operation to change wing lift distribution for pitch trim in the event of a jammed stabilizer. If electrical power fails, the bypass valve remains in the last selected position.

Shear points allow normal operation of essential flight control systems in the event of failure orjamming of related or interconnected secondary systems.

THIS PAGE IS INTENTIONALLY LEFT BLANK



FLIGHT CONTROLS - GENERAL

2. ROLL CONTROL AND INDICATING.

Control Wheel.
When rotated, mechanically positions aileron control tabs and spoiler control valves to control roll attitude of airplane. Full control wheel displacement is 100° either side.

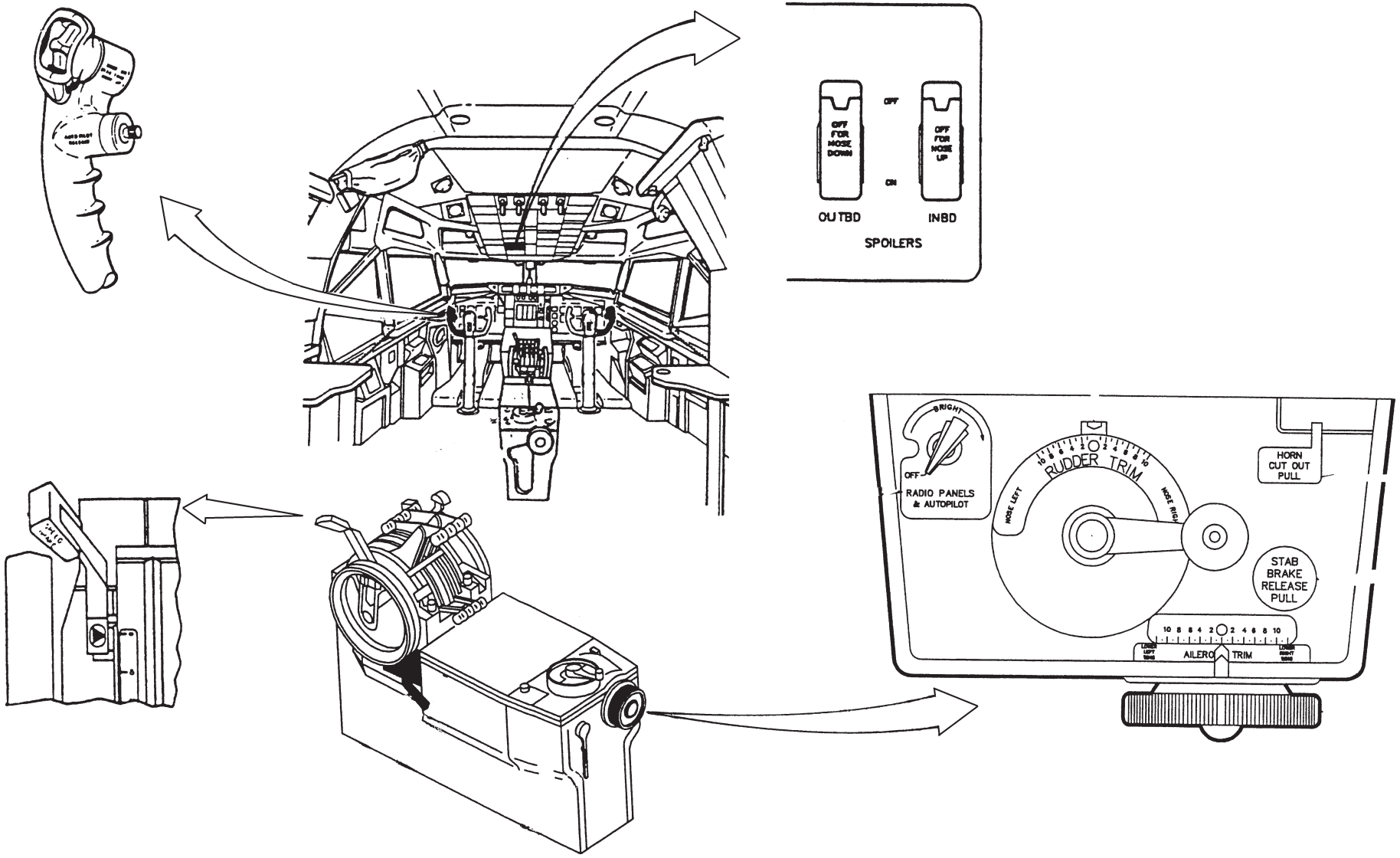
AILERON TRIM Wheel and Indicator.
When rotated, operates aileron control tab linkage to provide lateral trim. Adjacent pointer indicates amount of trim provided on scale. Scale markings are not in any standard units, but index trim units (10 either side).

