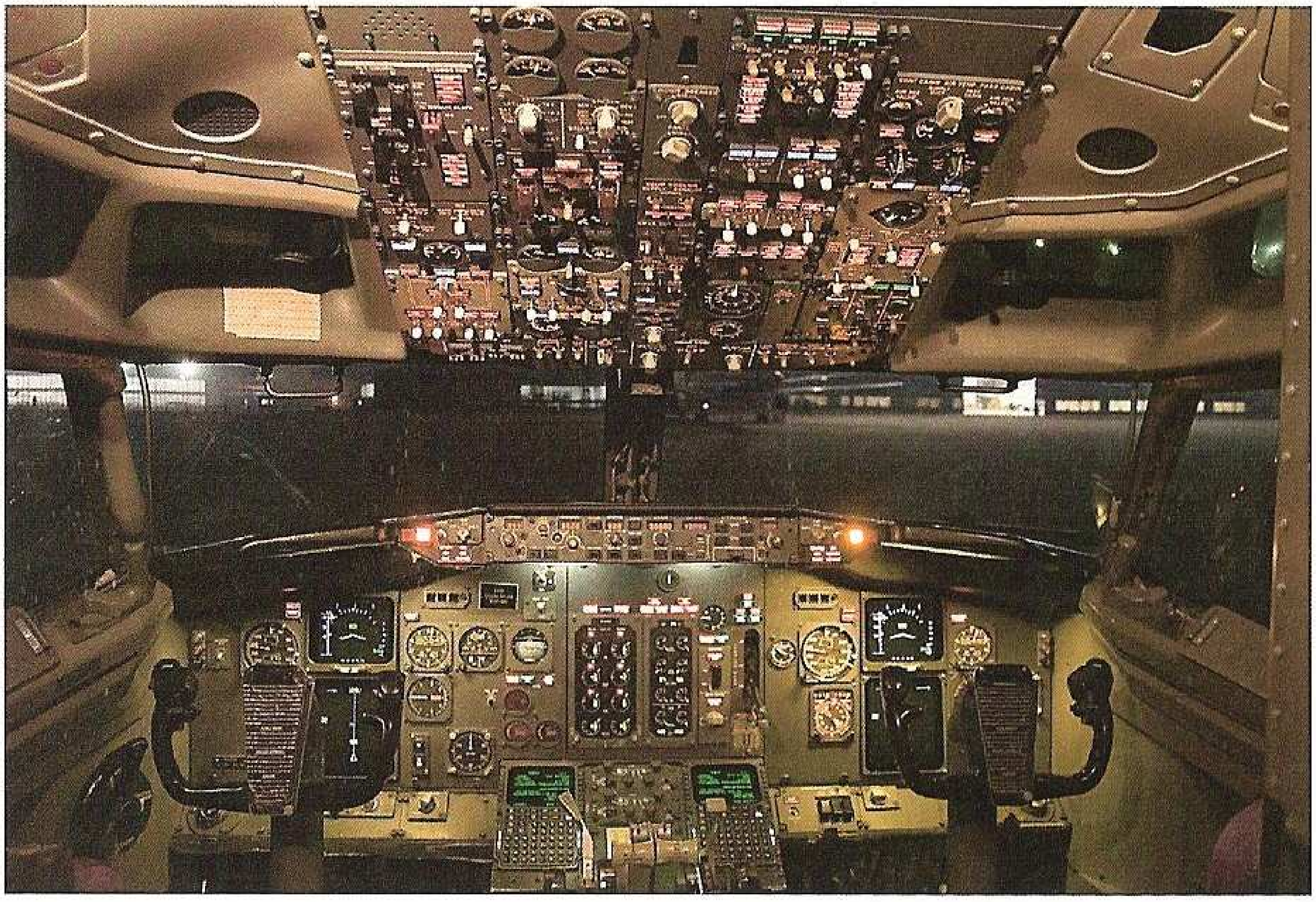
737 COCKPIT COMPANION

by
Bill Bulfer

737 Combi Cockpit Companion

-300/-400/-500
-600/-700/-800/-900



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FOREWORD
by Bruce Sprague, original author of the *COCKPIT PANEL NOTES*

After nearly thirty years of writing numerous gouges, flash cards, pamphlets, and booklets to help my fellow pilots (U.S. Air Force and Continental Airlines), I find myself ready to retire from this project. With my airline retirement coming up, I want to devote more time for family and other pursuits in the final years of my career.

I am passing the torch to Bill Bulfer, who is well known in the aviation community. Bill has created many pilot technical publications, both within his airline training department, and his own company, Leading Edge Libraries. His FMC User's Guide is used worldwide, and is the definitive source on the Boeing FMC system. Bill also started the Bluecoat Forum on the World Wide Web, for the latest source on advanced cockpit issues. Currently, Bill is a Captain on the Boeing 737 (all models through the new -900). He is eminently qualified to carry on this project.

I feel very confident that Bill will give these *COCKPIT PANEL NOTES* a much needed update, along with the addition of numerous drawings and schematics. I will be carrying his book in my flight kit, and I wish him well in this new endeavor!

Bruce Sprague
March 1998

WARNING! This guide is not authorized nor endorsed by any airline or regulatory body. Some material contained in this guide may be out-of-date, changed and / or incorrect. Your Flight Manual takes precedence over any information in this manual.

Thanks to Southwest Airlines Maintenance Training for the information regarding flaggged instruments on the classic.

ORDER FORM

HOW TO ORDER A COCKPIT COMPANION:
CLASSIC, COMBI, SW, AT, WJ, RYR, CAL, ASA, AA, -700/BBJ, or NG/BBJ

HOW TO ORDER AN FMC GUIDE:
737 FMC GUIDE (NG or Combination), or the BIG BOEING FMC GUIDE

Go to **www.cockpitcompanion.com** and click on the desired category (Cockpit Companion or FMC Guide), then follow the prompts. Prices range from $35 to $60. Shipping prices vary according to the method (US Post Office or FedEx.)

Estimated Priority Mail in the USA is $7.00, $9 to Canada, $12 to Europe, the Pacific Rim, Africa, South America, Russia, and Asia.

E-MAIL: billbulfer@comcast.net
For any type of message as the web site does not have a comment space.

PHONE: 209 - 723 - 4500

UPDATED MANUAL

Changes are incorporated as information becomes available. New versions of the *COCKPIT COMPANION* are published quite often. The publication date of this manual is on the bottom of this page. Occasionally you may want to purchase an updated manual to ensure you have the latest information.

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Other documents I've found useful in learning the 737 are:
737 FMC User's Guide – Bill Bulfer www.cockpitcompanion.com
Pat Boone's Boeing 737 Management Reference Guide www.B737MRG.net
Chris Brady's Boeing 737 Technical Site www.b737.org.uk
Cockpit Review – Canova Aviation Pub www.canovair.com

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HOW TO USE THIS GUIDE

This version of the *737 COCKPIT COMPANION* is a combination book, in that it describes the 737 "classic" (300-400-500) and the 737 Next Generation (600-700-800-900).

If you are going through initial training, you must, of course first read your carrier's Flight Manual. Once you have done this, then the Cockpit Companion can be used to help refresh your memory on key points. The *737 CC*, as you will notice, goes a couple of levels deeper into each system than you need for your oral.

Refer to this guide for oral prep, simulator PC review, and in the cockpit when needed. Be sure to refer to your Flight Manual for the final authority! Your Limitations, Operating Parameters, Minimum Equipment List, and Quick Reference Handbook will probably differ from those in this manual.

This guide is basically put in the order of starting at the top of the cockpit, and covering the panels one by one, until you reach the aft end of the control stand. The Table of Contents follows this order.

This is not a procedures manual; it is a quick reference manual for systems and controls.

To lookup an item quickly, use the Index; the Index is going to be your primary way to find things. Some systems have components scattered all over the cockpit.

I recommend you have colored pens available. It's very helpful to color certain light modules; you'll need orange, red, green, and blue. Oh, did I forget yellow!

Power sources are listed in the Circuit Breaker section (back). This is a work-in-progress.

IMPORTANT: Some differences exist among the various models of the non-EFIS and EFIS 300-400-500, and the 737NG (Next Generation) 600-700-800-900 aircraft. These differences are annotated with (EFIS), (3-4-5), (NG). Items specific to the different models will be annotated with (3-4-5) or (6-7-8-9). Information labeled as (NG) applies to the 600-700-800-900 models.

Maintenance documents are my main resource and take precedence when a conflict arises between different flight manuals.

I'm sure your equipment will have some differences. As you go through the *737 CC*, note those differences and send them to me for possible inclusion in a later publication. It's educational for us to see what others are doing in the industry. There are many satisfactory ways to operate the 737 but I suppose each carrier's flight standards department likes to think they have the "best" way. I'd like to get each of us to help the other out in capturing and disseminating information we all need to continue in our quest to become better pilots.

As you go through the manual, record your recommendations and send them to me for inclusion in a later printing. I'll send you a complimentary updated *737 CC*. The *COCKPIT COMPANION* continues to be modified as I learn more about this great little airplane.

CONVENTIONS: (do not use any of these in lieu of your company manuals or procedures)
(L/OP) - Limitation and/or Operating Parameter
(MEL) - Minimum Equipment List

- certain items are legally allowed to be inop without adversely affecting aircraft safety and reliability
- if an equipment malfunction occurs after gate departure and prior to takeoff, it is not necessary to return to the gate or delay a takeoff to install a placard provided the QRH Abnormal procedure is accomplished, the item can be inop per the MEL, dispatch deviation procedures can be accomplished without maintenance action or repairs and Dispatch is notified, if required

(option) - Optional equipment
(QRH) - Quick Reference Handbook
(REG) - FAA/CAA regulation
(AD) - Airworthiness Directive or Immediate Adopted Rule (IAR)

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MINIMUM EQUIPMENT LISTING

TABLE OF CONTENTS

GLOSSARY

A

A/P Autopilot
A/S Airspeed
A/T Autothrottle
AC Alternating Current
ACARS Aircraft Communications Addressing and Reporting Sys
ACM Aircraft Condition Monitoring Sys
ACP Audio Control Panel
ACP Audio Control Panel
ACQ Acquire
ACT Active
ADC Air Data Computer
ADF Automatic Direction Finder
ADI Attitude Director Indicator
ADIRS Air Data Inertial Reference Sys
ADIRU Air Data Inertial Reference Unit
ADM Air Data Module
AFDS Autopilot Flight Director Sys
AFM Airplane Flight Manual
AGL Above Ground Level
AI Anti–Ice
ALT Altitude
ALTN Alternate
AM Amplitude Modulation
ANP Actual Nav Performance
ANT Antenna
AOA Angle of Attack
APCH Approach
APP Approach
APU Auxiliary Power Unit
ARINC Aeronautical Radio, Incorporated
ARPT Airport
ATA Actual Time of Arrival
ATA Air Transport Associaton
ATC Air Traffic Control
ATS Selective Call System
ATT Attitude
AUTO Automatic
AUX Auxiliary
AVAIL Available

B

B/C Back Course
BARO Barometric
BITE Built In Test Equipment
BPCU Bus Power Control Unit
BTB Bus Tie Breaker
BRT Bright
BTL DISCH Bottle Discharge (fire extinguishers)

C

C Captain, Celsius, Center
CAB Cabin
CANC/RCL Cancel/Recall
CAPT Captain
CB Circuit Breaker
CCDL Cross Channel Datalink
CCW Counter-clockwise
CDS Common Display Sys
CDU Control Display Unit
CFFU Cargo Fire Flight Deck Unit
CG Center of Gravity
CHKL Checklist
CLB Climb
CLR Clear
CMD Command
COMM Communication
CON Continuous
CONFIG Configuration
CPS frequency meter
CRS Course
CRZ Cruise
CSD Constant Speed Drive
CTL Control
CTR Center
CVR Cockpit Voice Recorder
CWS Control Wheel Steering

D

DAA Digital Analog Adaptor
DADC Digital Air Data Computer
DC Direct Current
DDG Dispatch Deviations Guide
DEP ARR Departure Arrival
DES Descent
DEU Display Electronic Unit
DFCS Digital Flight Control System
DFDAU Digital Flight Data Acquisition Unit
DH Decision Height
DIFF Differential
DISC Disconnect
DME Distance Measuring Eq.
DSP Display Select Panel
DSPL Display
DU Display Unit
DYD Digital Yaw Damper
DYDC Digital Yaw Damper Coupler

E

E/D End of Descent
E/E Electrical and Electronic
EADI Electronic Attitude Director Indicator
EDP Engine Driven Pump
EE Electronic Equipment
EEC Electronic Engine Control
EEMK Enhanced Emergency Medical Kit
EFIS Electronic Flight Instrument Sys
EGPWS Enhanced Ground Proximity Warning Sys
EGT Exhaust Gas Temperature
EHSI Electronic Horizontal Situation Indicator
EIS Engine Indicating Sys
ELEC Electrical
ELEV Elevator
EMDP Electric Motor Driven Pump
EMER Emergency
ENG Engine
EO Engine Out
EPC External Power Contactor
EQUIP Equipment
ER Extended Range
ETOPS Extended Range Operation with Twin Engine Airplanes
EVAC Evacuation
EXEC Execute
EXP Expanded
EXT Extend

F

F Fahrenheit
F/D or FLT DIR Flight Director
F/O First Officer
FAC Final Approach Course
FCC Flight Control Computer
FCTL Flight Control
FDAU Flight Data Acquisition Unit
FDR Flight Data Recorder
FFM Force Flight Monitor
FMA Flight Mode Annunciations
FMC Flight Management Computer
FMS Flight Management Sys.
FPA Flight Path Angle
FPM Feet Per Minute
FPV Flight Path Vector
FREQ Frequency
FSU Fuel Summation Unit
FT Feet
FTE Flight Technical Error
FWD Forward

G

G/P Glidepath
G/S Glide Slope
GA Go–Around
GCB Generator Control Breaker
GCR Generator Control Relay
GCU Generator Control Unit
GEN Generator
GLS GPS Landing System or GNSS Landing Sys
GPM Gallons Per Minute
GPS Global Positioning Sys
GPWS Ground Proximity Warning Sys
GRD Ground
GS Ground Speed

H

HDG Heading
HDG REF Heading Reference
HDG SEL Heading Select
HF High Frequency
HGS Heads up Guidance Sys
HLD Hold
HMU Hydro Mechanical Unit
HPA Hectopascals
HPSOV High Pressure Shut Off Valve
HRD High Rate Discharge
HSI Horizontal Situation Ind.
HUD Head-Up Display
HYD Hydraulic

I

I/C Intercom
IAN Integrated Approach Nav
IAS Indicated Airspeed
ICAO International Civil Aviation Authority
IDENT Identification
IDG Integrated Drive Generator
IFE In-Flight Entertainment Sys.
IGN Ignition
ILS Instrument Landing Sys
IN Inches
INBD Inboard
IND LTS Indicator Lights
INOP Inoperative
INT or INTPH Interphone
INTC CRS Intercept Course
IRS Inertial Reference Sys
IRU Inertial Reference Unit
ISDU Inertial Sys. Display Unit
ISFD Integrated Standby Flight Display
ISLN Isolation

K

K Knots
KGS Kilograms
KIAS Knots Indicated Airspeed
KVA kilo volt amps

L

L Left
LAS Load Alleviation Sys
LBS Pounds
LCD Liquid Crystal Display
LDG ALT Landing Altitude
LE Leading Edge
LED Leading Edge Device
LIM Limit
LGTU Landing Gear Transfer Unit
LIM Limit
LNAV Lateral Navigation
LOC Localizer
LPM Liters per Minute
LRC Long Range Cruise
LWR CTR Lower Center
LWR DSPL Lower Display

M

M Mach
MAG Magnetic
MAN Manual
MCD Main Cargo Door
MCG Minimum Control Ground
MCP Mode Control Panel
MDA Minimum Descent Altitude
MEA Minimum Enroute Altitude
MEC Main Engine Control
MEL Minimum Equipment List
MFD Multifunction Display
MHZ Megahertz
MIC Microphone
MIN Minimum
MKR Marker
MLG Main Landing Gear
MMO Maximum Mach Operating Speed
MMR Multi-Mode Receiver
MOD Modify
MSG Message
MTRS Meters

N

N1 Low Pressure Rotor Speed
N2 High Pressure Rotor Speed
NAV RAD Navigation Radio
NSE Nav System Error
ND Navigation Display
NG Next Generation
NLG Nose Landing Gear
NM Nautical Miles
NORM Normal
NPS Nav Performance Scales

O

O2 Oxygen
OAT Outside Air Temperature
OFST Offset
OHU Overhead Unit
OUTBD DSPL Outboard Display
OVHD Overhead
OVHT Overheat
OVRD Override
OXY or O2 Oxygen

P

P/RST Press Reset
P/S Pitot Static
PA Passenger Address
PASS Passenger
PDE Path Deviation Error
PBE Protective Breathing Equip
PCU Power Control Unit
PERF INIT Performance Initialization
PFC Primary Flight Computers
PFD Primary Flight Display
PLI Pitch Limit Indicator
PMC Power Management Control
PNL Panel
POS INIT Position Initialization
POS Position
PPH Pounds Per Hous
PREV Previous
PRI Primary
PROX Proximity
PRSOV Bleed air shutoff valve
PSEU Proximity Switch Electronic Unit
PSI Pounds Per Square Inch
PSU Passenger Service Unit
PSI, PSID Pounds Per Square Inch
PSIG Pounds Per Square Inch Gauge
PSU Passenger Service Unit
PTH Path
PTT Push To Talk
PTU Power Transfer Unit
PWR Power
PWS Predictive Windshear Sys

GLOSSARY

Q

QRH Quick Reference Handbook
QTY Quantity

R

R Right or Range
R/T Radio Transmit
RA Radio Altitude
RCCB Remote Control Circuit Breaker
RDMI Radio Distance Magnetic Indicator
REC Recorder
RECIRC Recirculation
REF Reference
RET Retract
REU Remote Electronics Unit
RF Refill
RNP Required Navigation Performance
RPM Revolutions Per Minute
RPR Rudder Pressure Reducer
RSEP Rudder System Enhancement Package
RST Reset
RTE Route
RTO Rejected Takeoff
RTP Radio Tuning Panel
RUD Rudder
RVR Runway Visual Range
RVSM Reduced Vertical Separation Minimum

S

S/C Step Climb
SAT Static Air Temperature
SCU Suppression Control Unit
SEL Select
SELCAL Selective Call Sys
SFP Short Field Performance
SMYD Stall Management Yaw Damper
SOV Shutoff Valve
SPCU Standby Power Control Unit
SPD Speed
STA Station
STAB Stabilizer
STAT Status
STBY Standby
STD Standard
STS Status or Speed Trim Sys
SVC Service
SYS System

T

T or TK or TRK Track
T or TRU True
T/C Top of Climb
T/D Top of Descent
T/R Thrust reverser
TA Traffic Advisory
TAI Thermal Anti Ice
TAS True Airspeed
TAT Total Air Temperature
TAWS Terrain and Warning Sys
TCAS Traffic Alert and Collision Avoidance Sys
TDZE Touch Down Zone Elev
TE Trailing Edge
TEMP Temperature
TERR Terrain
TFC Traffic
TFR Transfer
THR HOLD Throttle Hold
THR-R Thrust Reduction Alt.
TLA Thrust Lever Angle
TO Takeoff
TO/GA Takeoff/Go–Around
TSE Total System Error
TRU or TR Transformer Rectifier Unit
TXP Transponder

U

UCM Uncommanded Motion
UNLKD Unlocked
UPR DSPL Upper Display
USB Upper Side Band
UTC Coordinated
UTIL Utility

V

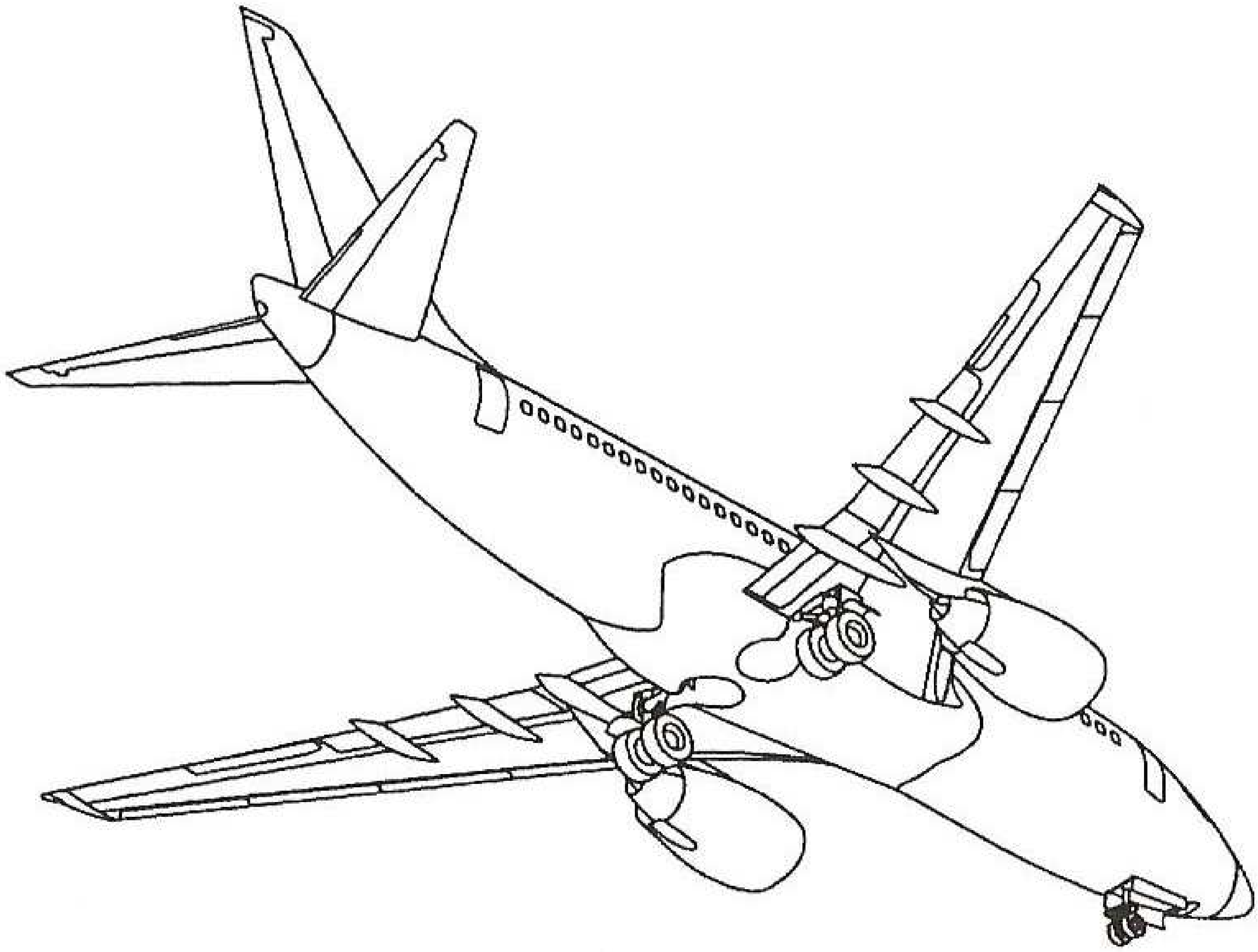
V/S Vertical Speed
V1 Takeoff Decision Speed
V2 Scheduled Takeoff Target Speed
VANP Vertical Actual Navigation Performance
VERT Vertical
VHF Very High Frequency
VMO Maximum Operating Speed
VNAV Vertical Navigation
VOR VHF Omnidirectional Range
VR Rotation Speed
VREF Reference Speed
VRNP Vertical Required Navigation Performance
VSI Vertical Speed Indicator
VTK Vertical Track

W

WAI Wing Anti Ice
WPT Waypoint
WTRIS Wheel To Rudder Interconnect System
WW Wheel well
WXR Weather Radar

X

xfer transfer
XPDR or XPNDR Transponder
XTK Cross Track



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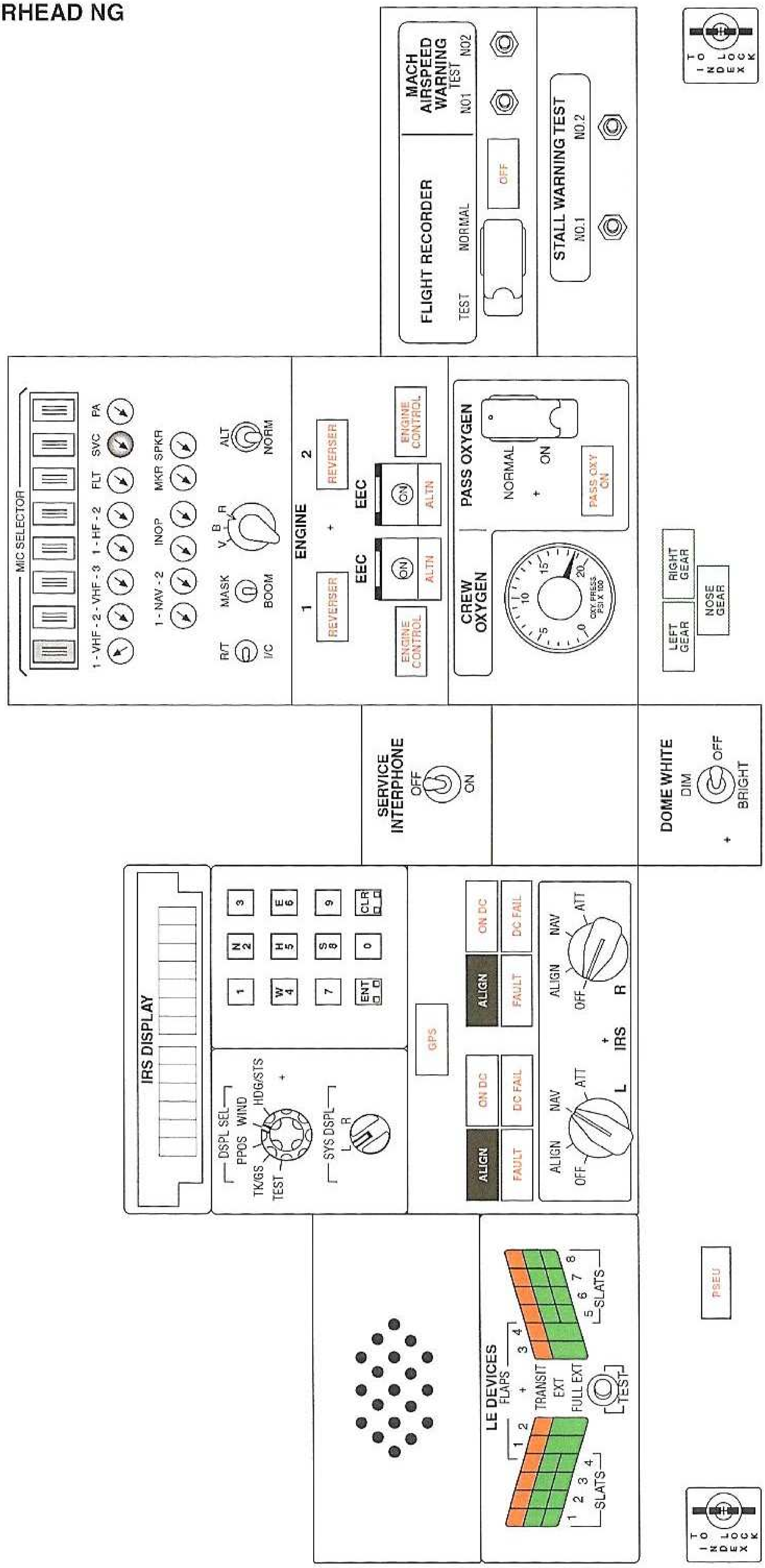
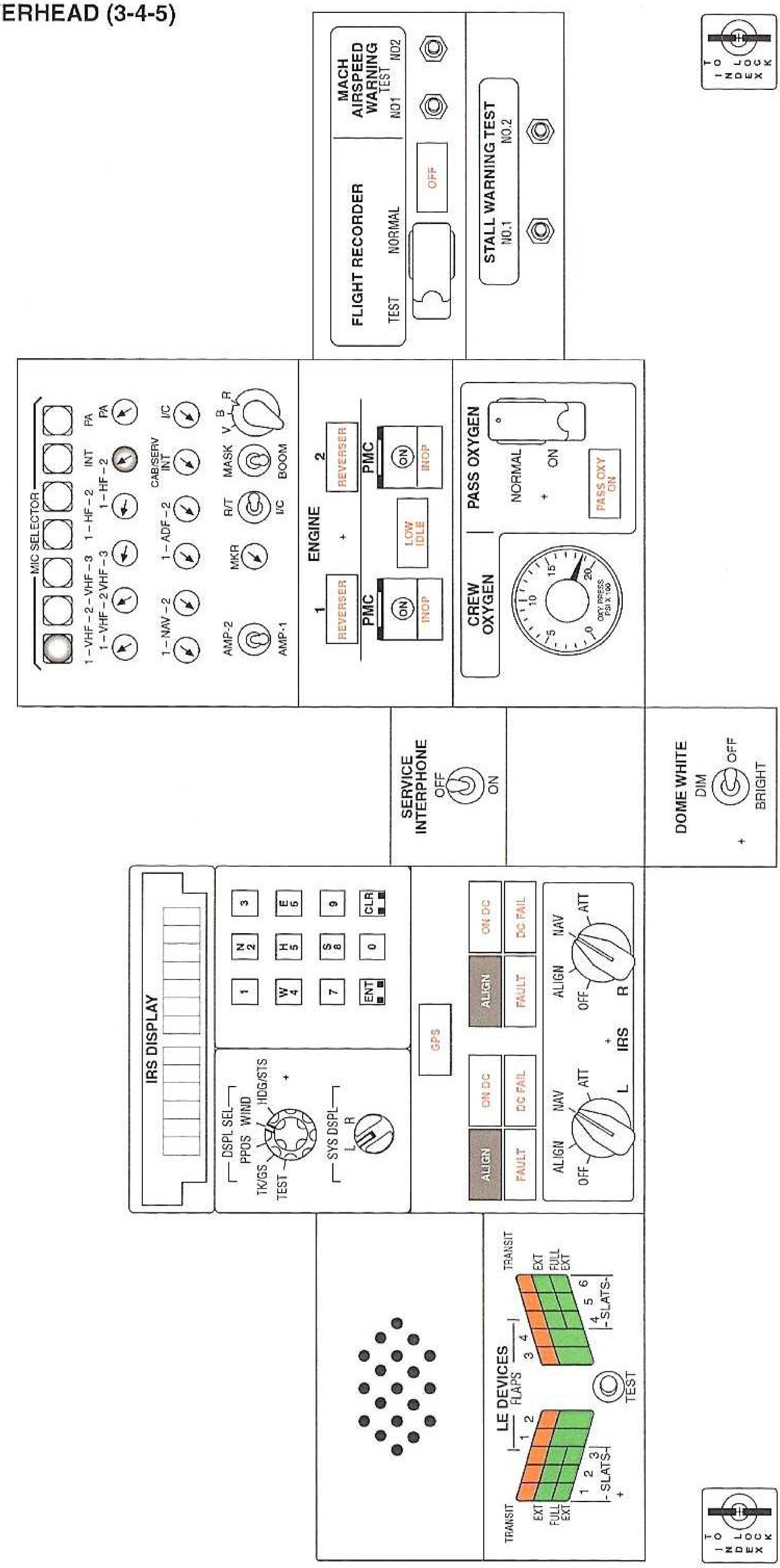
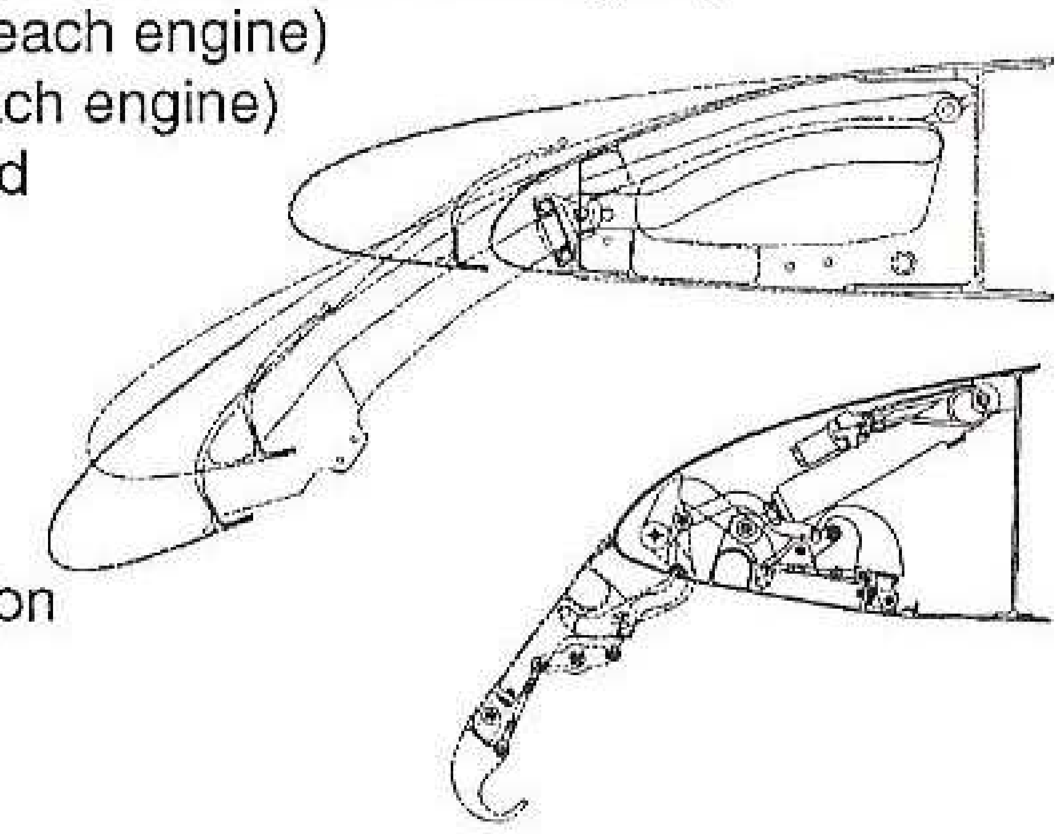
AFT OVERHEAD NG



AFT OVERHEAD (3-4-5)



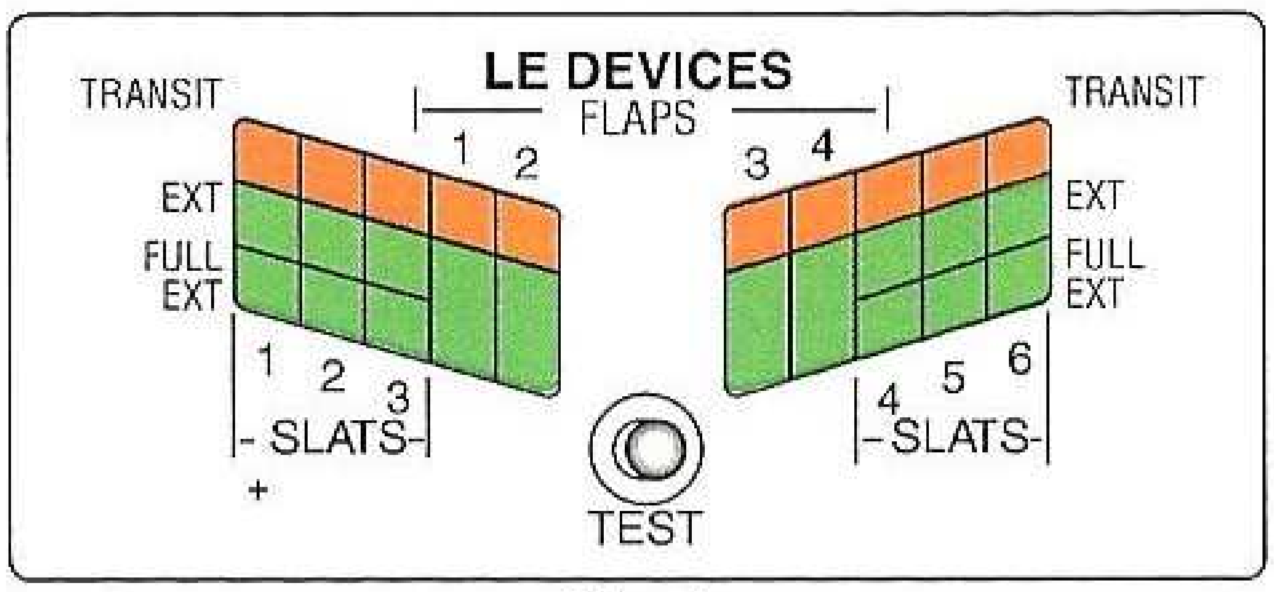
LE DEVICES ANNUNCIATOR PANEL
- indicates position of 2 individual leading edge flaps (inboard of each engine)
- (3-4-5) indicates position of 3 slats (outboard of each engine)
- (NG) indicates position of 4 slats (outboard of each engine)
- extinguished = corresponding LE device retracted



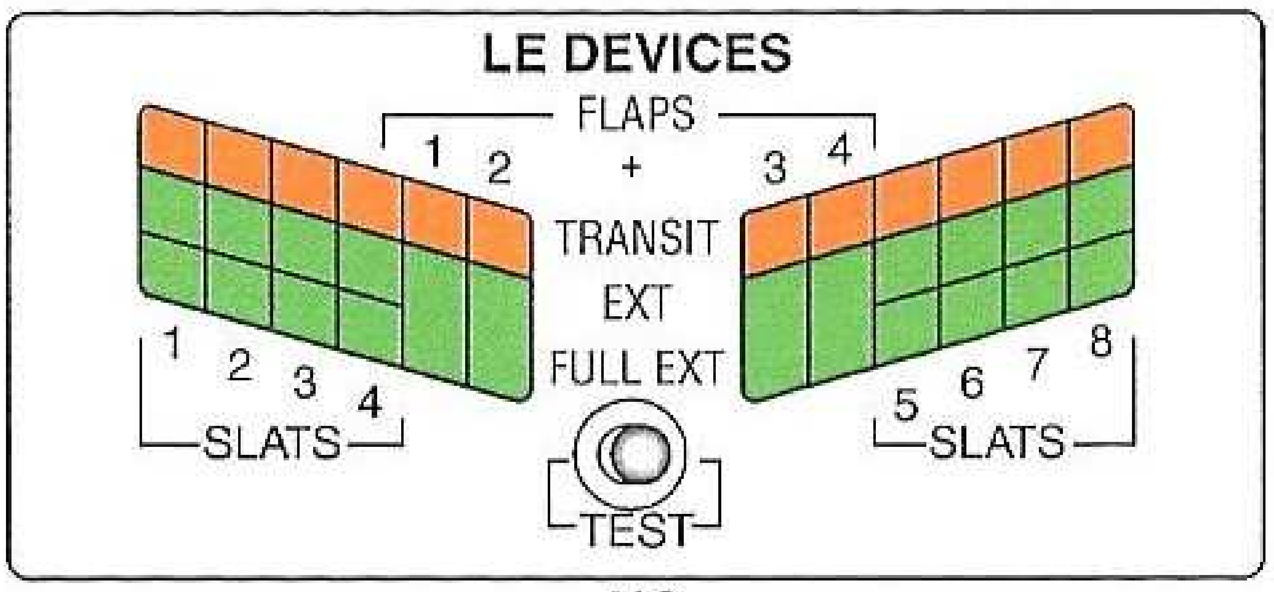
LE DEVICES TRANSIT lights (amber)
- corresponding LE device in transit

LE DEVICES EXT lights (green)
- corresponding LE slats in intermediate EXT position
  - this is normal position with flaps 1, 2, or 5

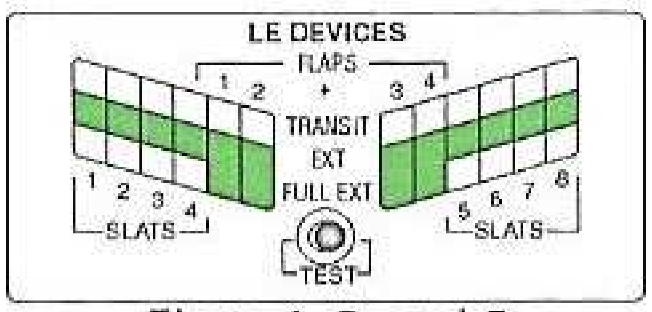
LE DEVICES FULL EXT lights (green)
- corresponding LE device fully extended
  - max speed 230 kt
- as the trailing edge flaps extend past flaps 5 the sealed low-drag LEDs move to the slotted FULL EXT
- when the flaps are retracted, the sequence is reversed
- will indicate FULL EXT position during auto-slat extension
- leading edge flaps
  - 2 are inboard of each engine
  - move to FULL EXT as soon as the trailing edge flaps are extended
- (NG option short-field package)
  - seal between outboard leading edge flap and engine cowl is retracted during landing. This allows flow of high energy air at the pylon-wing intersection for improved lift during takeoff
    - remains in place during takeoff for single-engine performance
  - (6-7) the LEDs remain at the low drag position at flaps 10
  - (8-9) the LEDs remain at the low drag position at flaps 15



Classic

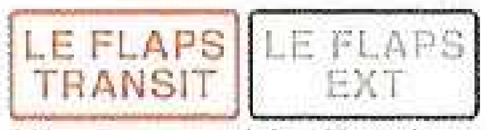


NG

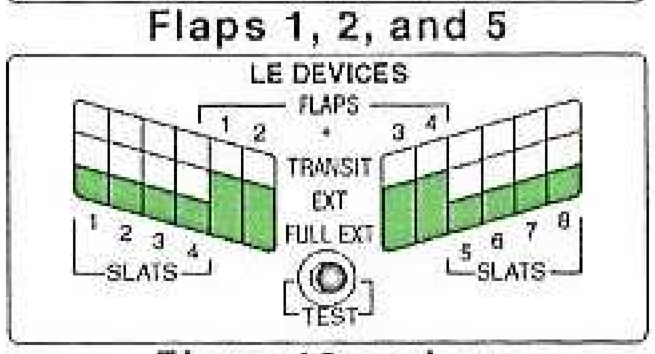


Flaps 1, 2, and 5

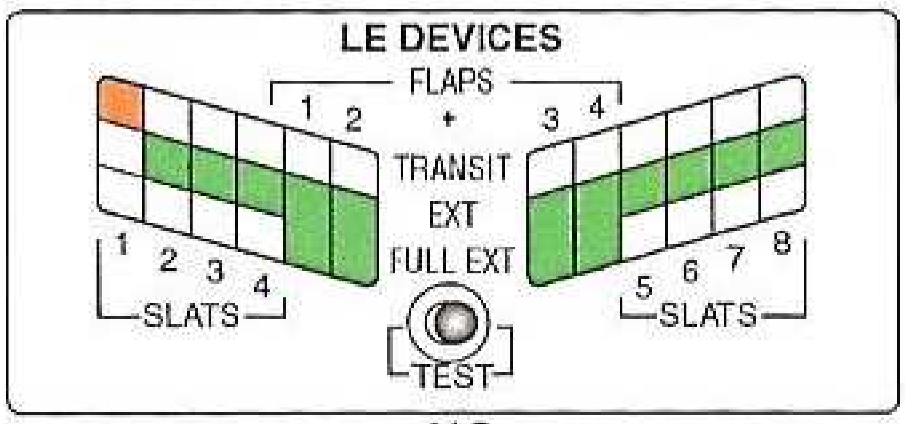
LE ANNUNCIATOR PANEL TEST
- press to test all panel lights



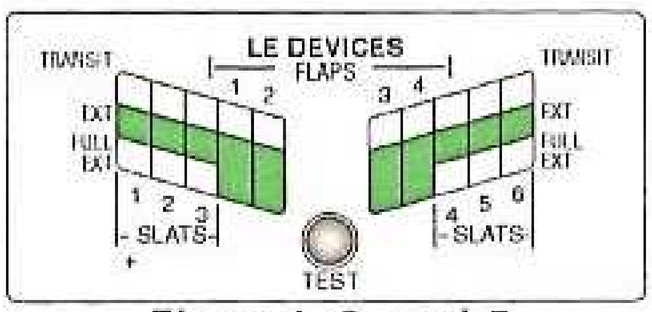
Front panel indications



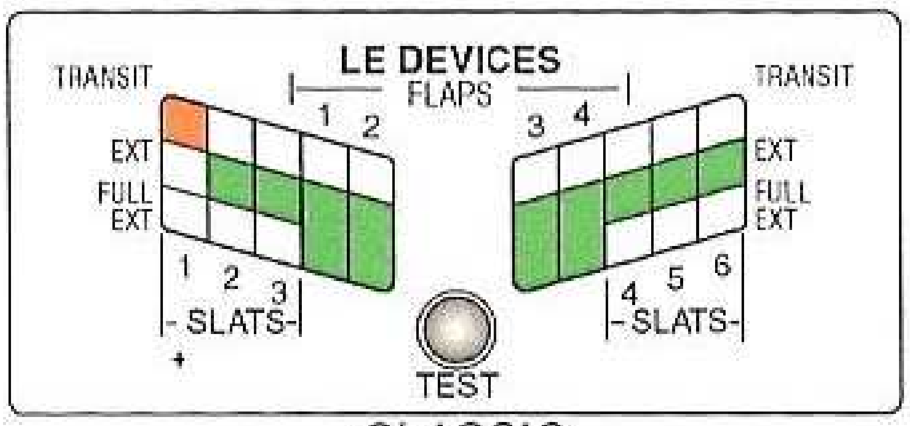
Flaps 10 and on



NG

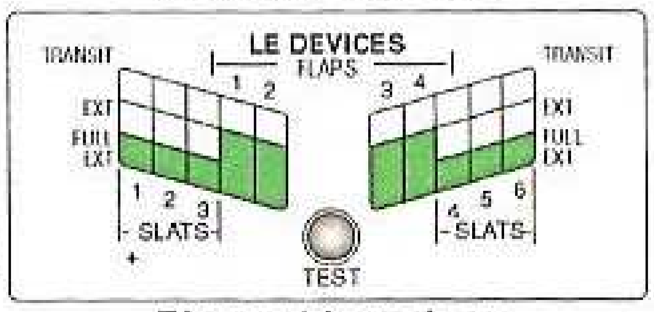


Flaps 1, 2, and 5



CLASSIC

Flaps 1, 2, or 5 and #1 slat not extended.