NOTE: Large amounts of aileron trim result in increased airplane drag because spoilersdeflect with ailerons.

SPEED BRAKE Control Lever.
When pulled in rearward direction, operates spoiler valves mechanically which causes spoilers to deflect. Moving handletofull rearposition deflects spoil ers, fully at airspeeds below approximately 200 KIAS. Intermediate handle positions deflect spoilers the number of degrees shown on scale at handle position. There is a detent at the 300 position. A pressure relief feature “spoiler blowdown” in the spoiler modular package allows spoilers to move down below control handle setting value if air loads on spoilers exceed relief setting.

SPOILERS Switches (Guarded On).
When set to ON, sets spoiler bypass valves for normal spoiler operation.
When set to OFF, INBD switch sets inboard spoiler bypass valve to prevent operation of inboard spoiler, causing nose up. pitching moment if spoilers are deployed. When set to OFF, OUTBD switch sets outboard spoiler bypass valve to prevent operation of outboard spoilers, resulting in nose down pitching moment if spoilers are deployed.

NOTE: When set to OFF, SPOILERS switches set spoiler bypass valves which dump fluid in the spoiler actuators to return. This allows the spoilers to blow down. Stabilizer Trim Control Switches



ROLL CONTROL AND INDICATING

3. PITCH CONTROL AND INDICATING.

Stabilizer/Trim Control Surfaces.
Two indepen-dent switches on outboard horn of each pilot's control wheel. LH switch controls electric trim drive motor and arms the electro-magnetic clutch circuit of the trim actuator. RH switch controls drive motor electric clutch circuit. When raised center portion is pressed upward (away from pilot's hand) switch completes circuit for nose down trim. When raised center portion is pressed down (toward pilot's hand), switch completes circuit for nose up trim. When either switch is released, trim does not operate.

Stabilizer Trim Light (amber).
Illuminates during electromanual trim when stabilizer trim control switch is actuated. The trim actuator motor control relay is energized.

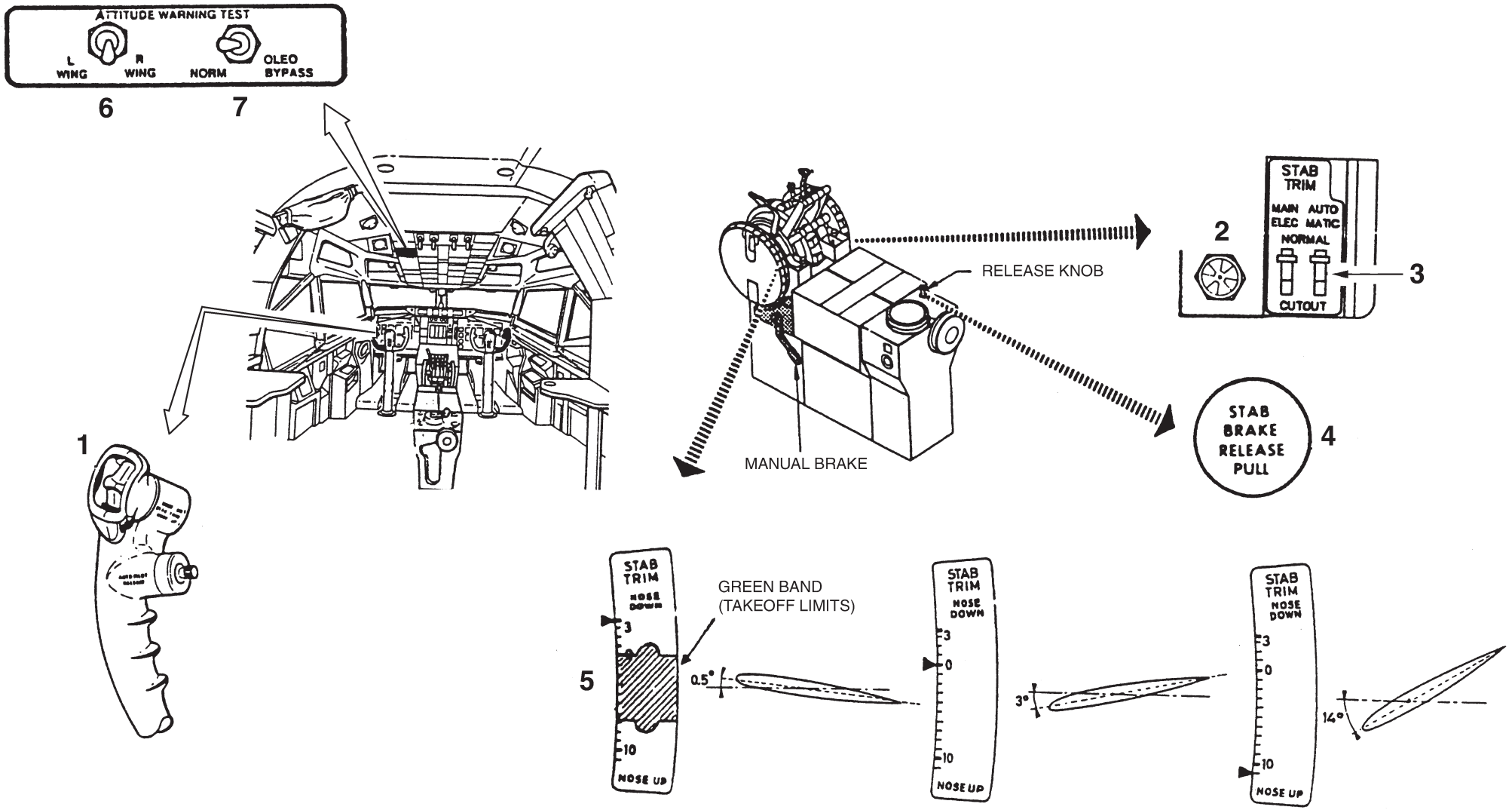
STAB TRIM CUTOUT Switches.
One switch for each electric trim system. When set to NORMAL, trim system is enabled. When set to CUTOUT, trim system is disabled. MAIN ELEC switch controls trim actuator drive, operated by pilot's stabilizer trim switches. AUTOMATIC stabilizer trim cutout switch controls Mach trim input to trim servo drive.

STAB BRAKE RELEASE Knob.
When pulled, releases manual stabilizer trim brake.

STAB TRIM Indicators (Two Places).
Two scales, one on each side of control stand, indicate stabilizer position in "units" of approximately one degree. The indicator pointer rides on a scale graduated from 3,5 units AND to 11 units ANU. Indicator green band from 0,2 unit nose down to 6,75 units nose up shows allowable trim range for takeoff . Warning horn will sound when No. 3 throttle is advanced on the ground if stabilizer is not in green band. Zero stabilizer trim position corresponds to -3° stabilizer angle. Indicator can be ± 1/2 unit from actual stabilizer position due to system tolerances and cable slippage.

ATTITUDE WARNING TEST OLEO BYPASS.
When held in BYPASS, bypasses landing gear safety relay, simulating flight condition for ground testing of stall warning system. When set to NORM, removes bypass. Has no function in flight.

ATTITUDE WARNING TEST L WING R WING.
When held in L WING position, with oleo bypass switch set to BYPASS, causes a simulated stall signal to the left signal summing unit which then causes the stick shaker to operate. When held in R WING position, same function is performed in right signal summing unit which then causes stick shaker to operate.



PITCH CONTROL AND INDICATING

4. RUDDER CONTROL AND INDICATING.

RUDDER Boost Switch.
When set to ON, opens hydraulic valve to rudder boost pressure indicator and rudder power unit. When set to OFF, rudder power unit and indicator are depressurized and boost power is not available for rudder and yaw damper. The yaw damper disengages and the rudder boost low pressure light illuminates.

WARNING: WHEN SETTING RUDDER BOOST TO ON IN FLIGHT, MAKE SURE RUDDER IS IN NEUTRAL (CENTERED) POSITION. STRUCTURAL LOADS CAUSED BY RAPID RUDDER MOVEMENT (IF DEFLECTED) COULD CAUSE DAMAGE TO AIRPLANE.