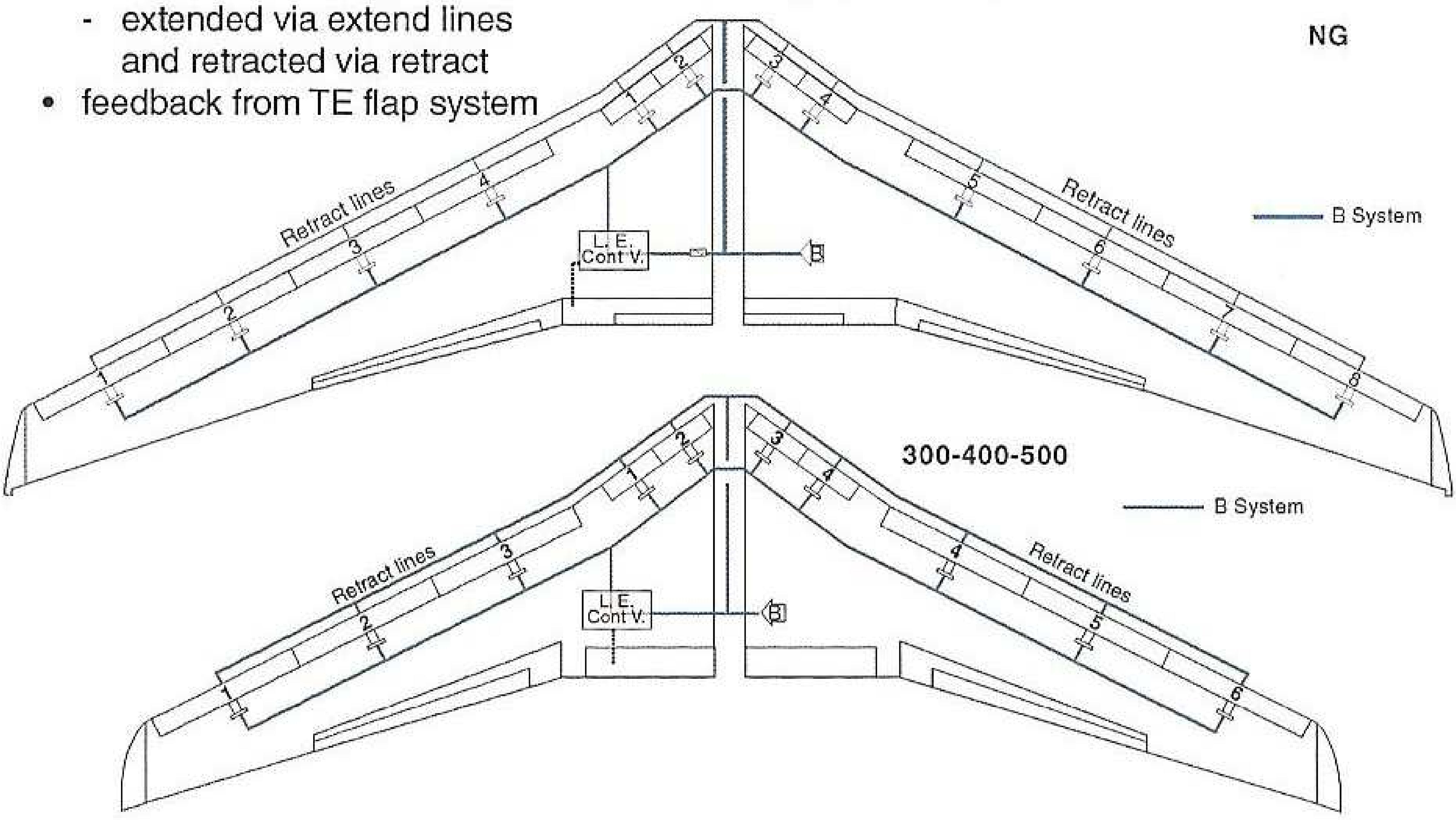
Flaps 10 and on

(QRH) LE Flap Transit Light On
- if only one LE transit light is on, do not exceed 300 kt or M.65, whichever is lowest
- if more than one LE transit light is illuminated, do not exceed 230 kt

(QRH) LEDs Fail to Retract
- if any LED transit lights are illuminated, plan a 15° flaps landing
- land at the nearest suitable airport

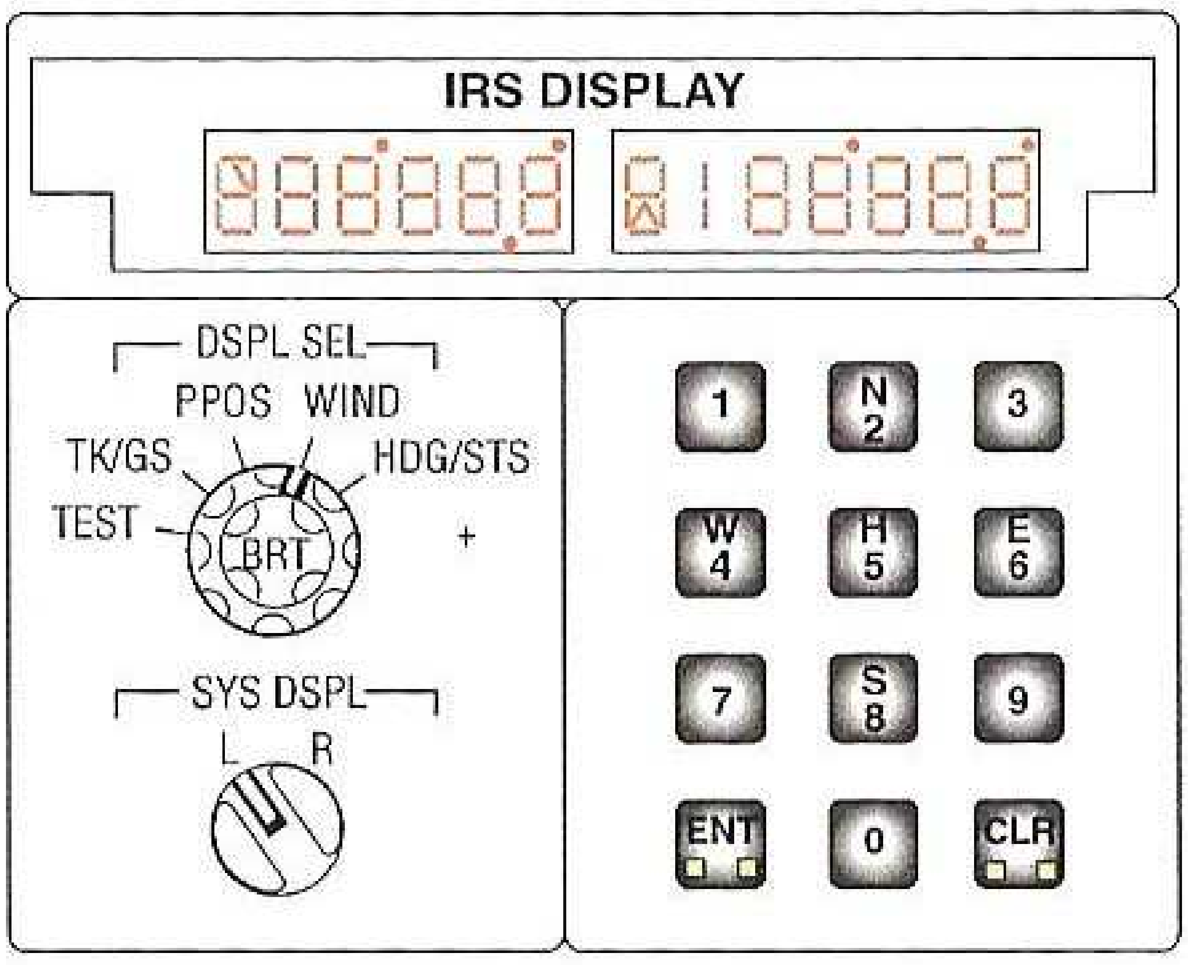
Leading Edge Devices Notes

- LE Devices normally extended and retracted by system B hydraulics
  - extended via extend lines and retracted via retract
- feedback from TE flap system moves LE flap control valve



- (NG) leading edge vortilons added to outboard LEDs to keep airflow attached over the outboard section of the wing
- If a LE flap or slat is not in the correct position, one of these indications will show on the LE devices annunciator panel: TRANSIT amber light comes on, incorrect EXT or FULL EXT green light comes on, or no lights come on

AFT OVERHEAD PANEL

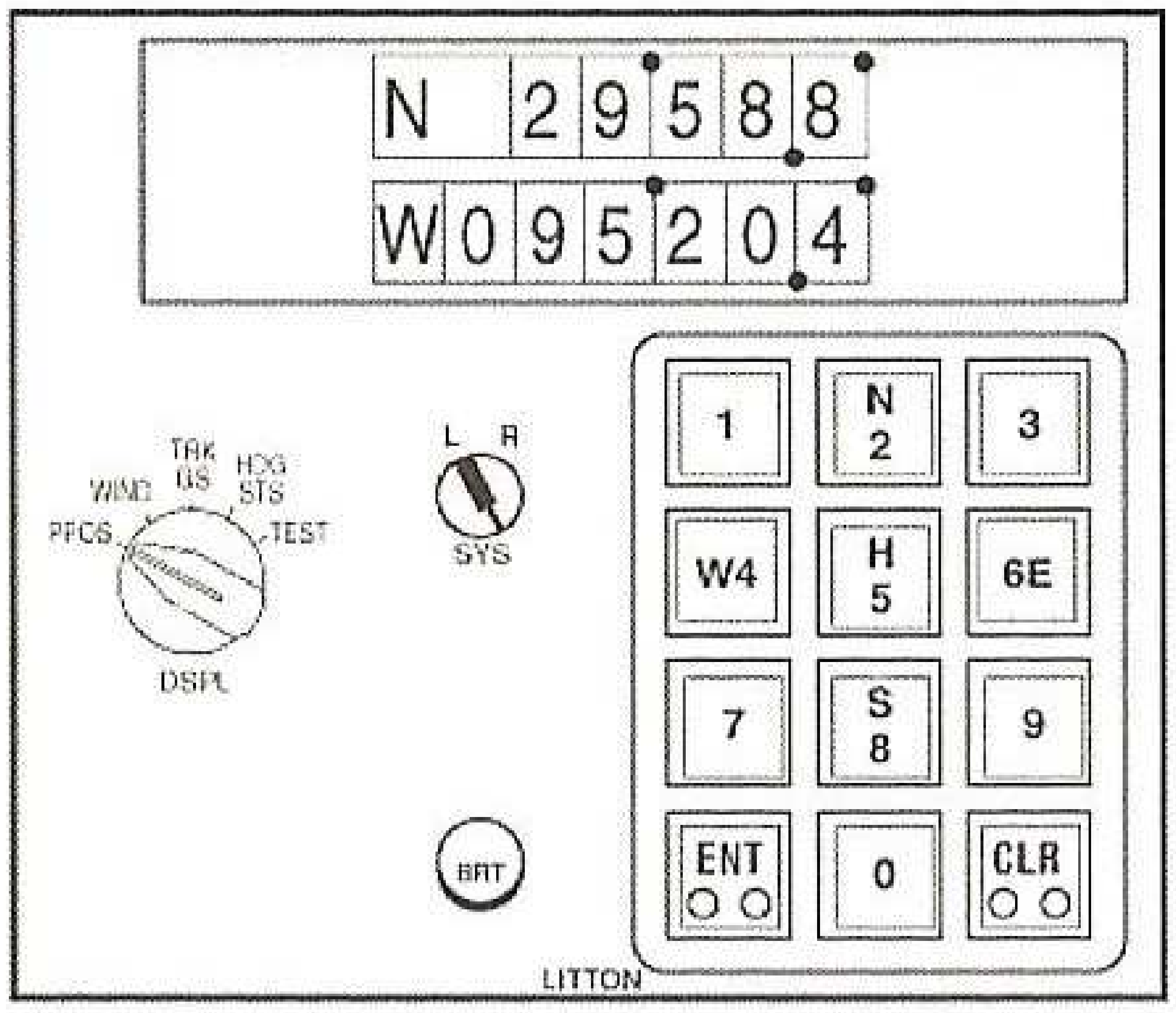


IRS SYSTEM DISPLAY UNIT (ISDU)

- powered by 28 vdc from left and right IRU/ADIRU

DATA DISPLAYS

- two segmented windows display data for the IRS selected with the SYS DSPL
- the type of data displayed is normally determined by the SYS DSPL, however keyboard entry of present position or mag heading will override the SYS DSPL
- the last digit of each window is for a decimal place (tenths)



DISPLAY SELECTOR

- selects the desired function or data for the data displays. Displays are for the IRS selected with the SYS DSPL

TEST (spring loaded)
- disabled in flight or in ATT mode
- all lights in the ISDU momentarily illuminate, then for 8 seconds fault messages are generated, followed by internal self-test
- respective ADI (L or R) indicates 45° bank to left then ATT flag
- respective HSI (L or R) indicates 15° heading (including RMI) then MAP flag

- positioning the Lights Test switch on the center instrument panel to TEST also illuminates all lights in the ISDU

TK / GS (Track / Ground Speed) - the left/top window displays true track angle (course) from 0 - 359.9 (0.1° resolution)
- the right/bottom window displays ground speed (knots)
- if the FMCs fail, the CDS shows ADIRS track and groundspeed

PPOS (Present Position) - present Lat and Lon are displayed (0.1 minute resolution)

WIND - the left/top window displays true wind direction
- the right/bottom window displays wind speed knots (will display 100 kts on ground)

HDG / STS (Heading / Status) - the left/top window displays true heading
- the right window displays any applicable IRU maintenance codes (last two digits)

MALFUNCTION CODE TABLE (display selector in HDG/STS) **01 - 10 (3-4-5) 01 - 38 (NG)**

01	ISDU FAIL	02	IRU FAILURE	03	EXCESSIVE MOTION	04	ALIGN FAULT
05	L DAA FAILURE	06	R DAA FAILURE	07	ADC DATA INVLD	08	ENTER PPOS
09	ENTER HEADING	10	ISDU POWER LOSS	18	NO ADR DATA	19	IR PROG PIN INVLD
20	ADR FAIL	21	ADR PROG PIN INVLD	22	TAT PROBE SIGNAL FAIL	23	AOA SIGNAL FAIL
24	NO AOA REF SIGNAL	26	NO BARO 3 REF SIGNAL	27	NO PITOT ADM DATA	28	NO STATIC ADM DATA
29	NO BARO 1 DATA	30	NO BARO 2 DATA	31	NO IR DATA	32	PITOT ADM DATA INVLD
33	STATIC ADM DATA INVLD	34	BARO 1 DATA INVLD	35	BARO 2 DATA INVLD	36	BARO 3 SIGNAL FAIL
37	IRU DATA INVLD	38	AIR/GND LOGIC INVLD				

- during IRS alignment the right window also displays the minutes remaining until alignment is complete
- (3-4-5 Honeywell) the window displays "7" (at the third digit) until the time remaining reaches 6 minutes. The display then counts down in 1 minute intervals
- (3-4-5 Litton) the bottom window displays minutes remaining until alignment is complete. Displays "10" then counts down in 1 minute intervals
- (NG) for alignments greater than 15 minutes, the window displays 15 until the time remaining reaches 14 and then counts down in 1 minute intervals

BRT (brightness control) - ROTATE: adjusts brightness of the data displays

SYSTEM DISPLAY SELECTOR (SYS DSPL)
- two position system display selects the left (L) or right (R) IRS for the data displays

KEYBOARD
- provides for manual IRS entry of present position or magnetic heading
- the keyboard functions independently from the positions of the display selector and the system display selector
- you can also use the CDU to enter the present position on the POS INIT page

ALPHA KEYS
- PRESS - the data displays are controlled by the keyboard when the N, S, E, or W (Lat / Long), or H (heading) key is pressed. Arms the keyboard for numeric entries

NUMERIC KEYS
- pressing permits manual entry of present position (Lat and Long) when either ALIGN light is illuminated
- permits manual entry of present magnetic heading when either mode selector is in ATT. You can also use the CDU POS INIT page for heading entry

CLEAR KEY (CLR)
- illuminated = the integral cue lights illuminate following an ENT operation if the self-test determines the data to be an unreasonable value (entry not accepted by the IRSs)
- pressing extinguishes the cue lights. If the cue lights are already extinguished, pressing the CLR clears the associated data display of data keyed-in but not yet entered (or not accepted)
- 2 or more maint. codes cause the CLR key light to illuminate - push to show codes

ENTER KEY (ENT)
- illuminated = the integral cue lights illuminate when the N, S, E, or W (Lat / Long), or H (heading) entries are being keyed

When keying is completed:
- pressing the cue lights extinguish and the keyed data is simultaneously entered into each IRS following completion of a valid self-test for data reasonableness. The data displays are again controlled by the display selector

(MEL) IRS Data Display - ATA 34
(on aft overhead) may be inop provided one FMCS CDU operates normally

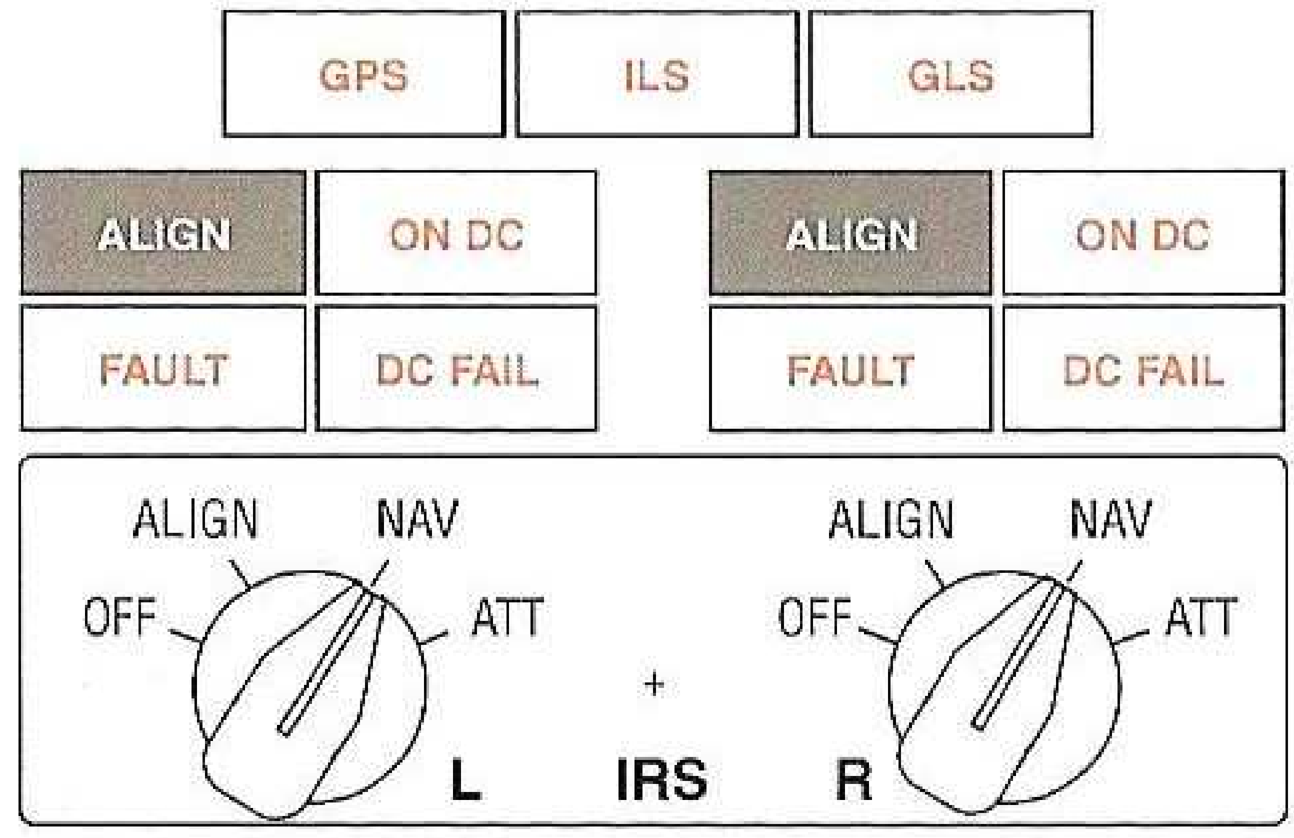
AIR DATA INERTIAL REF SYS (ADIRS) (NG)
- 2 primary functions: air data reference (ADR) and inertial reference (IR)
- provide inertial position and track data to the FMC as well as attitude, altitude and airspeed data to the displays
- ADIRUs process information measured by internal gyros and accelerometers, and from air data module inputs, the angle-of-attack sensors and other systems
- major components of the ADIRS are; 2 ADIRUs, 4 air data modules, an ISDU, a MSU, 6 static ports, 3 pitot probes, 2 angle-of-attack sensors, 1 TAT probe

(MEL) GPS (this should be on page 13 but I have a space problem)

Two GPSs required:
- for Non-localizer based GPS/Overlay approaches selectable in database if radio updating is unavailable during approach or if RNP limit demands its use for certain approaches

One GPS required for:
- for Non-localizer based RNAV/Overlay approaches selectable in database with single radio updating or if RNP limit demands its use for certain approaches

GPS not required for:
- RNAV/Overlay approaches selectable in database with dual radio updating or for Class II Navigation - ER (ETOPS)



IRS MODE SELECTOR
- controls the operating mode of the respective IRS

POWER SOURCE
- normal power for left IRS is 115 vac standby bus
- normal power for right IRS is #2 115 vac transfer bus
- alternate power for both is 28v switched hot battery bus
  - left until voltage drops < 18v
  - right for 5 minutes
- both AC and DC sources are required for start-up

(NG) ADIRS replaces IRS (Air Data/Inertial Reference System)
  - saves space and weight by putting ADC and IRU in a single unit

OFF (knob must be pulled out which decreases risk of accidental selection)
  - alignment is lost
  - all electrical power is removed from the system after a 30 sec shutdown cycle
  - after going to OFF, wait at least 30 secs before powering down aircraft

ALIGN
  - used for initial alignment or fast alignment. The plane must be parked.
  - from OFF to ALIGN initiates the alignment cycle (may be moved to NAV)
  - regular alignment is from latitude 70.2° south to latitude 70.2° north
  - high latitude alignment is from 70.2° north to 78.2° north and from 70.2° south to 78.2° south
  - fast alignment, the IRS must already be aligned and takes 30 seconds
    - position switch from NAV to ALIGN, enter present position, then return to NAV
      - will zero the system residual velocity errors and level the system
      - does not correct internal heading errors
  - if you go to ALIGN position in flight, you will lose the alignment

NAV (Navigation) detented
  - system enters the NAV mode after completion of the alignment cycle and entry of present position
  - provides full IRS data to airplane systems for normal operations. Normal position
  - ON DC light on for about 10 secs is normal
  - do not move out of this position inflight, or you will lose navigational reference!

  (NG) moving mode switch from NAV to OFF kicks yaw damper off

ATT (Attitude) 2 second delay prevents accidental selection
  - backup mode providing gyro data (pitch, roll, and compass) if nav function fails
    - heading precesses and must be occasionally re-entered
  - keep aircraft straight and level for 30 sec as IRU calibrates to 0° pitch and roll
  - IRS position and ground speed information is lost
  - cannot use FMC for navigation if all IRSs are in ATT

(QRH) IRS Inop
- attitude information is invalid (ATT flag in view and ALIGN light on)
  - if ATT is available, ATT flag will disappear in approximately 30 seconds
- heading information is invalid (HDG flag in view)
  - if ATT is available, HDG flag will disappear when the actual magnetic heading is manually entered via CDU or ISDU. The magnetic compass is your only valid heading reference to update the IRS heading if both IRSs are in ATT
  - in ATT, heading precesses approximately 15° per hour

(MEL) IRS - ATA 34 (EFIS 3-4-5 and NG) (NA for non-EFIS a/c - can't switch V/S)
- except for ER ops, one may be inop provided remaining IRS is used for both ADIs, both HSIs, and both VSIs. Flight is restricted to day VMC, standby mag compass and standby horizon operate normally, and the A/P is not used

ALIGN light (white)

- illuminated (steady) = the respective IRU is operating normally in either the ALIGN mode, the initial ATT mode, or the shutdown cycle
- illuminated (flashing) = alignment cannot be completed due to IRS detection of one of the following:
  - a/c movement stops alignment; when motion stops a new alignment begins (code 3)
  - significant differences between previous and entered positions (assumed error) or an unreasonable present position entry (actual error - code 4)
  - needs present position entry (code 8)
    - enter position. If it still flashes, enter a second time. You must enter the correct lat and lon. If second entry is req'd, you may have made a mistake in the entry!
- extinguished = IRS not in the ALIGN mode
  - (mode selector in NAV) alignment completed; full IRS data is available
  - (mode selector in ATT) attitude information is available; heading information is also available following entry of the initial magnetic heading

FAULT light (amber)

- illuminated = a system fault which affects the respective IRS NAV and/or ATT mode(s) has been detected

(QRH) IRS Fault

IRS MODE ....ATT
- if this attempt at partial recovery of the IRS works...

CDU OR ISDU .... ENTER HEADING
- if this fails

ATT & COMPASS SWITCHES ....BOTH ON 1 / BOTH OF 2
- placing the master LIGHTS TEST switch to TEST for 10 seconds may preclude this fault when associated with first alignment of the day

ON DC light (amber)

- illuminated = the respective IRS is operating on DC power from the switched hot bat bus (AC power is not normal and has been removed). Battery switch must be ON
- 5 second illumination is normal during alignment (backup DC power self test)
- right IRS will only operate for 5 mins on DC power

DC FAIL light (amber)

- illuminated when battery power is insufficient to maintain IRU operation (< 18v)
- if you see both DC FAIL lights come on, the switched hot battery bus is not powered or the battery is almost dead! Check BAT volts
  - loss of battery means loss of alternate DC power to the standby buses
  - cannot start the APU
  - if the amperage reading is negative, check the Battery (P6-4 E14), Hot Battery Bus (P6-4 E15), Switched Hot Battery Bus (P6-4 E16) and the Ground Service Bus (P6-4 E13) circuit breakers If one is found tripped, reset only once.

(QRH) DC Fail Light On (single, not both)
  - if the other lights are extinguished, the IRS is operating normally on AC power

(MEL) Right IRS DC Fail Light - ATA 34
  - may be inop provided remaining IRS MSU lights are not illuminated and A/P dual channel mode is not used during approach
  - if left IRS DC FAIL light illuminates, assume that both IRS DC FAIL lights are illuminated
    - refer to DC FAIL non-normal procedure

GPS, ILS, GLS LIGHT

GPS	ILS	GLS

- each light is dual channel
- with a single GPS, ILS or GLS failure, the light will illuminate when RECALL is pressed, indicating failure of a single receiver (nothing to do with loss of signal)
- with a dual GPS, ILS or GLS failure, the light will illuminate by itself
  - with loss of both GPS, the FMC will then obtain position information using radio (DME) and IRS sensor inputs
  - IRS annunciation and MASTER CAUTION also illuminate
- test NAV head as failure may have occurred in Multi Mode Receiver (MMR)

(QRH) GPS Inop

- domestic ops - no action required
- international ops - refer to nav equipment requirements for specific route
  Example: Class II Navigation in the Carribbean (route A300) requires two FMCs and two IRUs if both GPSs are inop. If one FMC is inop, at least one GPS is required
- circuit breakers labeled MMR1 and MMR2

NAV Systems Notes

- two Inertial Reference Units each contains three laser gyros and three accelerometers. These sense angular rates and linear accelerations. The sensed data is resolved to local vertical coordinates and combined with air data inputs to compute the following: position (latitude, longitude), attitude (pitch, roll, yaw), true and magnetic heading, windspeed and direction, velocity, accelerations, angular rate data, and altitude.
- IRU alignment consists of determining local vertical and initial heading. Both accelerometer and laser gyro inputs are used for alignment. The alignment computations use the basic premise that the only accelerations during alignment are due to the earth's gravity; the only motion during alignment is due to the earth's rotation. Accelerations due to gravity are always perpendicular to the earth's surface and thus define the local vertical. This local vertical is used to erect the attitude data so that it is accurately referenced to vertical. Once vertical is established, the laser gyro sensed earth rate components are used to establish the heading of the airplane.
- full alignment recommended time permitting
- normal alignment; OFF to NAV, ON DC lights for 10 secs, then ALIGN lights; enter PPOS
  (3-4-5) 10 minutes 6 seconds required for alignment
  (NG) variable alignment time as a function of latitude between a minimum of 5 min at the equator to 17 min at 78.25°, north or south latitudes
    - 6 min. 40 sec. in Newark (40North); 5 min. 20 sec. in Mexico City (19North)
    - 5 min. 9 sec. in Guayaquil (02South)
  - will not be more than 10 min if the present position lat is between 60° N and S
  - alignment time is fixed at 10 min between latitude of 60° and 70.2° N or S
  - alignment time is fixed at 17 min between latitude of 70.2° and 78.25° N or S
  - ADIRU will not align at a latitude more than 78.25° N or S because very little *earth rate exists (none at the poles)*
- magnetic variation is stored in each IRU memory
  - (3-4-5) between 73° North and 60° South (NG) between 82° North and 82° South
- in latitudes outside of these parameters, the heading provided by the IRU will be True
- residual ground speed when parked after a flight should be less than 20 kts
  - tolerance using the IRS MONITOR page should be 3 + 3T nm, where T = time (hrs)
- The flight management system (FMS) is comprised of the following components:
  - flight management computer system (FMCS)
  - autothrottle (A/T)
  - autopilot/flight director system (AFDS)
  - inertial reference systems (IRS)
  - global positioning system (GPS)
- each of these components is an independent system, and each can be used independently or in various combinations

- reasonableness tests
  - the IRU compares entered longitude with the LAST POS longitude stored in non-volatile memory
    - the IRU does not calculate its own longitude
    - if the difference you enter is greater than 1°, the ALIGN annunciator flashes, status code 4 shows and ENTER IRS POSITION displays on CDU
    - this could legitimately occur (i.e. the entry is correct) if the IRU was newly installed
  - the IRU also compares entered latitude with the LAST POS latitude
    - the IRU calculates its own latitude
    - if the difference is greater than 1°, the ALIGN annunciator flashes
  - a re-entry of the position data will be accepted, causing the align annunciator to return to its constant-on condition
  - after the alignment period, the entered latitude is compared with the IRU computed latitude during alignment
    - if no match, ALIGN will flash, SET IRS POSITION on CDU, ALIGN time "0" on ISDU
    - second entry of wrong latitude causes FAULT light to illuminate and status code 2
- GPS calculates latitude, longitude, altitude, accurate time, and ground speed
  - each system sends satellite signals to MMRs 1 and 2
- multimode receiver (MMR)
  - supports ILS and GPS functions and can be modified to support GLS
  - get inertial reference data from ADIRUs and contains GPS receiver
  - MMR sends data to FMCs, clocks, GPWS

(L/OP) Max Flight Operating Latitude

- 82°N and 82°S, except for the region between 80°W and 130°W, the max flight operating latitude is 70°N, and the region between 120°E and 160°E, the max flight operating latitude is 60°S

PROXIMITY SWITCH ELECTRONIC UNIT light (amber) (NG)

PSEU

- illuminates on the ground only
- illuminates when a no-dispatch type fault has been detected or when either air/ground system is in override mode
- OVERHEAD annunciator light and MASTER CAUTION illuminate
- dual channel light
  - resetting the MASTER CAUTION will extinguish the PSEU light if single channel fail
- light is reset by maintenance through a BITE check to repair the cause of the fault
- inhibited
  - when thrust lever is advanced for takeoff, in flight, and for 30 seconds after landing

(QRH) PSEU light

- if PSEU light does not extinguish when MASTER CAUTION is reset, do not takeoff

(MEL) PSEU Fault - ATA 32

- may be dispatched with faults indicated by the PSEU light
  - provided the PSEU is checked for faults before each departure
  - provided the PSEU light can be extinguished by pressing the MASTER CAUTION light and PSEU P/N 285A1600-4 or later is installed
    - if the PSEU light will not extinguish by pressing the Master Caution, a hard fault is present and requires evaluation by Maintenance prior to dispatch

(FIX) PSEU light on

- pull PSEU circuit breaker for excess of 10 minutes to clear memory

PROXIMITY SWITCH ELECTRONIC UNIT (PSEU) (NG)

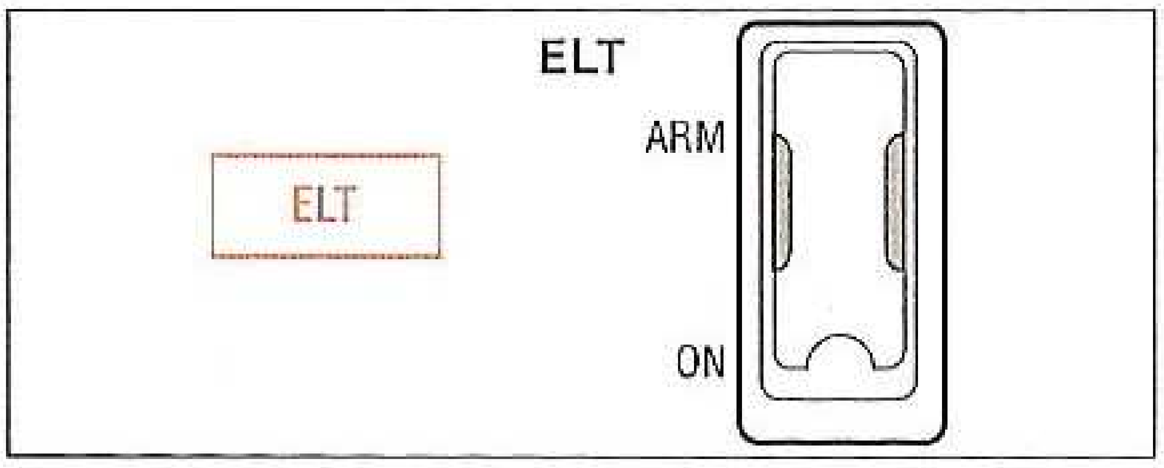
- PSEU is a component of the air/ground system
- many systems send signals to the PSEU through position sensors and switches
- these are the systems/components controlled by the PSEU

landing gear transfer valve	landing gear position indicating and warning
speedbrake deployed indication	takeoff warning
door warning	air/ground relays

VIDEO ON light (option)

- illuminated (white) - a video system program is being displayed in the cabin

ELT switch and light (option)



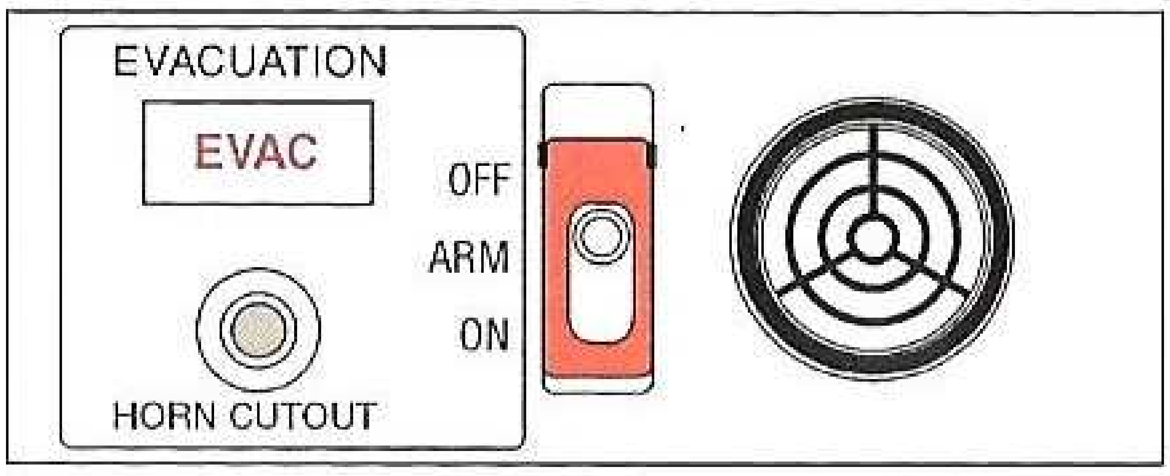
ELT light (amber)
- illuminates when ELT has been activated and is simultaneously transmitting on 121.5, 243.0, and 406.0 mhz
- if the ELT has been activated, it can be reset by placing the switch to ON then back to ARM

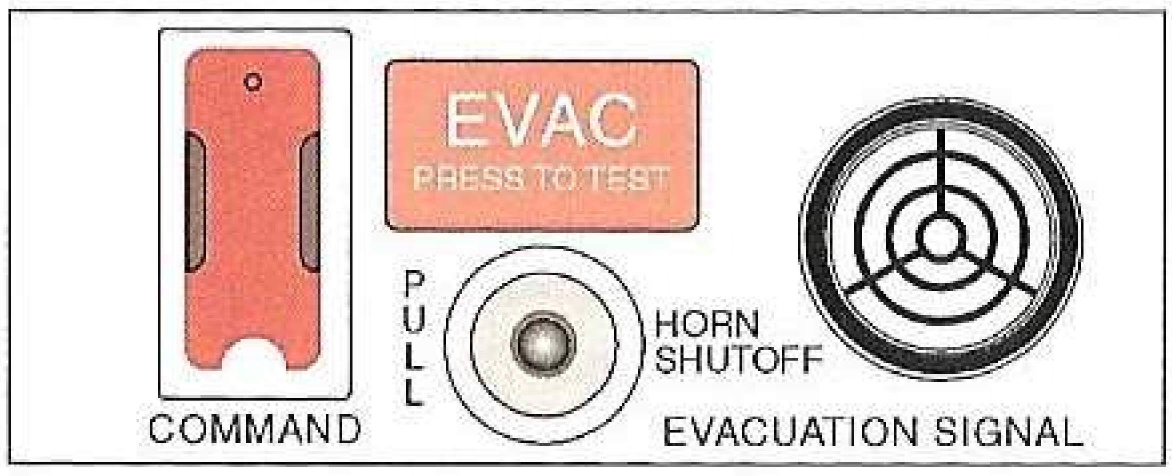
ARM (guarded)
- ELT transmits automatically when it reaches its preset G-Load limit

ON
- manually activates ELT

- in case of uncommanded ELT activation
  ELT SWITCH......................ON THEN ARM

EVACUATION CONTROL PANEL (option)





EVAC light
- illuminates (red) and flashes when any activation switch is moved to ON

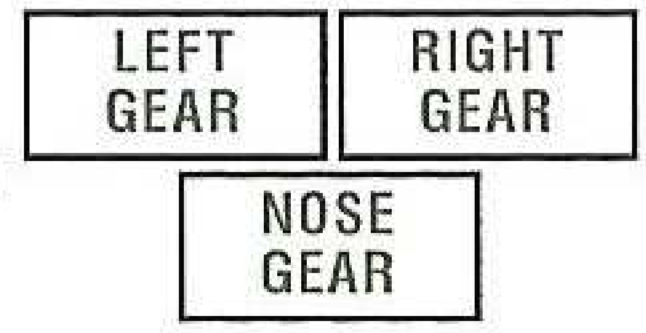
OFF
- deactivates FA EMER EVAC switch
- the cockpit alert light illuminates and a chime will sound if the FA EMER EVAC switch is activated

ARM (guarded)
- allows forward FA EMER EVAC switch to initiate evacuation signal

ON
- activates evacuation signal at all locations

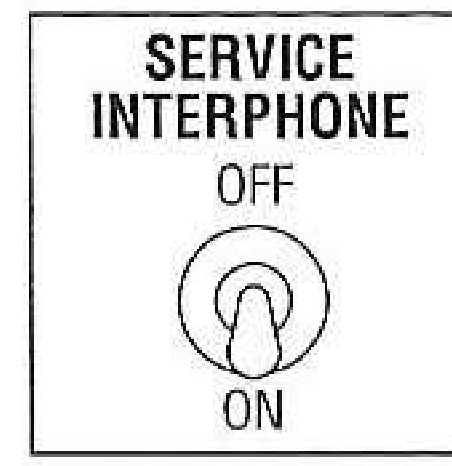
HORN CUTOUT
- push to silence the horn at that panel only

GEAR LIGHTS - AFT OVERHEAD (NG) (green)



- an auxiliary landing gear indicating system replaces viewing ports for the landing gear and illuminates when down and locked
- one green light for the specific strut is all that is required for a down-and-locked indication in flight, either from the front panel (primary) or from the aft overhead (auxiliary)
- both primary and auxiliary are required for dispatch

SERVICE INTERPHONE switch

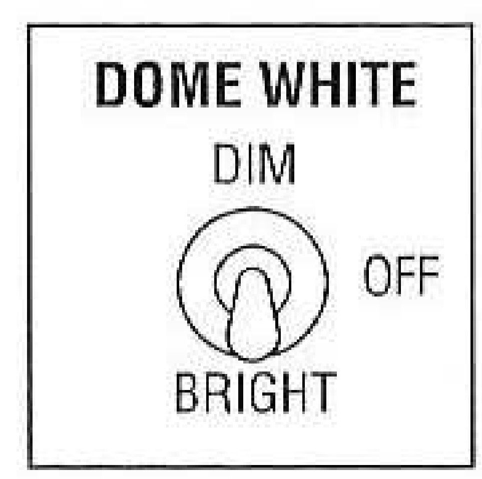


- provides communication between maintenance personnel and the flight crew through external jacks at various locations around the aircraft (external power control panel, EE compartment, fueling station, right and left main wheel wells, aft galley, and APU service area)

OFF
- external jacks are deactivated
  - disconnects microphone inputs
  - audio can still be heard
- communications between the cockpit and flight attendants is normal

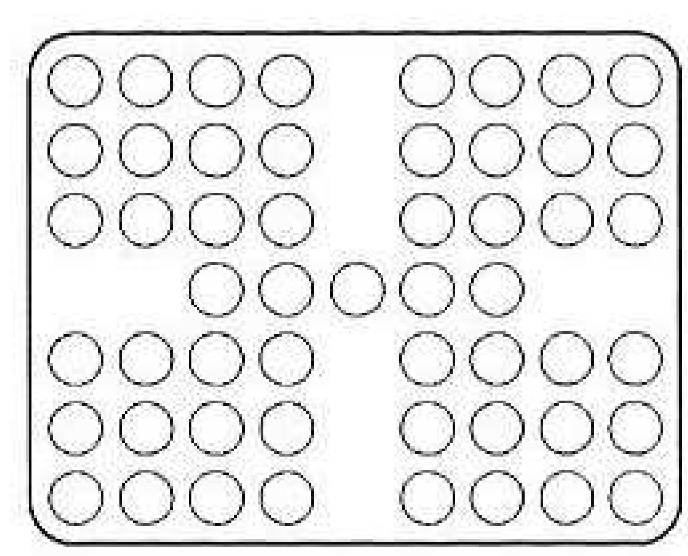
ON
- external jacks are connected
- communications between all Service Interphone jacks is available

DOME LIGHT



DIM / OFF / BRIGHT - controls two dome lights (P6 and P18 panels)
- left dome light has 2 bulbs - one is for the emergency exit light system

AURAL WARNING SYSTEM



- takeoff warning system (intermittent horn)
- cabin altitude warning system (intermittent horn)
- landing gear warning system (steady horn)
- digital flight control warning system (wailer for A/P disconnect)
- mach warning system (clacker)
- fire warning system (bell)
- SELCAL system (chimes)
- crew call system (chimes)

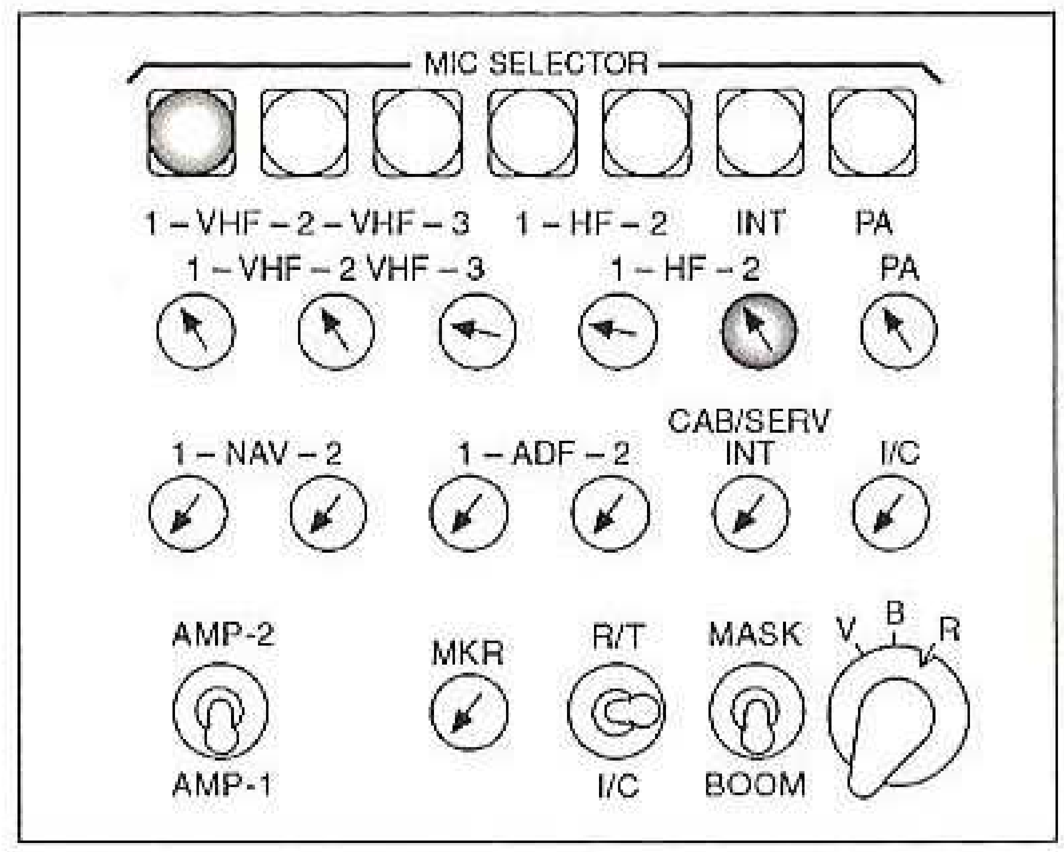
INTERPHONE SYSTEM

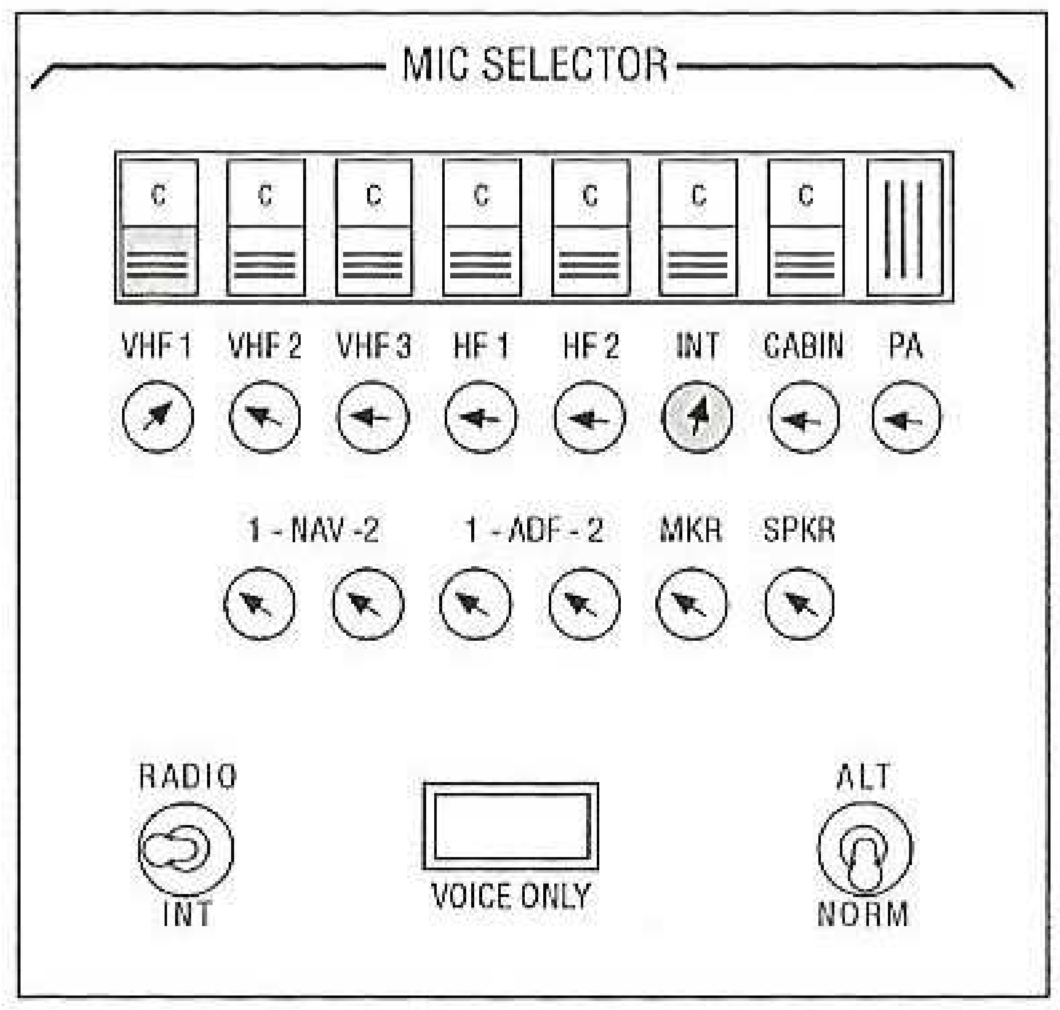
- consists of flight deck-to-ground, flight deck handset, cabin attendant handset, alerting system (chime/light on flight deck and galleys)

AFT OVERHEAD PANEL

AUDIO SELECTOR PANELS - ASP *(your layout will be different)*

- the Remote Electronic Unit (REU) manages the communication between the flight deck stations, service and flight interphone, and all related communication, radio, navigation, and recorder system
- it determines which selections have been made on the ASP, and then sends appropriate signals to the selected systems





MIC SELECTOR

- press to activate respective radio or PA
- lights up only one switch at a time
- allows reception also, even if receiver switch is not pressed (except for the interphone)
- can also use hand microphone which bypasses the ASP
- SVC = Service Interphone
  - to cabin and exterior jacks
- PA: mutes speakers (EFIS mutes only respective speaker)
  - overrides the flight attendant PA
  - could also use pedestal hand mic

RECEIVER switches

- press to activate respective radio; press again to deactivate
- rotate for volume
- may push multiple switches
- illuminates when pushed

FILTER switch

V (Voice) - receives only NAV/ADF voice audio
B (Both) - receives NAV/ADF voice and 1020 Hz identification signals (no filters used)
R (Range) - the 1020 Hz coded ID signals are passed while the audio is attenuated

MASK-BOOM or OXY-BOOM switch (if installed)

- selects the oxygen mask or boom microphone for transmissions
- (option) switch removed - auto switches to mask when mask regulator is pressurized

PUSH-TO-TALK switch

- spring loaded to center position

R/T (radio/transmit)
  - keys the oxygen or boom mic for transmission as selected by Mic Selector
  - can also use switch on pilot yoke (lower to interphone, upper for Mic Selector)

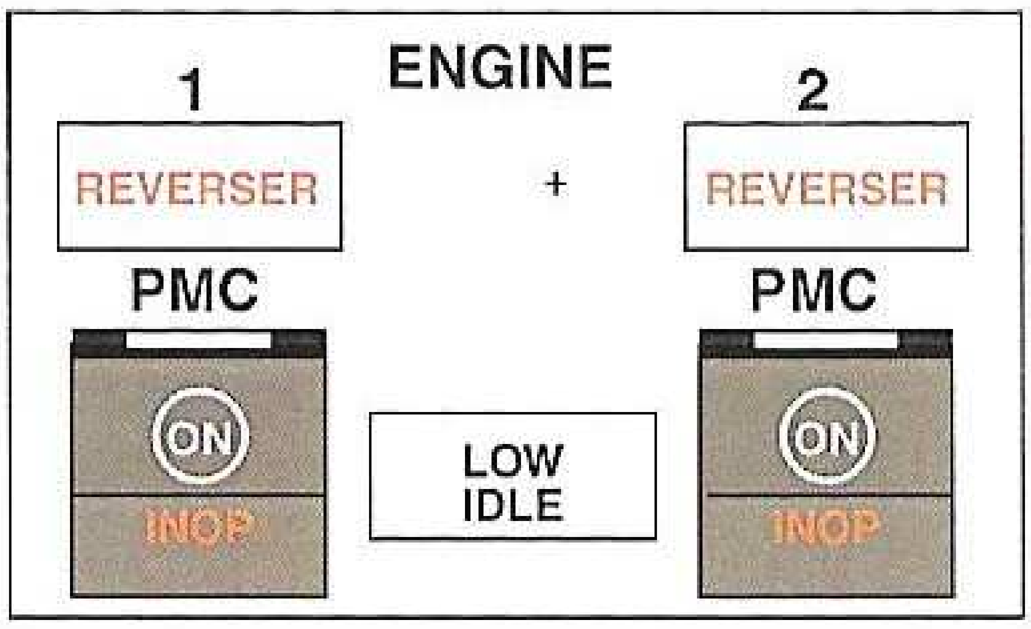
I/C (intercom)
  - keys the interphone; bypasses the Mic Selector