BEFORE ACTUATING BOOST EITHER RUDDER BOOST (LOWER) OR DUMMY RUDDER OVERRIDE (UPPER) SWITCH IN FLIGHT, PHYSICALLY IDENTIFY BOTH SWITCHES TO MAKE SURE PROPER SWITCH IS ACTUATED. OPERATION OF WRONG SWITCH COULD CAUSE LOSS OF CONTROL OR STRUCTURAL DAMAGE.

DUMMY-RUDDER NORMAL-OVERRIDE.
The RUDDER override switch itself is not available. A dummy (cover only) simulates the RUDDER override switch and serves for E-3A training purposes only.

RUDDER BOOST Low Pressure (Red).
When on, indicates pressure in supply line to rudder power control unit is below 2500 psi when it should be 3000 psi.

RUDDER Boost Pressure Indicator.
Indicates pressure in auxiliary hydraulic system in thousands of psi,
if RUDDER boost switch is ON.

- Normal pressure - 3000 psi
- 2250 psi if above 250 KIAS and flaps up
- See “HYDRAULIC SYSTEM”.

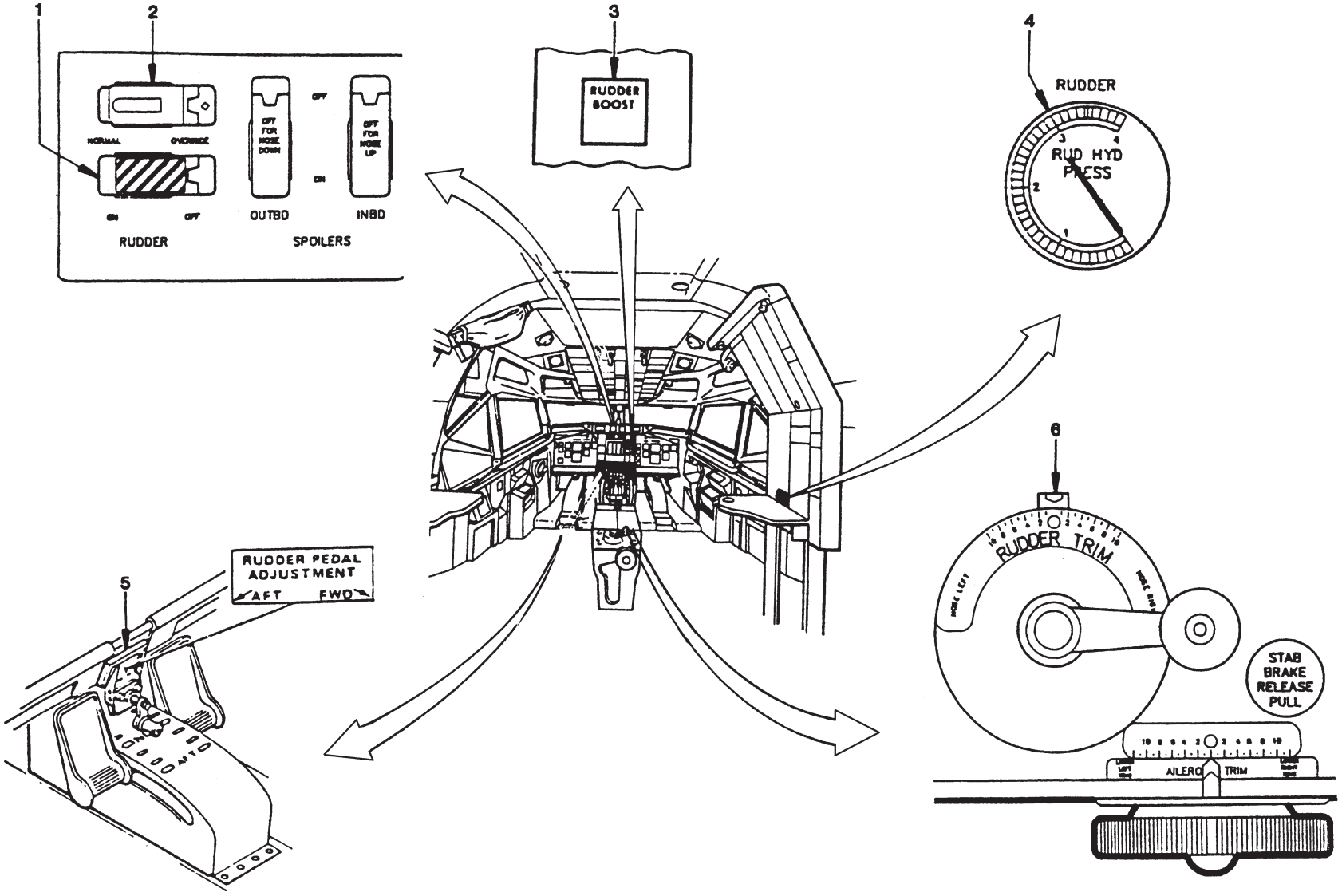
Rudder Pedals and Adjustment Crank.
Rudder Pedals control the rudder with rudder boost power available.
With hydraulic boost pow.er OFF, the pedals control the rudder control tab. Rudder pedals may be adjusted forward and aft by adjustment crank.
Pulling crank afterwards and turning it clockwise moves pedals forward. Turning crank counterclockwise moves pedals aft.

RUDDER TRIM Handle and Indicator.
Handle controls amount of rudder trim. Handle movement clockwi'se trims rudder to right. Counterclockwise movement trims rudder to left. Trim is applied by power unit when rudder is powered and applied by trim tab when rudder is unpowered. Scale indicates relative amount of trim in arbitrary "units". Actual amount of rudder movement is less with boost OFF.

NOTE: If rudder trim is applied against a rudder motion (without pedal input in trim direction) a brake in trim mechanism causes a "ratcheting" sound.

During rudder trim check, verify that pedals follow rudder trim input and return towards neutral position.

THIS PAGE IS INTENTIONALLY LEFT BLANK



RUDDER CONTROL AND INDICATING

5. FLAP AND SLATS CONTROL AND INDICATING.

EMERGENCY FLAP Master Switch.
In OFF position, deactivates emergency.flap system.
In ON position, operates bypass valve in each trailing edge flap hydraulic system (by-pass valves rotate into by-pass position) and arms emergency flap control switches.

Emergency Flap Control Switches.
Will remain in UP or OFF position but are spring loaded from DOWN to OFF.

When set to UP, switch energizes electric motor to drive associated flap to full up from full down in approximately 3 minutes.

When set to DOWN, must be held in position to energize electric motor to drive associated flap to full down from full up in approximately 3 minutes. Spring loaded to OFF position which de-energizes motor.

FLAPS Position Indicators.
Display position of trailing edge flaps, both inboard and outboard, in degrees, with ‘a tolerance of ± 3° at extreme flap positions, or 6° between pointers.

LE FLAP Lights (Leading Edge Flap Lights) (Green).
Illuminate when all the associated leading edge flaps and slats are fully extended. Each set of flaps and slats (inboard, center and outboard) operate a microswitch in series with the light