AMPLIFIED switch (non-EFIS)

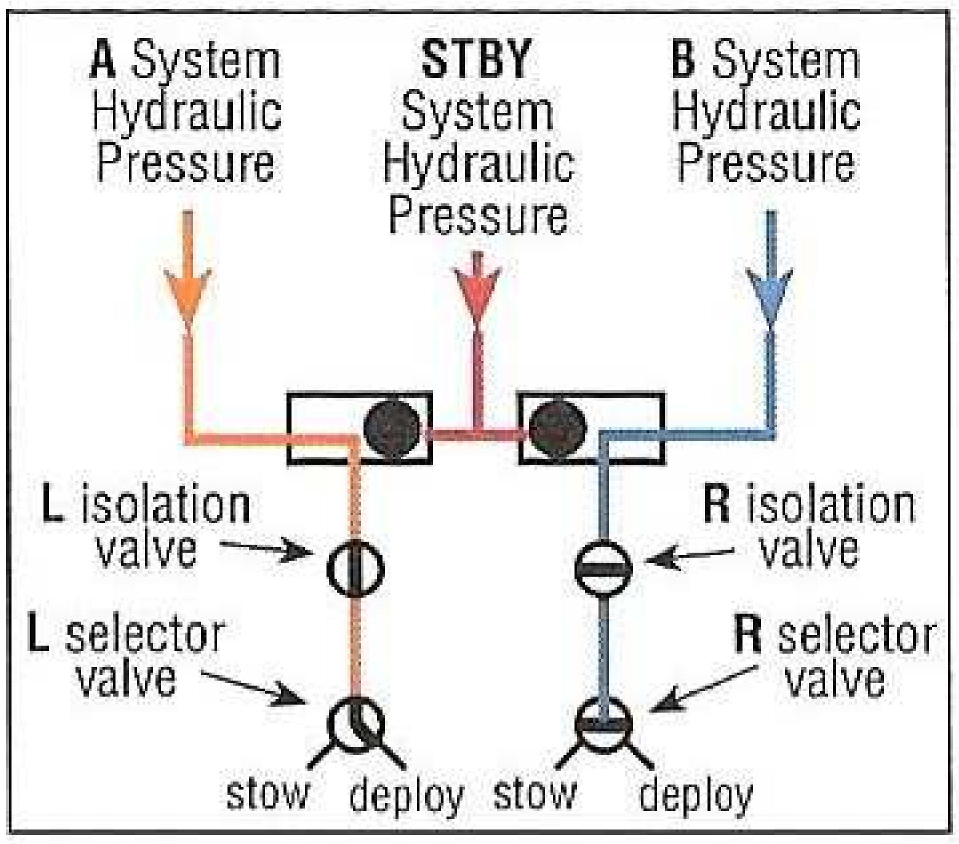
- used to select the desired amplifier for the ASP
- there are ASP panels for Captain, FO, and jump seat
- both Capt and FO have an overhead speaker, with integral ON/OFF volume controls
- on EFIS aircraft, volume controlled by ASP speaker and individual volumes

ALT / NORM switch

- ALT degraded mode hardwires Capt and observer's PTT to #1 Com, FO to #2 Com
- no speaker in ALT mode and headset volume control is preset
- hand mic, PA and interphone from respective ASP are inop



REVERSER LIGHTS (amber)
- illuminates for 10 sec. during normal T/R stow operation
  - extinguishes 10 seconds later if the reverser sleeves are fully stowed and the isolation valve is closed
- if the REVERSER light illuminates at any other time, a malfunction has occurred
- if a REVERSER light is on for more than 12 secs the MASTER CAUTION and ENG annunciator lights come on
  - isolation valve or thrust reverser control valve (selector valve) is not in commanded position
  - one or two T/R sleeves are not in their commanded position
  - auto-restow circuit has been activated
  - (NG) a failure has been detected in synchronization shaft lock circuitry



(QRH) Reverser Light On

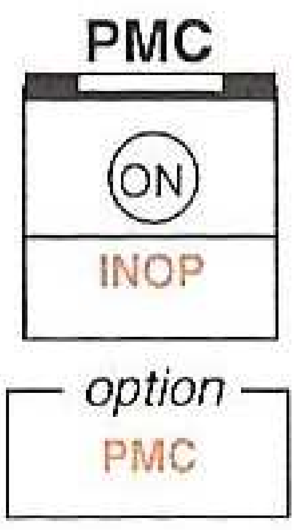
inflight
  - additional system failure may cause uncommanded reverser deployment

on ground
  - pull and reset IND/SYS and CONT/SYS C/B (P6-2, C-5 thru 8)
    - do not pull these C/Bs in flight
  - if that doesn't work, cycle the reverse thrust lever (someone must clear the engine)
  - if the light remains illuminated, do not take off

PMC (3-4-5)

POWER MANAGEMENT CONTROL (PMC) switch (3-4-5)

ON - (ON in view) the PMC is on
OFF - (blank) the PMC is selected off
option - the PMC switches are on the E11 rack in forward EE compartment



(L/OP) Powerplant, PMC
- both PMCs must be either ON or OFF for takeoff

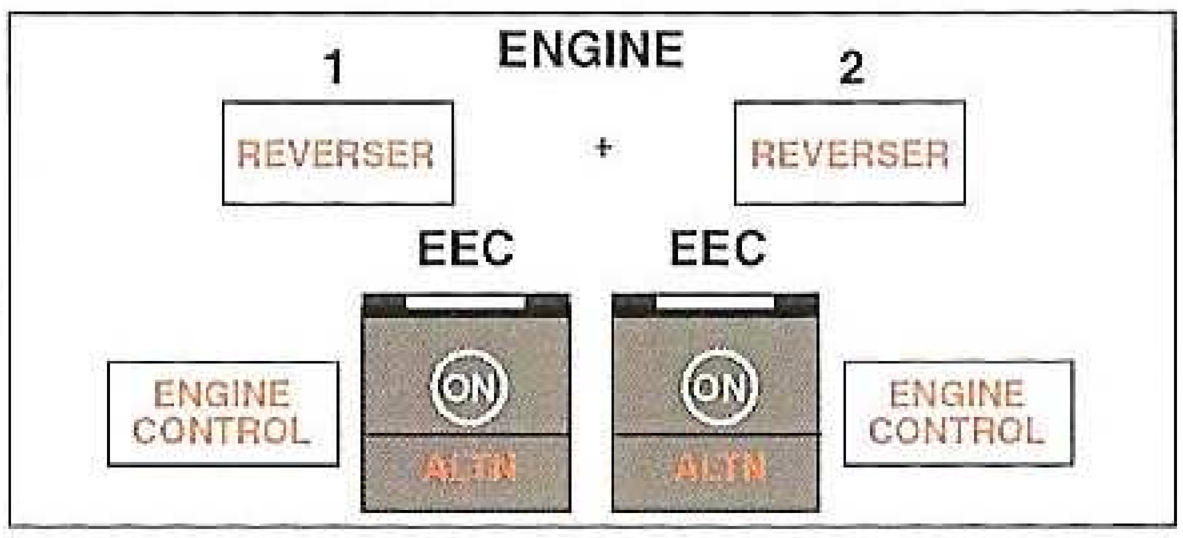
PMC INOP lights (amber) (3-4-5)
- illuminated = the PMC is inop or the PMC is selected OFF
  - MASTER CAUTION and ENG annunciator illuminate
- extinguished indicates that PMC has been selected ON and no faults exist
- inhibited during starter engagement
- performance penalties with PMC inop (see your Flight Manual)

option - PMC inop lights on overhead are labeled PMC and function the same

(MEL) PMC Inop - ATA 73
- may be inop provided both are turned off and performance adjustments are made

LOW IDLE light (3-4-5)
- air/ground sensing prevents LOW IDLE light from illuminating on the ground
- illuminated = shows there is not sufficient engine RPM
  - start lever is IDLE and engine speed is less than 25% N1 in flight (push throttle up)
  - idle reset solenoid (provides low idle on ground) is energized and TLA is 9.5° or less
- MASTER CAUTION and ENG annunciator illuminate
- deactivated when an engine start lever in CUTOFF
- (option) start switch is in FLT and one or both engines are below 45% above 500 ft RA

EEC (NG)



ELECTRONIC ENGINE CONTROL

ON (white)
- indicates normal control mode is selected
- engine ratings calculated by EEC from sensed atmospheric conditions and bleed air demand

ON (blanked)
- switches have been manually de-selected

ALTN in view (amber)
- related EEC has automatically switched or manually selected to the alternate mode
- both ON and ALTN in view if the EEC has automatically switched to soft alternate mode

(QRH) EEC Alternate Mode

on ground
- consult MEL 73-10 for effectivity. If aircraft is not in compliance, do not takeoff. If in compliance, place both EEC switches to ALTN, turn the autothrottle off, and (-7) use full rated thrust (-8-9) reduce max takeoff thrust by 2.2% N1.

in flight
- autothrottle off, retard both thrust levers to mid position, and place both EEC switches to ALTN (push one switch at a time and ensure that the switch is in it's outermost position. The white ON light goes out, indicating hard ALTN mode selected. Turn autothrottle on. Max thrust limiting is available with autothrottle on. Both engines must be operated in the alternate mode.

ENGINE CONTROL lights (NG) (amber)
- EEC detects an engine control failure that does not allow airplane dispatch
- does not come on in flight
- comes on when all these conditions occur:
  - airplane is on the ground, an engine is running, groundspeed less than 80 kts, and a no dispatch engine fault occurs
  - re-activates on the ground more than 30 seconds after landing

(QRH) Engine Control light
- DO NOT TAKEOFF with this light illuminated

Engine System Notes

1. PMC (3-4-5)
   - provides signals to the main engine control (MEC) to adjust N1 fan speed to compensate for variations in fan inlet temperature and pressure
   - provides electronic adjustment of the MEC to obtain optimum power settings for take-off, climb and cruise flight conditions without constant adjustment of the thrust lever
   - provides smooth acceleration, minimizes EGT overshoot, and offers limited overspeed protection
   - powered by the N2 speed sensor, which is an ac generator
   - when a takeoff is performed with the PMCs OFF or inop, engine rpm may be expected to increase as speed increases during the takeoff roll. This increase in rpm may be as much as 7% at high airport elevations. The takeoff performance charts for PMC OFF take into account the rpm change. Normal thrust setting technique for takeoff should be employed, with thrust set by 60 kts. Do not reduce thrust during takeoff after once correctly setting thrust, unless engine parameters increase above maximum limits (red radials). PMC OFF takeoffs may be performed using the autothrottle
   - V1MCG must be increased to compensate for increased differential thrust during takeoff
2. EEC (NG)
   - controls the engine fuel and control system
   - has 2 modes, normal and alternate, to control HMU electronically ("throttle by wire")
     - HMU supplies fuel for engine servo valves and combustion (burner stage valve)

  - normal mode, the EEC limits thrust to max certified for current conditions
- each EEC has two computers, called channels (A and B)
  - one is in active control while the other computer is in standby (dual channel mode)
  - independent but connected by a cross channel datalink (CCDL) during engine ops
  - if the active channel is not valid, EEC changes the stby channel to the active channel
  - swaps channels at each engine start if the previous engine run was more than 76%
- EEC calculates the engine thrust with N1 speed and ambient pressure and temperature conditions. The EEC uses N1 speed to control engine thrust
- EEC uses N2 speed for thrust management and idle control
- EEC gets TAT from T12 sensor on the engine while on the ground and from the #1 ADIRU 5 minutes after takeoff (needs airflow through heated probe to be useful)
- during engine starts on the ground, the EEC can detect hot, hung, and wet starts
- provides auto-relight for flameout protection
- normally powered by EEC alternator on the front face of the accessory gearbox
  - respective transfer bus provides power when EEC does not receive power from the EEC alternator, such as during engine start until N2 is 15%
- 2 modes, normal (**ON**) and alternate (**ALTN**), to control HMU electronically
  - HMU supplies fuel for engine servo valves and combustion (burner stage valve)
  - normal mode, the EEC limits thrust to max certified for current conditions
    - static air temperature is calculated from TAT and Mach number
- 2 alternate EEC modes, soft and hard (also called soft and hard reversionary modes)

  soft alternate mode
  - automatically switches when the EEC does not receive all inputs it requires
  - both **ON** and **ALTN** in view if the EEC has automatically switched to soft alternate mode
  - thrust can be less than normal or engine exceedance can occur if outside air conditions change; Mach number is not available so EEC has to estimate Mach number
  - with automatic transfer, EEC locks in a thrust offset to prevent thrust from changing when the control mode changes; this thrust offset is removed if the thrust lever is retarded to idle or if **ALTN** is selected
  - if one EEC is in normal and the other is in soft altn, it can cause thrust lever stagger
  - loss of either DEU results in a loss of signal to both EECs
    - the EEC **ALTN** lights illuminate and each EEC reverts to the alterate mode to prevent the engines from operating on a single source of data

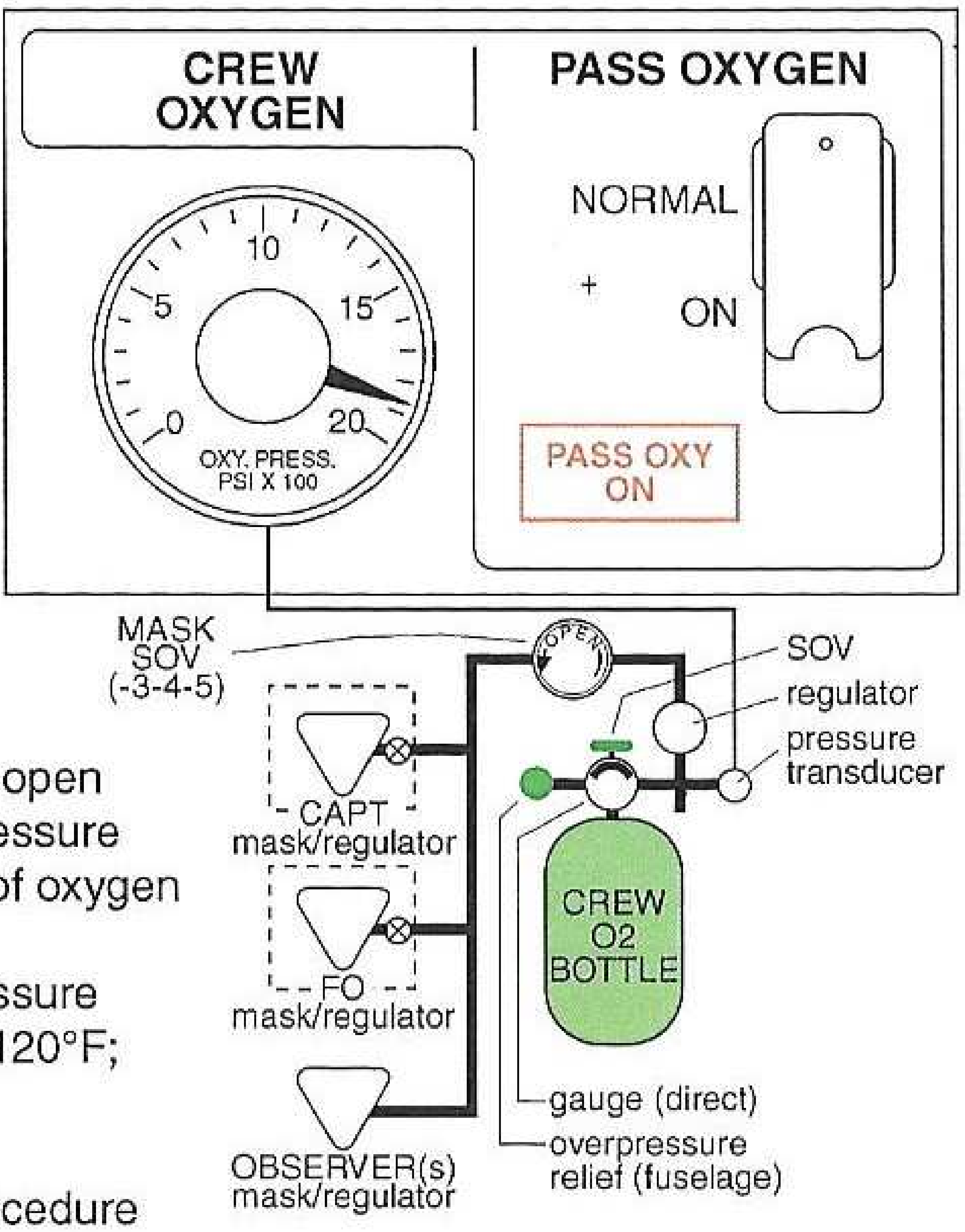
  hard alternate mode
  - switch manually selected **OFF** - only **ALTN** in view; **ON** is blanked
  - placing both EECs in hard alternate (**ALTN**) prevents thrust lever stagger
  - EEC uses internal software table to calculate mach number thrust rating
  - N1 or EGT exceedances are possible during hot day conditions
- at higher thrust levels there can be an uncommanded large thrust change when the EEC changes from the soft alternate mode to the hard alternate mode
- provides N1 and N2 redline overspeed protection in both normal and alternate

3. Idle speeds

   (3-4-5) has 2 idle speeds, low (approximately 22% N1) and high (approximately 32% N1)
   - high idle is used for all phases of flight, which varies slightly with flight conditions
   - to reduce braking requirements, high idle switches to low idle 4 sec after touchdown
     - the 4 sec delay is provided to enhance engine speed acceleration for reverse thrust
     - engine is held in low idle by a solenoid; therefore with normal electrical failure engine automatically goes to high idle

   (NG) has 3 idle speeds controlled by the EEC
   - ground idle, flight idle and approach idle
   - approach idle is selected in flight if flaps are in landing configuration or engine anti–ice is ON for either engine
     - approach idle improves engine acceleration time for go-around
     - in flight, if a fault prevents the EEC from receiving flap or anti–ice signals, approach idle schedule begins below 15,000 feet MSL
     - approach idle is maintained until 5 sec after touchdown

OXYGEN



CREW OXYGEN GAUGE and MISC

- reads pressure on crew O2 bottle in fwd cargo compartment
- green thermal discharge disc (3-4-5) forward of fwd cargo door (NG) - in aft EE compart with an access door in the forward cargo
- O2 gage is electrical (Batt bus so needs battery switch on)
- (3-4-5) mask shutoff valve (SOV)
  - located behind FO; CCW to open
  - if you're coming onboard after O2 maintenance, check the mask SOV is open
  - if the mask SOV is closed, trapped pressure will provide approximately 3 seconds of oxygen

(L/OP) Crew Oxygen, Quantity
  - reference chart for minimum crew pressure
  - 737 psi adequate for crew of three at 120°F; 1000 psi will cover all situations

(MEL) Oxygen Pressure Indicator ATA-35
  - may be inop provided an alternate procedure is used to verify that O2 supply is above min requirement for dispatch

CREW O2 BOTTLE PRESSURE FOR VARIATIONS OF AMBIENT TEMPERATURE 114FT^3

BOTTLE TEMPERATURE °C	°F	NUMBER OF CREW USING OXYGEN 2	3	4	BOTTLE TEMPERATURE °C	°F	NUMBER OF CREW USING OXYGEN 2	3	4
50	122	530	735	945	15	59	470	655	840
45	113	520	725	930	10	50	460	645	830
40	104	510	715	915	5	41	455	635	815
35	92	505	700	900	0	32	445	620	800
30	86	495	690	885	-5	23	440	610	785
25	77	485	680	870	-10	14	430	600	770
20	68	480	670	860					

PASS OXYGEN switch

NORMAL
  - automatic activation (electrical) at or above 14,000 ft cabin alt to drop masks
  - (option) activation above 14,650 cabin alt for a/c that operate into high elevation a/p

ON
  - manually activates system electrically to drop masks (consider placing to ON even if masks have already been activated automatically, to make sure)

Note: If the passenger oxygen system is activated either automatically or manually, the FASTEN SEAT BELT sign will illuminate if the FASTEN BELTS switch is in AUTO; the RETURN TO SEAT lights will not illuminate. The NO SMOKING lights (if installed) will illuminate if the no smoking switch is in AUTO

(option) the cabin ceiling lights will illuminate bright when the passenger oxygen system is activated either automatically or manually

PASS OXY ON light

- passenger system activated manually or automatically to drop masks
- MASTER CAUTION and OVERHEAD annunciator illuminate

Passenger Oxygen Notes

1. oxygen generators
   - 1 generator at each PSU, Flight Attendant Station, Lav and (option) galley
   - supplies oxygen for approximately 12 minutes (for descent)
   - creates oxygen through a chemical reaction by mixing sodium chlorate and iron
   - heat causes the white stripe on the generator to turn black indicating the generator has been fired (chemical reaction can cause generator temp to reach 450°F / 232°C)
2. oxygen masks
   - extra mask per each PSU (for F/A or child) - 4 masks for 3 seats
   - 2 masks in each lav, at each F/A station and galley area (if equipped)
   - pull firmly on tube to activate / fire the generator
     - O2 will flow to all masks in that unit providing continuous flow to reservoir bags
   - green in-line flow indicator shows O2 is going through the hose
   - mask doors can be opened manually with a pen at PSU's and with a credit card in lavs, at F/A stations and galley areas (if equipped)
   - once activated, the O2 flow is constant and cannot be shut off; it must be reset by mx
3. relay turns light on (PASS O2 ON)
   - relay should power solenoids to open PSU doors
     - light just means power went to the relay. Doesn't mean the doors opened for sure
4. WARNING: Oxygen in Use
   - when using passenger oxygen, the NO SMOKING sign should be on and strictly observed
   - do not use passenger oxygen with cabin altitude below 14,000 feet when smoke or an abnormal heat source is present. The use of passenger oxygen will not prevent the passengers from inhaling smoke
   - air inhaled is a mixture of oxygen and cabin air (2 valves on bag to ambient air)

PORTABLE OXYGEN BOTTLES (POB)

- 120 liters (4.25 cubic feet at 70°F), constant flow, charged to 1800 psi
  - high port 4 LPM, for first aid use (some marked with red dot)
  - low port 2 LPM, for walk around use (some marked with blue dot)
  - try to stop use at ± 500 psi so bottle does not have to be flushed
  - your carrier may require mask to be attached to a specific port

(MEL) Oxygen, Portable Bottles - ATA-34

- minimum of 1 bottle for each required F/A, (1 FA for each 50 seats)
  - i.e. you'll need 3 in all series 737 except the -800/900; there you'll need 4
  - special crew such as foreign language speakers may not be required crew

(MEL) Portable Oxygen Dispensing Units - ATA 35

- minimum dispatch pressure for the portable oxygen bottle is 1500 psi @ 70°F

(MEL) Passenger Oxygen System - ATA 35

- may be inop provided route has an MEA of 14,000 ft MSL or less, both the packs operate normally,remaining components of the pressurization system operate normally,airplane remains at or below FL 250, portable oxygen units are provided for 10% of the passengers ,and passengers are appropriately briefed

CREW OXYGEN BOTTLE (optional) and PBE

- 1 in cockpit , behind FO - (11 cubic feet at 70°F), 1850 psi, includes face mask
  - use large outlet - demand regulator for full face mask, supplies 100% O2 on demand
  - use small outlet for continuous flow mask and pressure regulator
    - 103 minutes at 3 liter constant flow
  - to turn ON: Yellow knob "Open" (open CCW)
- one PBE (protective breathing equipment) in the cockpit; self contained hood to breath and see in smoke, etc. Provides O2 for approximately 15 minutes

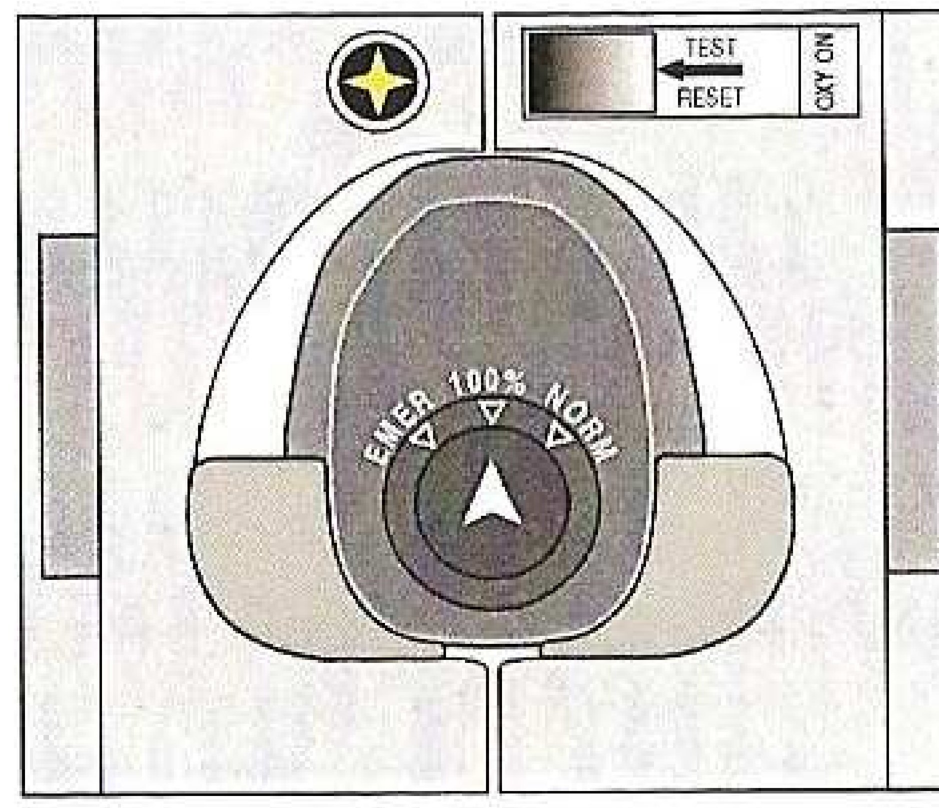
(REG) FAA - Oxygen Use By Passengers

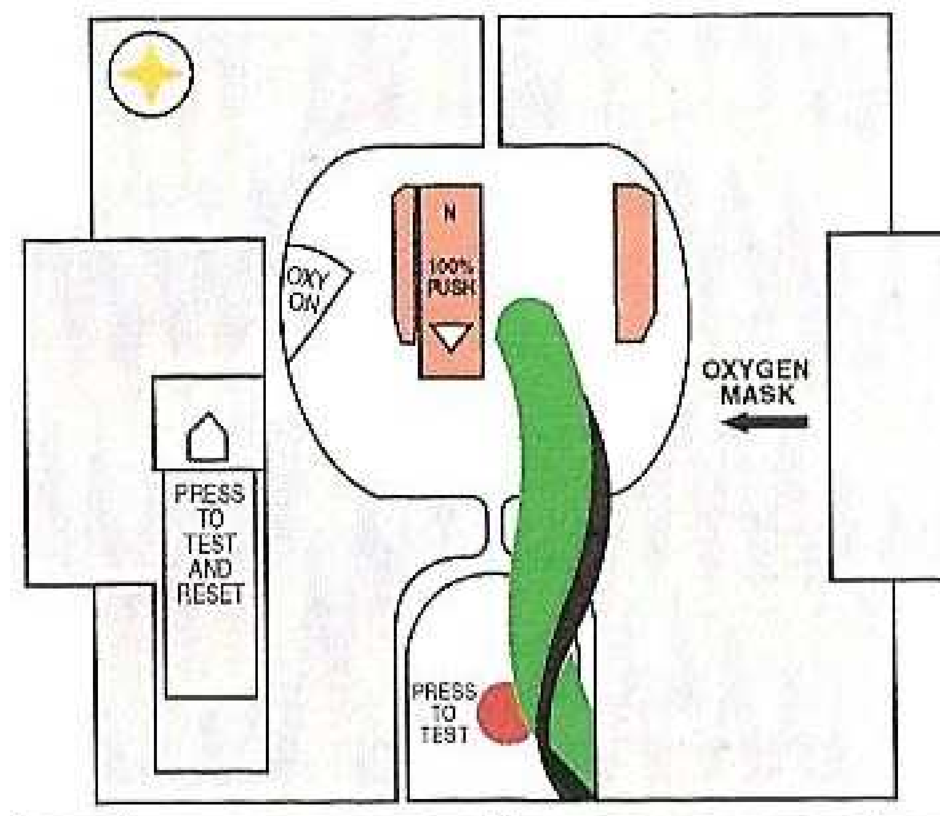
- passengers need oxygen above 15,000 ft

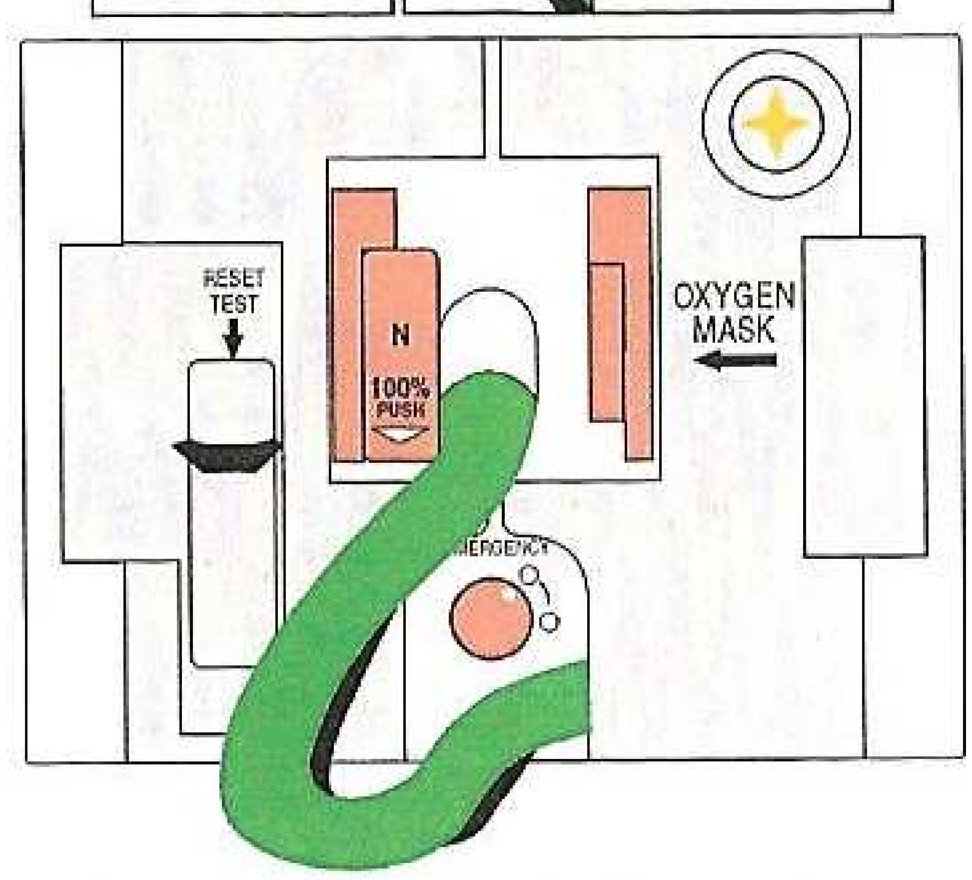
(REG) ICAO - Oxygen Use By Passengers

- between 10,000 ft and 13,000 ft MSL, passengers need oxygen except for first 30 min.

AFT OVERHEAD PANEL







CREW OXYGEN MASK

RESET / TEST

- press or slide - with the left O2 mask panel door closed and the OXY ON flag not displayed, turns O2 on momentarily to test regulator
- left door opens valve to masks, O2 ON flag
- flow indicator:
  black = no flow, yellow cross = O2 flow (no flow indicator on jump seat mask(s)
- red release lever: squeeze and pull to get mask

MASK USE

- squeeze and pull up right red lever to inflate harness - release to secure on head

NORMAL / 100% Selector

- Normal (lift) mixture (diluted with cabin air to allow bottle to last longer)
- ratio depends on cabin altitude
- 100% (push) O2 on demand

EMERGENCY / TEST Selector

- for Emergency: rotate clockwise 100% under positive pressure at all altitudes
- to Test: press red knob (O2 to mask)

- use RESET TEST and/or open left door to insure O2 is flowing (O2 FLAG on)

OXYGEN MASK PREFLIGHT CHECK

Note: it is not necessary to remove mask to perform the preflight check

- make sure mask is stowed properly and set to 100%
- place MASK / BOOM switch to MASK (if installed)
- flt interphone volume knob on ASP up
- turn speaker volume up
- press I/C transmitter with one hand
- press I/C transmitter and hold the RESET/TEST lever down listening for sound of escaping O2 over speaker or headset, then release I/C switch
  - observe yellow cross to confirm oxygen flow
  - check O2 gauge is within limits; if it dropped to zero, the valve at the bottle is closed
- check operation of emergency airflow by selecting emergency button or position for 3 seconds (3-4-5) this also checksmask SOV is not closed

Crew Oxygen Mask Notes

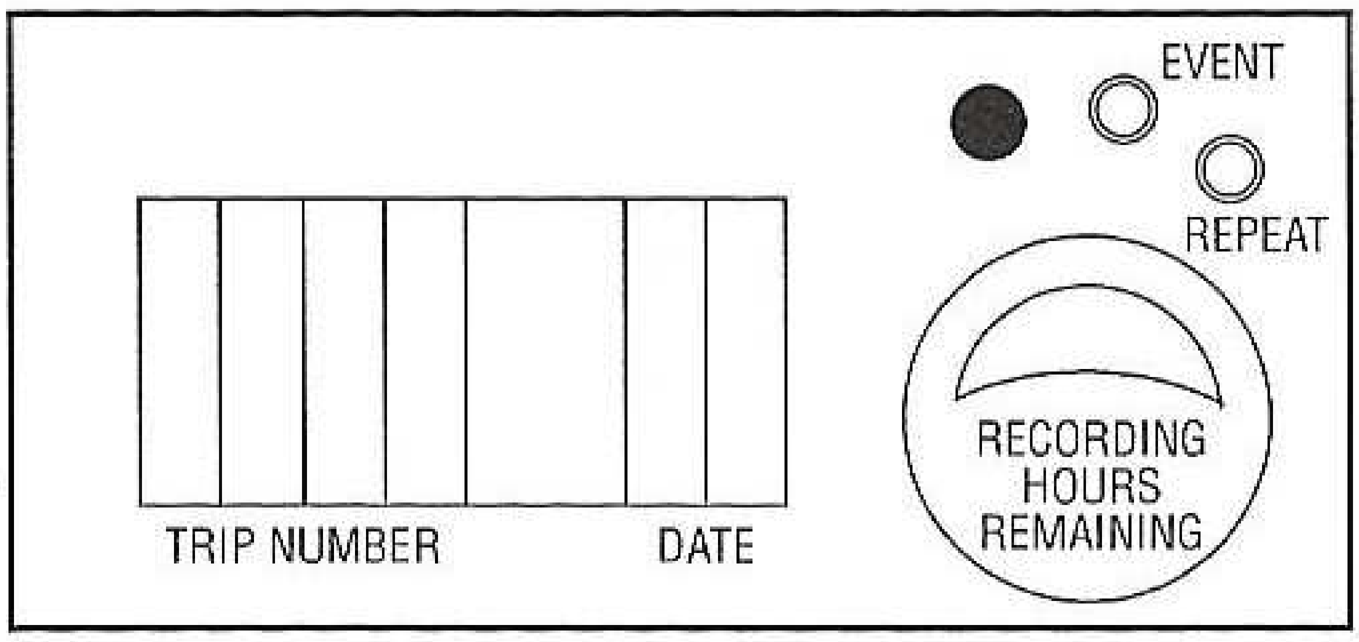
- with mask out and door closed, mask has pressure if OXY ON flag is in view, whether door is open or closed. Oxygen may leak from mask in this situation if left for long period
- to shut off O2 to mask, close door and press or slide RESET TEST. Oxygen is cutoff to the mask. Mask valve is opened (flow restored to mask) by opening the left door
- mask and goggles were designed to be put on and communications established within 15 seconds. Can you do this?
- observer's mask(s) is identical except has no stowage box, flow indicator, or reset lever
  - stowage box is optional equipment for observers mask

(REG) FAA - Oxygen Use By Flight Crew

- between 12,500 ft and 14,000 ft MSL, crew must use oxygen except for first 30 min.
- crew must use oxygen above 14,000 ft

(REG) ICAO - Oxygen Use By Flight Crew

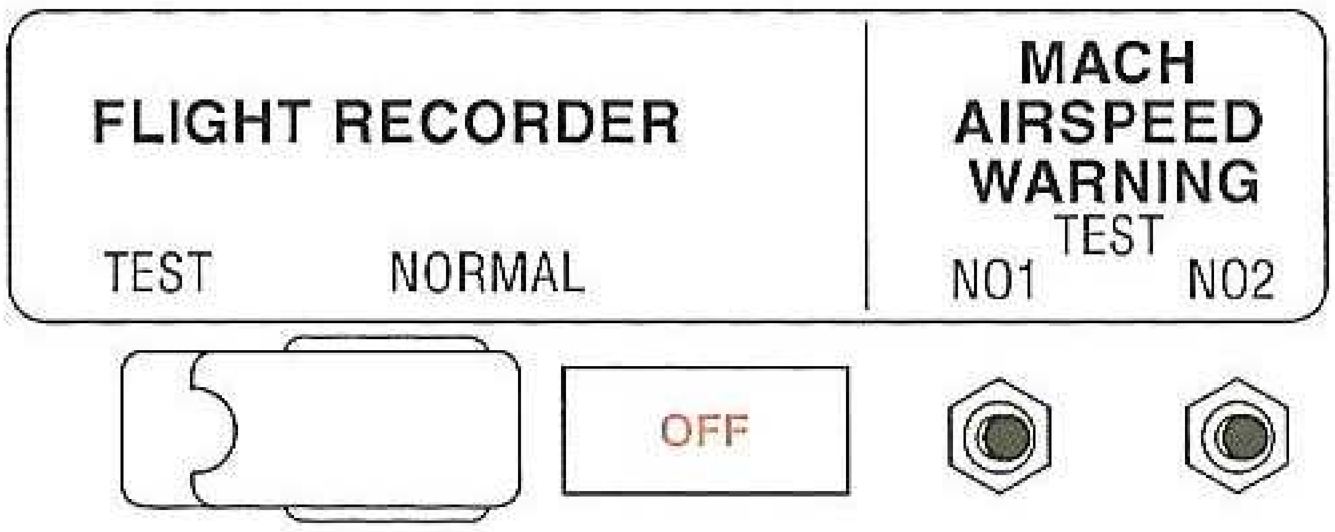
- crew must use oxygen above 10,000 ft



FLIGHT DATA RECORDER
- AC and DC powered

TRIP DATE SELECTOR (option)
- sets trip number and date (use local date, not "Z" date)
- EFIS and (NG) ACARS will automatically load this data

TRIP DATE LIGHT (amber) (option)
- illuminated = trip and date information is being recorded
- the 15 minute transcribing cycle does not interfere with the recording of other info



EVENT switch (option)
- pressing transcribes a mark on the tape to identify the time of the event
- do not use until after the Trip Date light is extinguished

REPEAT switch (option)
- press - hold until Trip and Date light illuminates
- repeats transcription of the trip and date information (forgot to set properly)
- initial application of power initiates transcription

RECORDING TIME REMAINING INDICATION
- not used (reads 0 at all times)

FLIGHT RECORDER TEST switch

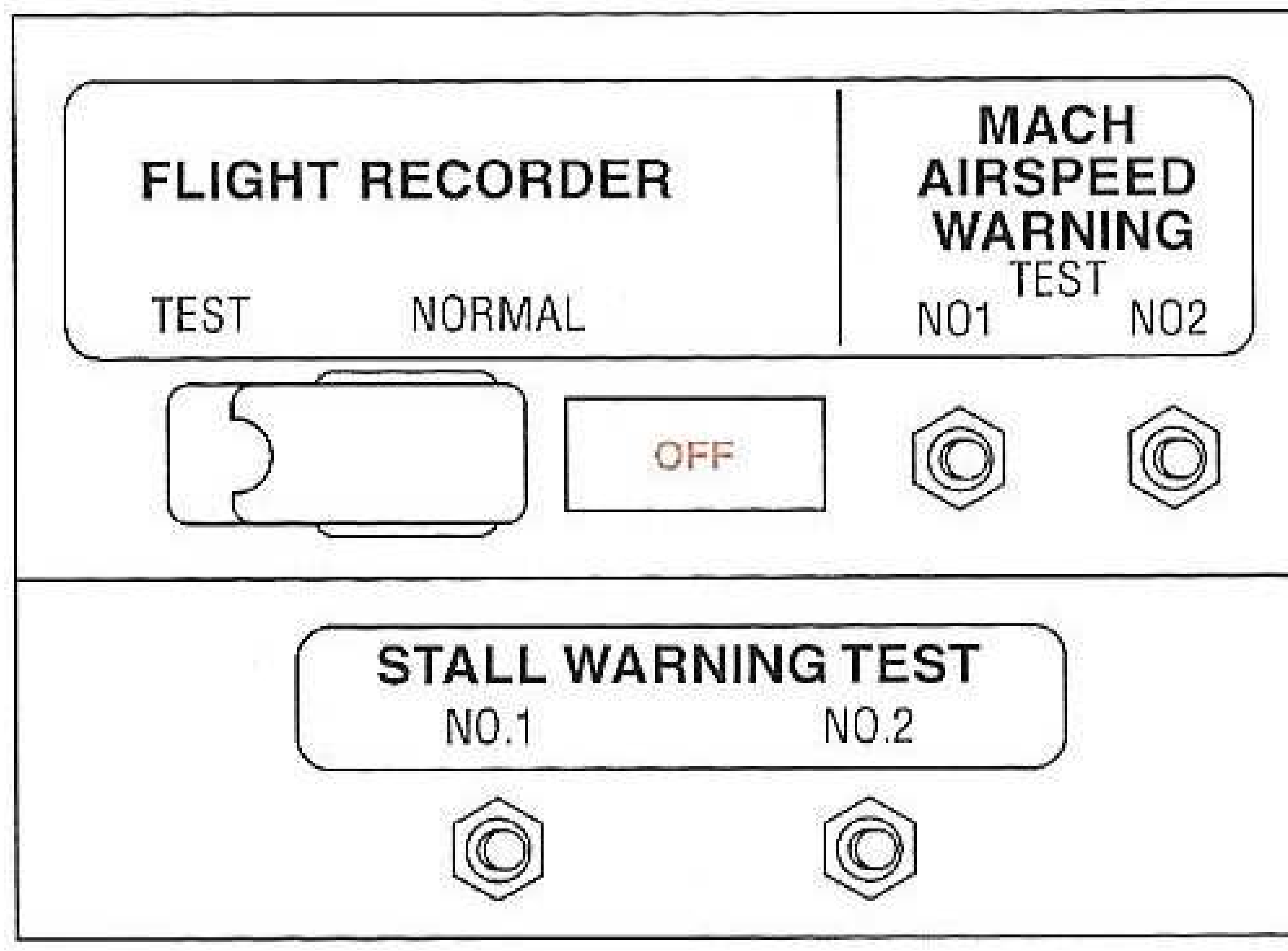
NORMAL (guarded position)
- inflight the recorder operates anytime electrical power is available
- on the ground, either engine must also be running (oil pressure switch activated)
  - opening Thrust Reverser Cont CB will prevent recorder from receiving oil pressure signal from respective engine

TEST bypasses the engine oil pressure switches and the air ground switch to power the flight recorder on the ground. Light should go out

FLIGHT RECORDER OFF light (amber)
- illuminated = indicates that the recorder is not operating or the test is invalid
- may indicate power failure, loss of input data, electronic malfunction, or tape malfunction
- extinguishes after engine start or at liftoff

Flight Recorder Notes
- Flight Data Acquisition Unit (FDAU) records permanent record for last 25 hrs of flight
  - system consists of digital flight data recorder, accelerometer, trip and date encoder
    - accelerometer installed near a/c center of gravity on aft side of rt main gear well
  - -1,000 to 50,000 ft, 100 to 450 kts, -3 to +6 g's, ATC events, engine RPM, TAT, pitch and roll, trailing edge flap, control wheel, column, and rudder pedal position, aileron, elevator, and rudder position, CDUs, print/event module, discrete flight data
- automatically recorded whenever powered
  - powered by Transfer Bus #1 and,
    - (3-4-5) Battery bus
    - (NG) DC Bus 1
- orange box located behind access door in the aft cabin ceiling
- underwater locator beacon on front of flight recorder

MACH AIRSPEED WARNING TEST PANEL



No. 1 and No. 2 buttons tests systems
- 2 independent clackers
- the only way to stop clacker is to reduce speed
- Vmo = 340 kt to 26,000 ft then M.82

(3-4-5)
  - controlled by each mach / airspeed indicator
  - test any time and gives clacker

(NG) controlled by ADIRUs
  - No. 1 tests the overspeed warn circuit in the left ADIRU
  - No. 2 tests right ADIRU circuit
  - test is inhibited while airborne

(MEL) Mach / Airspeed Warning Clacker - ATA 34
- both warning systems may be inop provided both mach indicators operate normally, and 330 kt / .76 mach airspeed limits are observed, and if the overspeed warning occurs earlier than scheduled during flight, speed must remain below the point at which the warning occurs (if warning occurs below .76 deactivate the system)

STALL WARNING TEST PANEL
- test is inhibited while airborne
- on EFIS series aircraft, sends data to SG for the EADI and EHSI stall symbol
- inputs: ADC, AOA, flap/slat, thrust, air ground logic
  - if test fails, turn B system hydraulic pump on to retract LEDs

STALL WARNING TEST (1 and 2)

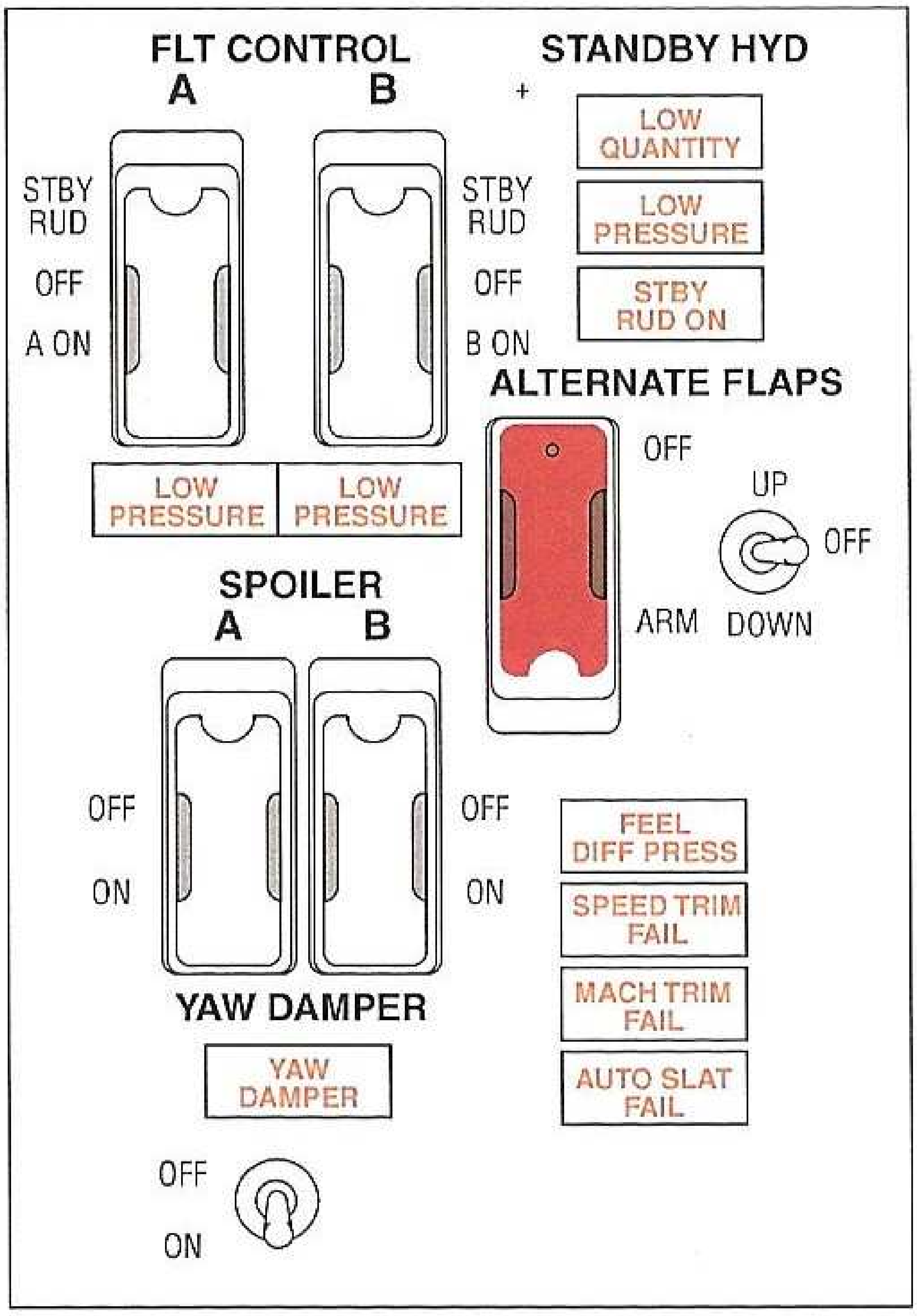
(3-4-5)
  - two independent stall warning computers - 1 to each stick
  - No. 1 button tests No. 1 stall warning computer and shaker
  - No. 2 button tests No. 2 stall warning computer and shaker