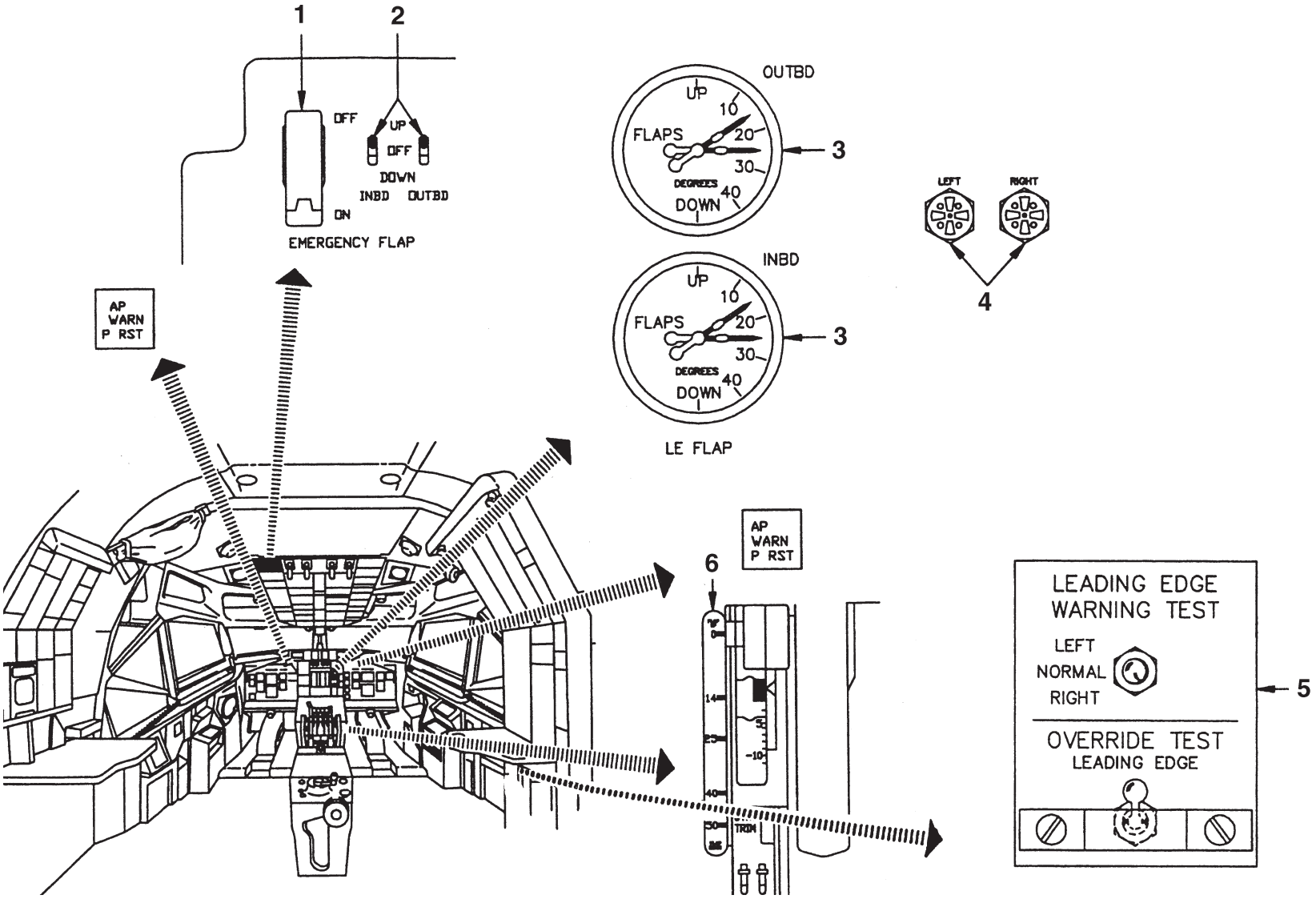
LE WARNING Override and LE WARNING Test Sws.
Two switches are installed beneath the flight engineer’s table.
Both switches are for maintenance purpose only to check proper operation of LE device annunciator and T/O warning system.

Flap Control Lever.
Controls both inboard and outboard hydraulic flap drive units.
Controls leading edge flaps through valve operated by trailing edge flaps between about 6° and 10° flap extension. Detents are provided at 0, 14, 25, 40 and 50° extension.

CAUTION: WHEN OPERATING FLAPS ELECTRICALLY WITH UTILITY HYDRAULIC PRESSURE AVAILABLE, SET FLAP LEVER TO A POSITION GREATER THAN OR EQUAL TO DESIRED DEGREE OF EXTENSION TO PREVENT DAMAGE TO HYDRAULIC DRIVES.

Flaps 14 Gate Retraction.
Prevents inadvertant movement of fIap Iever from 14° (takeoff position) to 0° position. Lever must be lifted to select 0° position. The flap lever is not restricted in movement from selected position towards down.