(NG)
  - requires that all AC transfer buses are powered for up to 4 minutes
  - each test switch tests its respective Stall Management Yaw Damper Computer (SMYD)
  - No. 1 SMYD computer shakes Capt control column
  - No. 2 SMYD computer shakes FO control column

(MEL) Stall Warning Systems - ATA 27
- one may be inop provided the remaining system is verified to operate normally prior to each departure by testing stick shaker

STALL MGMT YAW DAMPER SYS (NG)
- SMYD 1 connects to main rudder PCU and controls yaw damping during normal ops
- SMYD 2 connects to standby rudder PCU and operates WTRIS
- SMYD computers determine when to activate the stall warning based on ADIRU outputs, alpha vane angle of attack outputs, anti-ice controls, wing configuration, air/ground sensing, thrust setting, and FMC outputs
- SMYD computers provide outputs for all stall warning to include stick shaker and signals to the pitch limit indicator and airspeed displays and the GPWS windshear detection and alert

Stall Warning System Notes
- in some configurations the margin between stall buffet and stall is less than desired (7%), so an artificial stall warning device, a stick shaker, is used to provide the warning
- with hydraulic power off, the LEDs may droop enough to cause an asymmetric signal, resulting in failure of the stall warning system to test



FLIGHT CONTROL SWITCHES

- the following is an optional test during preflight and aids in staying current on system operations

ON (guarded position)
- normal operating position
- opens flight control shutoff valve to aileron, elevator, elevator feel, and rudder

OFF
- closes flight control shutoff valve
- corresponding hydraulic system pressure is isolated from aileron, elevator, elevator feel, and rudder
  - yaw damper switch flips off when sys B switch is placed OFF
- respective LOW PRESSURE light and FEEL DIFF PRESS light illuminate

STBY RUD
- closes flight control shutoff valve, isolating the aileron, elevator, elevator feel, and rudder
- activates the standby pump (arms Standby Hyd LOW PRESSURE light; it will blink when first turned on) and pressurizes the standby rudder power control unit (opens standby rudder shutoff valve indicated by the flight control LOW PRESSURE light extinguished)
  - this is in fact, the test of the standby hydraulic pump
- illuminates STBY RUD ON light
- thrust reverser(s) will be powered by the standby hydraulic system if necessary
- (NG) yaw damper switch can be turned back on, activating standby yaw damper, if both FLT CONTROL switches are placed to STBY RUD

- flight control and spoiler SOVs each have a position indicator and manual override lever

LOW PRESSURE lights (A and B) (amber)
- indicates low hyd press (< 1300 psi) to corresponding flight control units (elevator, aileron, rudder)
  (3-4-5) equipped with DYDC/RPR, the system A Flight Control LOW PRESSURE light will remain illuminated for 5-7 seconds when hydraulic system is initially powered up
- deactivated (goes out) when corresponding Flight Control switch is moved to STBY RUD and the standby rudder shutoff valve opens
  - the function is changed to that of a standby rudder shutoff valve position indicator
    - lights go out when the standby rudder shutoff valve is open

SPOILER switches (A and B) (maintenance purpose only)

ON - hydraulic pressure to flight spoilers locking them down

A OFF - closes A spoiler SOV which cuts off hyd pressure to A powered flight spoilers

B OFF - closes B spoiler SOV which cuts off hyd pressure to B powered flight spoilers

- ground spoilers not affected by this switch

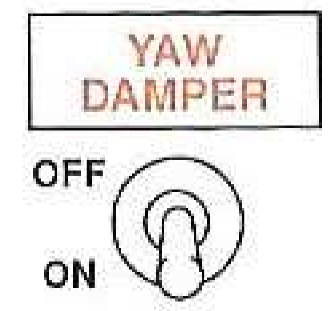
FORWARD OVERHEAD PANEL

YAW DAMPER light (amber)

- yaw damper is not engaged or is inop
  - losing B hydraulic press does not cause this light to come on but yaw damper is inop

Note: The delay before the light goes out (after the switch is turned on) is for the rate gyro to come up to speed

YAW DAMPER



YAW DAMPER switch

OFF - yaw damper disengaged, yaw damper light will be illuminated
- goes OFF if:
  - B FLT CONTROL switch to or through the OFF position
  - power interruption to #1 transfer bus for more than 2 sec
  - yaw damper rate gyro or actuator fail

ON
- yaw damper electrically engaged to main rudder PCU if B FLT CONTROL switch is ON
- solenoid held ON (does not require hydraulic pressure to be held in the ON position)

(NG)
  - engages standby yaw damper to standby rudder PCU if both the A and B FLT CONTROL switches are in the standby rudder position, using #2 SMYD

(MEL) Yaw Damper Inop - ATA 22
- may be inop provided yaw damper switch remains OFF and (3-4-5) Rudder Pressure Reducer system is verified to operate normally

STANDBY HYD

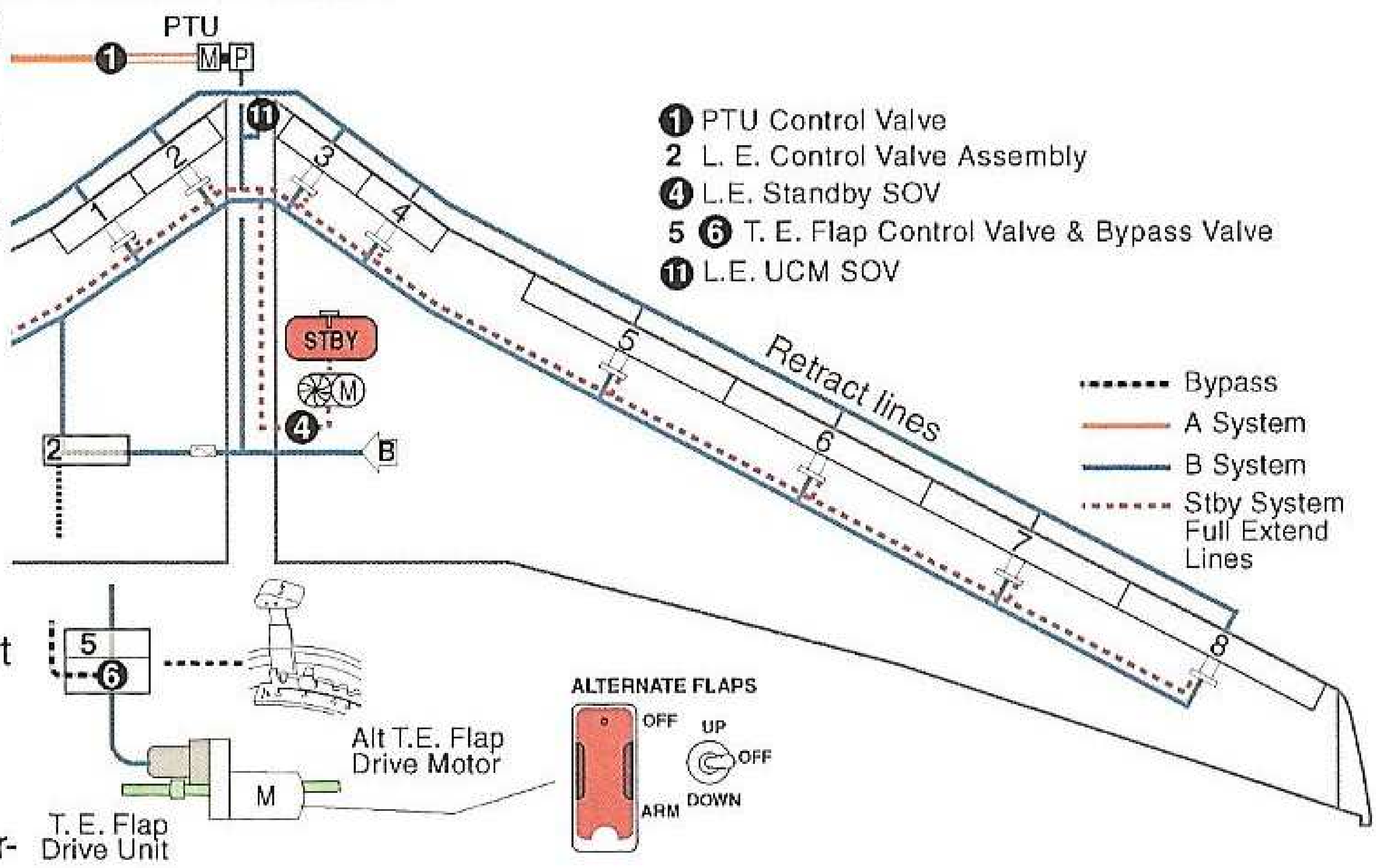
STANDBY HYD lights (amber)
- LOW QUANTITY light
  - always armed and illuminates at approximately 50%
  - leak in standby system will empty stby system and take B system down to
    (3-4-5) analog between half and refil, (3-4-5) EIS 64% (NG) 72%
- LOW PRESSURE light
  - armed with standby pump on or when automatic standby function is activated
  - indicates low output pressure of electric motor driven standby pump (< 1300 psi)
- STBY RUD ON light (as installed)
  - illuminated when the standby rudder PCU is pressurized

(MEL) Stby Hyd. Low Qty Light - ATA 29
- with all controls neutral, verify the system B hydraulic gauge indicates more than RFL

(MEL) Stby System Low Press Light - ATA 29
- may be inop provided standby sys LOW QUANTITY light operates normally and output of standby pump verified prior to each departure
- get ground clearance to extend LEDs. Position alternate flaps master switch to ARM
- momentarily place alternate flaps master switch to DOWN. Using aft overhead, check all LEDs in FULL EXT within one minute. Return alternate flaps master to OFF
- turn system B pump (ELEC 1) on until LE flaps are up

(QRH) Standby Rudder Light
- if the STBY RUD ON light is illuminated due to pilot positioning of FLT CONTROL A or B switch to STBY RUD, or in response to a hydraulic system non-normal situation, no crew action required
- if the STBY RUD ON light is illuminated with no other flight deck indications, avoid large or abrupt rudder pedal inputs

ALTERNATE FLAPS MASTER switch



OFF (guarded)
- normal operating position
- closes LE Standby SOV

ARM
- arms Standby Hydraulic LOW PRESSURE light
- starts standby pump
- arms alternate flaps control switch
- TE flap bypass valve goes to bypass position to prevent hyd lock of the flap drive
- (NG) disables LE UCM function

ALTERNATE FLAPS CONTROL switch
- functions only when Alt Flap Master switch is in ARM
- max 230 kt to begin extension

DOWN (momentarily) - opens LE Standby SOV and fully extends all LE devices using Standby hydraulic pressure (takes approx. 30 sec for LE flaps and 1 min for the LE slats)
- if held down, extends TE flaps electrically
- switch spring loaded OFF (you have to hold it to down)
- takes approximately 2 minutes from 0° to 15°

UP - retracts TE flaps electrically
- LE devices remain extended and cannot be retracted by the alternate flaps system
- switch is not spring loaded to OFF (it will stay in UP position, use caution)

Note: PTU control valve closes when the Alternate Flaps Master switch is moved to ARM and the Alternate Flaps control switch is moved to DOWN; this stops PTU operation
- if you lose B sys pressure (pumps) and flaps are extended (after takeoff), the LEDs can be retracted with PTU / B fluid using the Alternate Flap system (uses B sys retract lines)

(L/OP) Flight Controls, Alt Flaps Duty Cycle
- Flap position 0-15, 5 minutes off
- Flap Position greater than 15, 25 minutes off
- maintenance manual says 4 min on, 25 minutes off

Light	System armed when flaps are:
FEEL DIFF PRESS	UP* UP/DN
SPEED TRIM FAIL	UP/DN
MACH TRIM FAIL	UP
AUTO SLAT FAIL	DN (1-5)

* (3-4-5) and early production NG

FEEL DIFF PRESS light (amber)
- feel differential pressure switch monitors both A and B computer metered pressures and closes when it measures a difference of 25% between the 2 systems and FEEL DIFF PRESS light comes on
  - you may have lost A or B hydraulics or an elevator feel pitot system may have failed (elevator pitot tube may be blocked)
- MASTER CAUTION and FLT CONTROL annunciator also illuminate

(QRH) Flight Controls, Feel Diff Press Light
- no crew action required

(MEL) FEEL DIFF PRESS Light - ATA 27
- may be inop provided elevator feel system is verified to operate normally, daily

SPEED TRIM FAIL light (amber)
- dual channel - illuminated indicates failure of both speed trim functions in FCCs
- MASTER CAUTION and FLT CONTROL annunciator also illuminate
- indicates failure of a single FCC channel if illuminated when RECALL is pressed
- on (EFIS) (NG) series aircraft, this light will be on until the IRS's are aligned

(QRH) Flight Controls, Speed Trim Fail Light
- no crew action required

(MEL) Speed Trim System - ATA 22
- one may be inop provided remaining system and SPEED TRIM FAIL light operates normal Verify remaining system operates normally by pressing the annunciator panel. SPEED TRIM FAIL light, FLT CONT annunciator, and MASTER CAUTION light will illuminate. Press and release MASTER CAUTION light. If SPEED TRIM FAIL light and FLT CONT annunciator light extinguish, remaining system is operating normal

MACH TRIM FAIL light (amber)
- dual channel - illuminated indicates failure of both mach trim functions in FCCs
- MASTER CAUTION and FLT CONTROL annunciator illuminate
- indicates failure of a single FCC channel if illuminated when RECALL is pressed; if light can be extinguished by pressing MASTER CAUTION, system operates on remaining channel

(QRH) Flight Controls, Mach Trim Fail
- (3-4-5) if both channels inop, do not exceed .74 Mach
- (NG) if both channels inop, do not exceed 280 kts/.82 Mach

(MEL) Mach Trim System - ATA 22
- one may be inop provided remaining system and MACH TRIM FAIL light operates normal
- both may be inop provided limitations are observed and mach trim actuator is verified to be in the null/uncommanded elevator position

AUTO SLAT FAIL light (amber)
- dual channel
  (3-4-5) illuminated indicates failure of both autoslat channels of the FCCs
  - if illuminates when RECALL is pressed indicates a single FCC channel failure

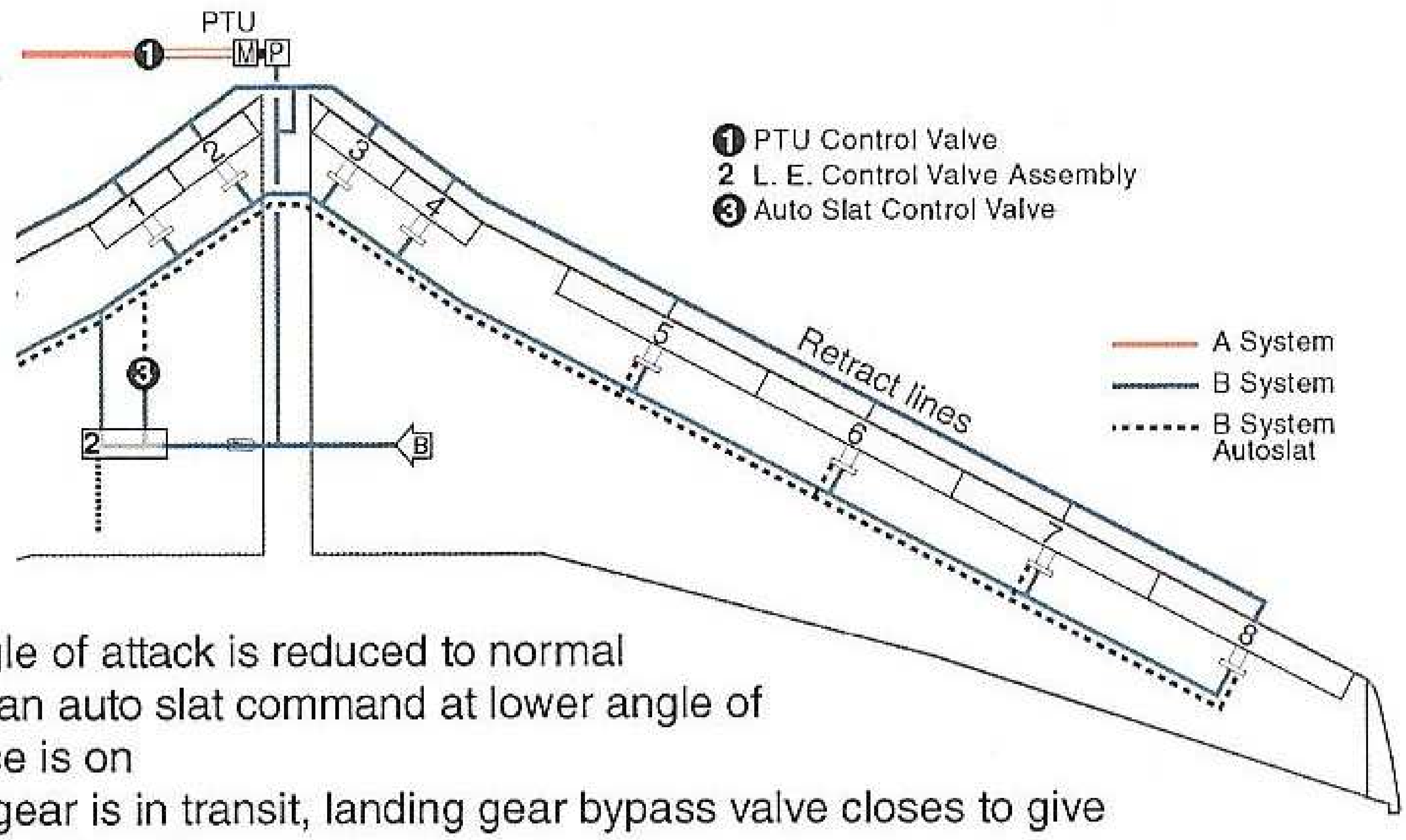
  (NG) illuminated indicates failure of both autoslat channels of SMYD
  - if illuminates when RECALL is pressed indicates a single SMYD failure
- MASTER CAUTION and FLT CONTROL annunciator illuminate

(MEL) Auto Slat Fail System - ATA 27
- one may be inop provided remaining system operates normal. Verify remaining system operates normal by pressing the annunciator panel. AUTO SLAT FAIL light, FLT CONT annunciator, and MASTER CAUTION light illuminate. Press and release MASTER CAUTION light. If AUTO SLAT FAIL light and FLT CONT annunciator light extinguish, remaining system is operating normal

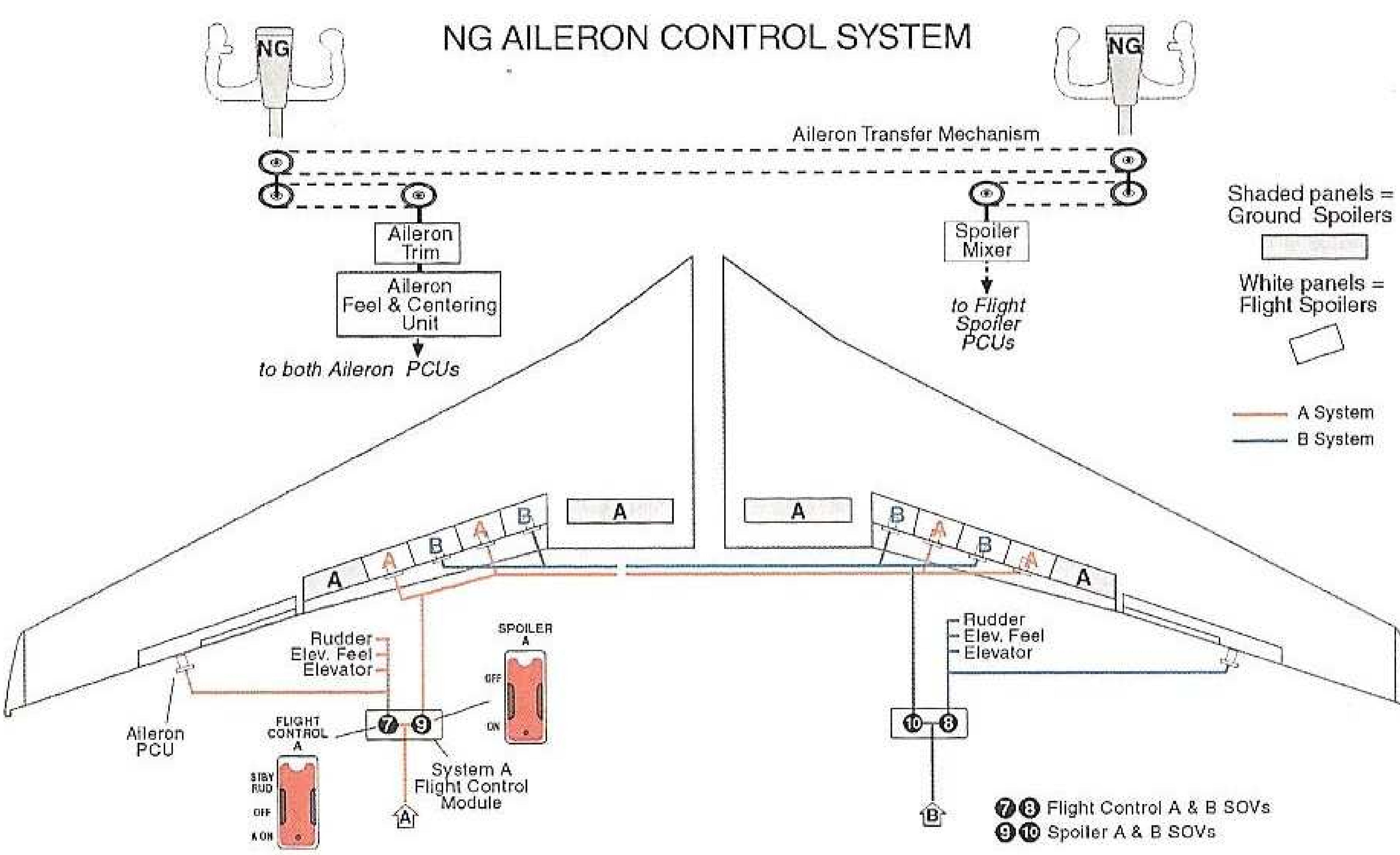
Flight Controls Notes

1. Digital Flight Control System (DFCS)
   - the DFCS incorporates two separate autopilot channels (A, B). Each channel controls the pitch and roll axes and provides mach trim and speed trim control
   - flight director commands and flag logic are connected to the captain's ADI (system A) and the first officer's ADI (system B)
   - DFCS control of the airplane is enabled by engaging channel A or B switch on MCP
   - when dual channel option is provided, channels A and B can be engaged simultaneously when making fail-passive automatic landings
2. Speed Trim - STS (nothing to do with high speed trimming with flaps down)
   - speed stability system designed to improve flight characteristics during operations with a low gross weight, aft center of gravity, and high thrust when the A/P is not engaged
   - purpose is to return the aircraft to a trimmed speed by commanding the stabilizer in a direction opposite the speed change
   - monitors inputs of stab position, thrust lever position, airspeed and vertical speed
   - trims stabilizer using A/P stab trim
     - you will see trim wheel turning slowly to counteract the pitching up
   - as aircraft speed increases or decreases from the trimmed speed, the stabilizer is commanded in the direction to return the aircraft to the trimmed speed
   - this increases control column forces to force the aircraft to return to the trimmed speed
   - as the aircraft returns to the trimmed speed, the STS commanded stabilizer movement is removed
   - operates stabilizer most frequently during takeoff, climb, and go-around
     - high power and low airspeed causes pitch-up
   - satisfies the req'mt of a 1 lb increase in stick force / 6 kt of airspeed from indexed speed
   - if you don't trim, the Speed Trim automatically trims to compensate
   - disengaged by engaging A/P or pilot makes trim inputs (from yoke)
   - system armed when
     - (3-4-5) TE flaps are extended, (NG) flaps up or down
     - (3-4-5) airspeed between 100-300 kts (NG) airspeed is between 100 kts to M 0.68,
     - 10 seconds after liftoff, 5 seconds following release of trim switches, N1 above 60%, autopilot not engaged
2. Mach Trim system
   - system provides automatic repositioning of the elevators as a function of Mach number
   - two things cause tuckunder (nose pitches down at high speed)
     - downwash behind wing decreases, increasing AOA of horizontal stabilizer, and center of pressure moves aft as speed increases. *Dole*
   - as the airplane enters the mach tuck region, FCCs use Mach information from the ADC / ADIRU, to compute a Mach trim actuator position which repositions the elevator feel and centering unit, which adjusts the control column neutral position (column will move)
     - armed above M .615
   - operates with or without the autopilot engaged

4. auto slat system
   - works only in the air, with flaps 1, 2, or 5
   - slats go from EXT to FULL EXT providing additional lift at high angles of attack (near stall)
     - retract from FULL EXT to EXT when angle of attack is reduced to normal
     - SMYD sends an auto slat command at lower angle of attack if anti ice is on
     - if the landing gear is in transit, landing gear bypass valve closes to give priority to auto slat system



   - uses B hydraulic system
     - if B engine pump pressure is low, PTU provides alternate pressure for auto slats by using A system pressure and B system fluid
     - airspeed data from ADIRU
     - self test each time flaps go from 10 to 15
   - amber LE FLAPS TRANSIT light inhibited with auto slat extend (forward panel)
5. ailerons
   - the aileron control wheels move cables that give input to the aileron feel and centering unit. This controls the aileron PCUs. The PCUs move the aileron wing cables and the ailerons
     - a transfer mechanism at base of the first officer's control column, supplies a mechanical link between the control wheels
   - in normal operation, the aileron transfer mechanism lets either pilot make the roll control commands. If the control wheel cannot move, the transfer mechanism lets a pilot operate the other control wheel
   - during normal operation, the aileron spring cartridge provides an input from the aileron system to the flight spoiler system



- if a jam occurs, the aileron spring cartridge and the transfer mechanism isolate the aileron system from the flight spoilers
  - if either the aileron or the spoiler control system jams, the other system can be operated independently by overcoming spring in the transfer mechanism
  - if the left control wheel cannot move, the first officer can operate the right control wheel and override the force of the torsion spring and the spring cartridge. The lost motion device, attached to the right control wheel, engages at 12° of control wheel movement and moves the flight spoilers only
  - if the right control wheel cannot move, the captain can operate the left wheel and override the force of the torsion spring and the force of the feel and centering mechanism. This allows control of the ailerons only
- if one aileron cannot move, the shear rivets at the body quadrants will shear and isolate this aileron. The other part of the aileron control system operates normally
- manual control forces are minimized by aileron balance panels and balance tabs
- balance tab travel is opposite to aileron travel, that is, a downward movement of the aileron produces an upward movement of the balance tab
  - panels provide aerodymanic press. assistance; as a panel is moved, aileron moves
- aileron trim
  - electrically changes the neutral position of the aileron feel-and-centering unit
  - input from the trim actuator to the feel-and-centering unit also backdrives the control wheels to rotate. This moves the aileron PCUs.
    - because the control wheel rotates, spoiler deflection may occur via the aileron cable-drive and spoiler mixer
  - needs electric power for the feel-and-centering unit and hyd. power for the PCUs
  - the aileron trim indicator placards show the amount of trim in units. Each unit shows 6° of control wheel rotation. The maximum trim available is 9.5 units (57° of control wheel rotation).
    - spoiler deflection can begin an any trim setting, depending on how your particular airplane is rigged
    - ground check: with hydraulic power available, apply 1 unit of aileron trim in either direction. Go outside, and from a position behind the wing, see if any spoiler panels have started to rise. If you trimmed right, check the right wing. If none, apply another unit and re-check. Airplanes will differ depending on how well they are rigged.
    - ideally, spoilers will not move until about 10° of control wheel movement
  - if aileron trim is used with the AP engaged, the trim is not reflected in the control wheel position. The AP overpowers the trim and holds the control wheel where it is required for heading/track control. Any aileron trim applied when the AP is engaged can result in an out-of-trim condition and an abrupt rolling movement when the AP is disconnected.