THIS PAGE IS INTENTIONALLY LEFT BLANK

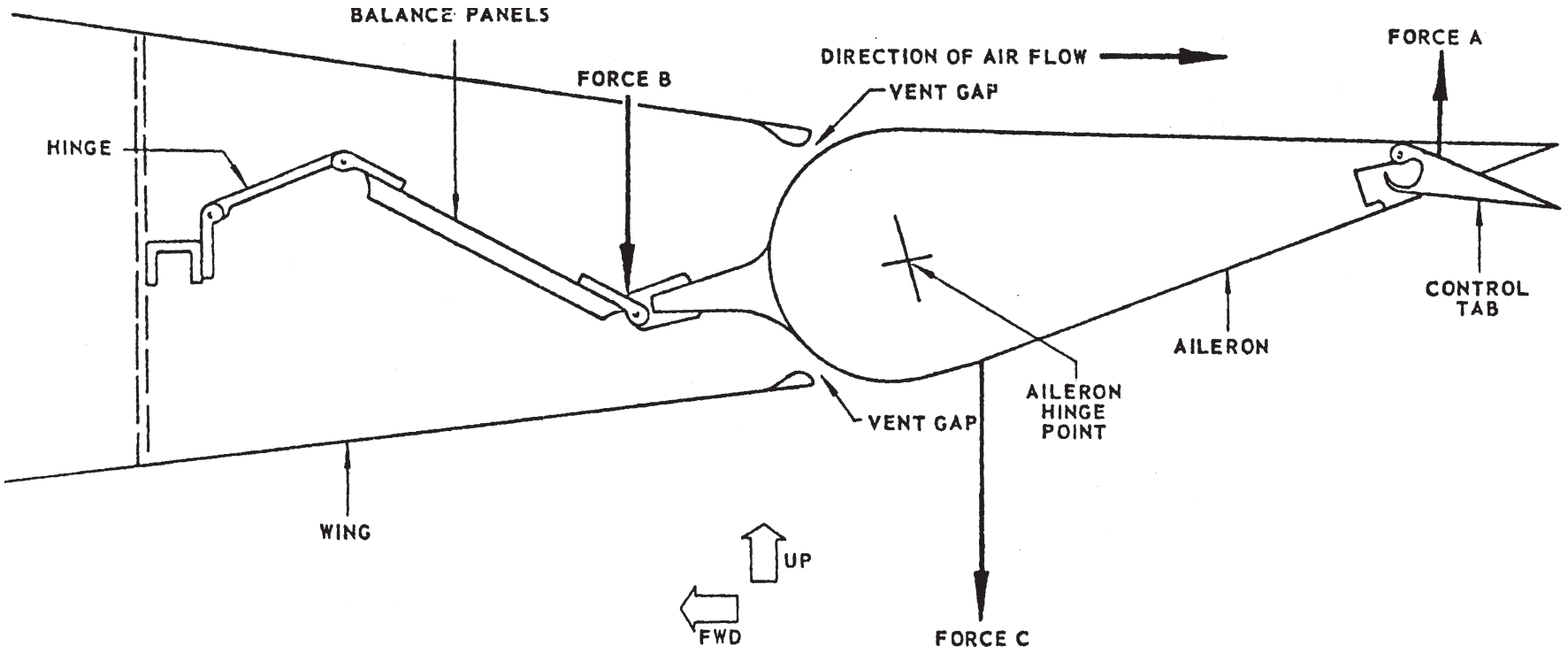


FLAP/SLAT CONTROL AND INDICATING

6. TAB/BALANCE PANELS.

Operation.
Air loads on the balance panels are dependent upon aileron position. Movement of the aileron during flight to either side of the faired position will result in differential pressure across the balance panels. The force created by the differential pressure acts on the balance panels in a direction that assists aileron movement. Variable air bleed progressively increases balance panel load as the aileron rotates from the faired position. Air seals, attached to the balance panel sides on the balance panels, rotate past coves (contoured sides of balance chamber structure) and are utilized for air bleed control.

Air Bleeds.
Air bleed reduces differential air pressure on the balance panels by establishing an air flow within the balance chamber. Full balance panel force is not required for small angles of aileron displacement since the manual force required to rotate the control tab through small angles is small. Controlled air bleed (flow area) is progressively decreased as the aileron displacement angle is increased. This action increases the differential air pressure on the balance panel as the aileron rotates from the faired position. The increasing load on the balance panel counteracts increasing air loads on the ailerons.



1. FORCE A INDUCED BY AIR PRESSURE DIFFERENTIAL ON CONTROL TAB INITIATES ROTATION OF AILERON
2. FORCE B INDUCED BY AIR PRESSURE DIFFERENTIAL ON BALANCE PANELS, AFTER AILERON IS DISPLACED BY TAB MOVEMENT
3. FORCE C AS INDUCED BY AIR PRESSURE DIFFERENTIAL ON AILERON, OPPOSING FORCES A AND B
4. ALL FORCES ARE PROPORTIONAL TO ANGULAR DISPLACEMENT OF SURFACES. FOR ANY GIVEN TAB DISPLACEMENT, AILERON ROTATES UNTIL THE MOMENT OF FORCE C IS EQUAL TO THE SUM OF THE MOMENTS OF FORCES A AND B
5. A CONTROLLED AIR BLEED IS PROVIDED AT THE ENDS OF THE AILERON TO PROPORTION FORCE B WITH DISPLACEMENT OF AILERON

BALANCE PANEL SCHEMATIC

THIS PAGE IS INTENTIONALLY LEFT BLANK