6. Elevators
   - cables connect the control columns to the elevator feel and centering unit. This controls the PCUs which move torque tubes that move the elevators
   - four inputs to the elevators: control columns, autopilot, mach trim, neutral shift
   - if a control column jams, an elevator control column override mechanism allows the columns to be separated (normally interconnected by a torque tube)
     - jam is freed by applying force against the jam, however elevator control is reduced
   - elevator balance panel and tab mechanism decreases the force necessary to move the elevator in flight
     - during manual reversion, when there is no elevator control input, the pressure forces across the elevator balance panel keep the elevator in the neutral position
     - when the elevator moves, the pressure forces cause the balance panels to move in the opposite direction of the elevator

     (NG) flaps up: tabs are balance tabs; move opposite elevator, assist elevator movement

     (NG) flaps not up and hydraulic power is on, elevator tabs are anti-balance tabs; move same direction as elevator
   - elevator feel computer (in the stabilizer jackscrew compartment)
     - receives pressure from hydraulic system A and system B, pitot pressure from the pitot tubes, and mechanical input from the stabilizer
     - uses pitot pressure and stabilizer input to control hydraulic pressure to the dual feel actuator in the feel and centering unit, which changes the control column force
     - the feel force of the feel and centering unit increases as the airspeed increases
     - elevator feel computer uses either hydraulic system A or B pressure, whichever is higher (will operate normally with only one hydraulic system operating)

(AD) Elevator Tab Vibration - (6-7-8-B-B2)
   - accumulation of de-ice fluid in the elevator balance bays or residue on the surface of the tab can contribute to Elevator Tab Limit Cycle Oscillation (LCO)
   - if the horizontal stabilizer is de/anti-iced, limit airspeed to 270 kts until certain maintenance procedures are performed

7. Horizontal stabilizer
   - electric motor(s) or manual wheel; no hydraulics (trims the pitch axis)
   - when the stabilizer moves, it also moves the elevators through the elevator feel and centering unit
   - yoke main motor trim switches will disconnect the A/P
   - main motor has two speeds: low speed and high speed (with flaps extended)
   - two cutout switches; below flap lever (one for main, the other for A/P)
   - two electric stab trim systems consist of a motor/brake arrangement
     - the brake of each electric trim system are locked when the brakes are not powered
     - the purpose of the brake is to hold the stabilizer in a fixed position when there is no trim action (if both brakes fail, grab the trim wheel to stop stabilizer float)

8. Rudder
   - rudder pedals move cables to the rudder feel and centering unit which adds artificial feel to pedals, centers pedals, transmits trim inputs to the aft control components
   - two full time hydraulic systems, A and B, each power half the rudder PCU
   - standby rudder PCU is controlled by a separate input rod and control valve and powered by the standby hydraulic system
   - all three input rods have individual jam override mechanisms that allows input commands to continue to be transferred to the remaining free input rods if an input rod or downstream hardware is jammed
   - main rudder PCU contains a Force Fight Monitor (FFM) that detects opposing pressure between A and B actuators
     - if the FFM trips, the standby hydraulic system is energized, the standby rudder SOV opens and STBY RUD ON light, MASTER CAUTION and FLT CONTROL annunciator illuminates
   - rudder trim switches on aft control stand repositions the neutral point of the rudder feel and centering mechanism; rudder pedals are displaced proportionally
   - rudder deflection on the (3-5) is 26°; (NG) is 29°

9. Rudder Pressure Reducer (RPR) (3-4-5)
   - reduces sys A hydraulic pressure to the rudder PCU which reduces rudder authority by about a third allowing crews more time to respond and recover from unnecessary large rudder deflections
     - also makes ailerons and spoilers proportionately more effective in deflections
   - Digital Yaw Damper Coupler activates and deactivates the RPR solenoid
   - on takeoff at 1000 ft RA, sys A hydraulic pressure to the rudder is reduced to 1000 psi
   - sys A hydraulic pressure returns to normal (3000 psi) during approach at 700 ft RA
   - if the RPR fails to change sys A pressure to normal at 700 ft the sys A flight control LOW PRESSURE light will illuminate, the standby hydraulic system will activate, the standby rudder SOV opens, and the standby rudder PCU is pressurized
     - a normal landing or a go-around may be executed, even with an engine failure
     - autopilot/autoland operations are not affected

     Note: There is no flight deck indication if the RPR does not change from normal pressure to low pressure at 1000 ft RA (after takeoff)
   - sys A hydraulic pressure to the rudder remains at or returns to normal (3000 psi) with loss of sys B hydraulic pressure, loss of both radio altimeters, or with engine failure
   - if any rudder pedal is pushed to its limit when the RPR transitions to reduced pressure, airloads on the rudder reduce max rudder deflection and rudder pedal position
   - if any rudder pedal is pushed to its limit when the RPR transitions to normal pressure, the ruder pedals will deflect further and the rudder deflection will correspondingly increase pressure
   - during preflight, when the hyd system power is established, the sys A flight control LOW PRESSURE light will remain illuminated for 5-7 seconds before extinguishing

(3-5) Rudder Pressure Reducer (RPR) System or Yaw Damper Inoperative Minimum Maneuvering Speeds (KIAS)

Flap Position	Gross Weight		
	Up to 117,000Lbs	117,000 Lbs to 138,500 Lbs	Above 138,500 Lbs
0	220	230	240
1	200	210	220
5	190	200	210
10	170	180	190
15	150	160	170
25	140	150	160

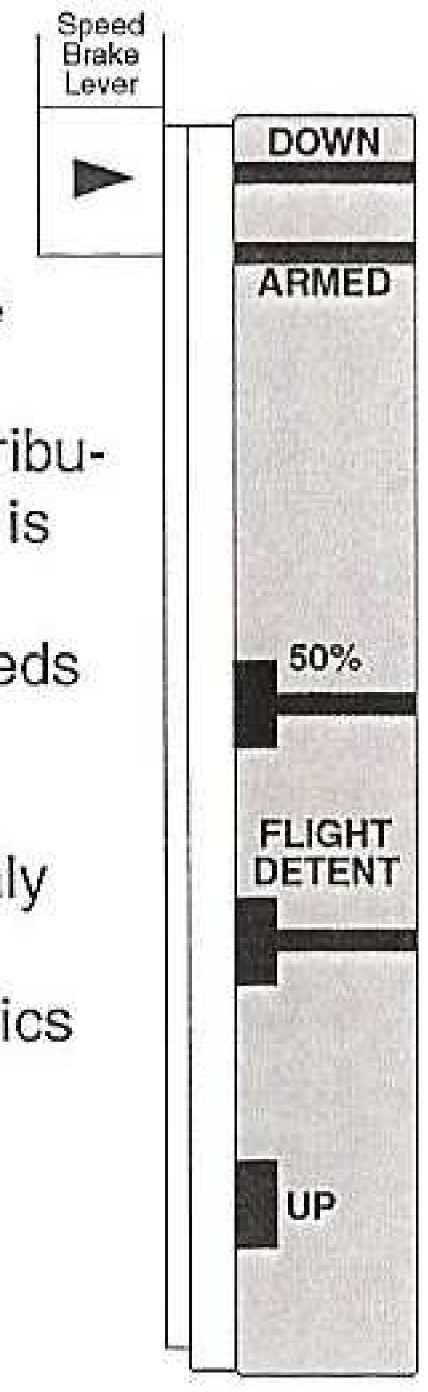
10. Rudder Pressure Limiter (NG)
    - reduces rudder authority when large rudder deflections are not required
    - controlled by logic in the FSEU and activates at 135 kts
11. Rudder Redesign
    - functionally equivalent to a 3-actuater system, but using 2 PCUs.
      - each valve is commanded with a dedicated control rod and override device
    - A malfunction in one actuator is reacted to by a second actuator, as with 757/767
    - simplex valves will be used, eliminating the need for the current dual-concentric design
12. (NG) Wheel to Rudder Interconnect Sys (WTRIS)
    - assists manual reversion turns, reducing pilot workload
    - available only when both A and B hydraulic systems are depressurized
      - FLT CONTROL switches are in STBY RUD and yaw damper has been reset to ON
    - SMYD 2 computer commands small amount of standby rudder deflection (up to 2.5°) when it senses control wheel input - WTRIS function is only in SMYD 2
    - pilot can override WTRIS input with rudder or trim
    - rudder movements by WTRIS does not displace rudder pedals

13. Crossover speeds
  - crossover speed evaluation has been studied by using a "steady-heading sideslip". In this maneuver, full rudder is applied and aileron is used to keep the aircraft from turning. The aircraft is then slowed to the speed at which full aileron input is reached. This maneuver tests the ability of the aileron to overpower a fully deflected rudder.
    The maneuver began at 200 kts (clean maneuvering speed) and reached full aileron deflection at 165 kts, just as stickshaker activated. This 35 kt margin is a considerable improvement over the earlier design. At flaps 1 full aileron deflection was reached at 148 kts. This is 20-25 kts slower than the maneuvering speed. For flaps 5, the crossover speed is 144 kts; for flaps 15, it is 123 kts. For flaps 30 and 40, the stickshaker activates before the crossover speed is reached.
  - these speeds are valid only at 1g because x-over speed is angle-of-attack dependent
    - aft yoke increases wing loading and crossover speed; crew must unload the aircraft (decrease AOA and g-force with forward yoke movement)
  - until the world fleet is completely modified (2010) there still will remain an area of exposure during takeoff, approach and landing (below 1000 ft), where the aircraft is below crossover speed (rudder authority exceeds that of the lateral control surfaces)
  - Rudder check (pre-departure): 2-3 seconds to smoothly push rudder pedals in each direction to the stop to fully exercise the PCU. Note any unusual rudder activity or kick
    - the rudder pedals should never kick back in flight
  - rudder pedal motion is an indication of a problem, such as high friction or a jam in the standby PCU or interference in the feedback linkage in the main PCU
14. Yaw damper
  - keeps aircraft stable around the vertical axis by minimizing dutch roll during manual or auto controlled flight and provides turn coordination (both 3-4-5 and NG)
  - capable of moving the rudder up to 3°
    - oscillations (dutch roll) are detected by the rate sensor in the yaw damper computer
    - main rudder PCU then displaces the rudder proportional to the yaw rate
    - most helpful at high altitudes and high airspeed
    - no rudder feedback is applied to the pedals

    (3-4-5)
      - Digital Yaw Damper (DYD) replaces mechanical rate gyro
        - installed with Rudder Pressure Reducer
        - receives inputs from yaw rate gyro and ADC and provides commands to RPR
        - if self test fails it auto shuts down the malfunctioning channel

    (NG) Stall Management Yaw Damper (SMYD)
      - SMYD 1 sends signals to the main rudder PCU to engage the primary yaw damper and move the rudder to reduce unwanted yaw motion and for turn coordination
      - SMYD 2 commands the standby rudder PCU to move the rudder for WTRIS, standby yaw damping, and turn coordination during manual reversion
      - problems with new yaw damper have been reported during power up if the rudder is not centered on the ground (i.e. hyd off, in crosswind)
        - BITE believes fault has occurred and both channels drop off line
        - switch hydraulics on and after rudder centers, reset yaw damper
  - powered by B hydraulic system only
  - yaw damper switch solenoid-held to ON position
    - lose power to No. 1 transfer bus for more than 2 seconds and switch drops off
    - pilot can override yaw damper inputs with rudder or trim inputs
  - if B system hydraulic pressure is lost the yaw damper system is inoperative but the switch will stay ON and the YAW DAMPER light does not illuminate
    - yaw damper continues to send signals to yaw damper control (PCU), but no rudder movement takes place
  - put system B flight control switch to STBY RUD and the switch kicks off as you go through the OFF position and the YAW DAMPER light comes on

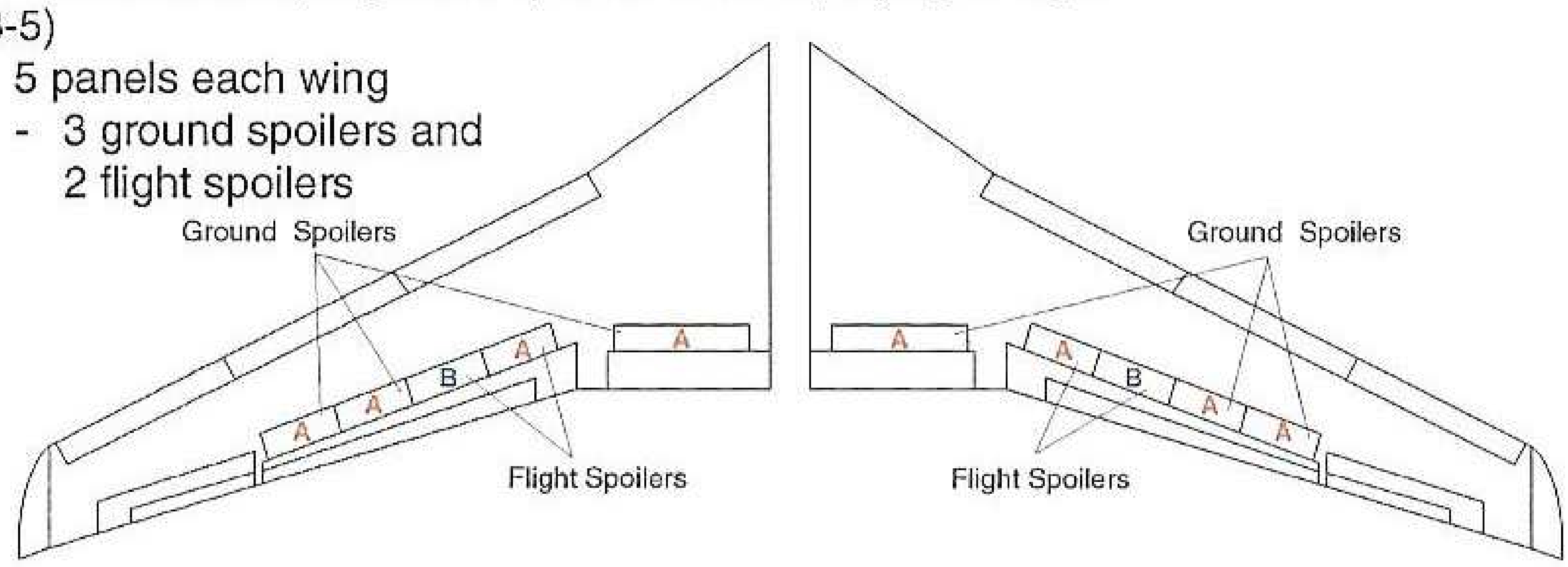
15. standby yaw damper (NG) with turn coordination
    - both main and standby yaw dampers controlled by the SMYD computers
    - during manual reversion flight, both FLT CONTROL switches are placed to STBY RUD. The yaw damper switch can be reset to ON and the standby hydraulic system powers the standby yaw damper
        - inputs not shown on indicator
16. winglets - source *Boeing Aero Magazine*
    - creates more efficient flight characteristics in cruise and during takeoff and landing
        - approx. 4% increase in range but you must be at LRC and OPT altitude (130 nm)
        - reduction in flap drag during 2nd segment climb allows for increase in payload
    - blended winglet can be retrofitted on any model
    - winglet aerodynamics
        - 8.5' high, 4'7" added to wingspan, 378 lbs total
        - winglets affect the part of drag called induced drag
        - the lift vector of the winglet, which is slightly forward, offsets part of the induced drag created by the lift of the wing
        - the magnitude of the induced drag is determined by the spanwise distribution of vortices shed downstream of the wing trailing edge (TE), which is related in turn to the spanwise lift distribution
        - induced drag can be reduced by increasing the length of the TE that sheds the vortices; winglets increase the spread of the vortices along the TE, creating more lift at the wingtips
        - the *blended* wingtip allows for the chord distribution to change smoothly from the wingtip to the winglet



    - structural design considerations from the perspective of loads and dynamics
        - most of the wing box is designed for 2.5-g maneuvers
        - static loads are highest on the mid-to-outboard part of the wing when speed brakes are extended
        - the inflight speed-brake angle was reduced 50% to reduce this load
        - a load alleviation system is installed to protect the wing structure from exceeding structural design load margins with the spoilers deployed under certain high gross weight and airspeed conditions
            - operates in flight when the flaps are up, gross weight is greater than (-7) 143,000 lbs / (-8) 155,000 lbs, and IAS is greater than 320 kts
            - if the system is activated and the speedbrake lever is greater than the 50% position, it will automatically reposition to the 50% position
            - movement past the 50% position is restricted but can be overridden
            - for airplanes in production the wings are strengthened throughout the wingbox to accommodate the winglet loads with full speed-brakes deployed to in-flight detent
        - a wingtip with a winglet is most highly loaded during sideslip, therefore the sideslip maneuver became the design case for the wingtip and winglet
        - dynamic flight load to the outboard wing is also increased due to weight of winglet
        - flutter requirements were met by adding wingtip ballast to the -800
17. Spoilers
    - aileron PCU movement feeds spoiler mixer, which moves spoilers to assist ailerons
        - if the spoilers are rigged properly, they will start to rise with control yoke at approximately 1.5 units (6° control yoke)
        - if hydraulic pressure is lost, a check valve prevents spoiler float
    - when functioning as spoilers, the flight spoiler panels raise on the wing on which the aileron rotates up; when used as speed brakes, the spoiler panels on both wings
    - the spoiler mixer and ratio changer mix inputs from the control wheel and the speedbrake lever. The spoiler mixer then sends these commands to the flight spoiler actuators and the ground spoiler control valve
    - the spoiler mixer mixes the control wheel input with the speedbrake lever input. When the speedbrake lever moves up, the ratio changer decreases the amount of roll control for the flight spoilers

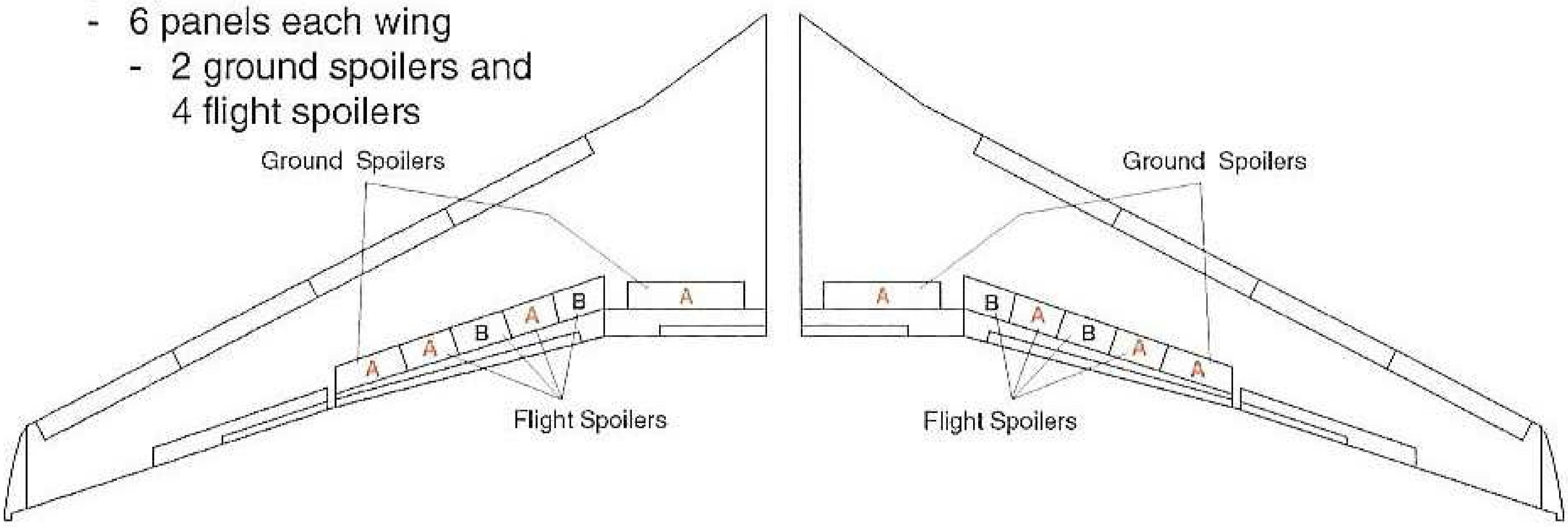
- all the spoilers move up when the airplane is on the ground, and only the flight spoilers move up when the airplane is in the air
- the flight spoilers are at their maximum positions when the control wheel turns more than 70° or when the speedbrake lever moves to the UP position
- max hinge moment on the spoilers is limited by a check valve in each actuator, permitting the spoiler panels to blow down if limiting speed is exceeded with spoilers up
- all spoiler panels will extend automatically if takeoff is rejected and reverse thrust is selected. Wheel spin-up (60 kts) must have occurred on any two main wheels
- during reject if greater than 60 knots and a thrust reverser raised you automatically get ground spoilers, armed or not
- auto spoilers, on landing, with lever ARMED
  - all flight spoilers rise to full extend on landing at wheel spin-up
  - all ground spoilers rise to full extend on landing when right main gear strut is compressed; this opens the ground spoiler interlock valve
    - the ground spoiler interlock valve limits use of the ground spoilers to ground operation and keeps ground spoilers from deploying in flight

(3-5)
- 5 panels each wing
  - 3 ground spoilers and
    2 flight spoilers



- spoiler switches maintenance function only
- ground spoilers fully extend to 60° when speed brake lever is greater than 29°
- flight spoilers extend 40° max

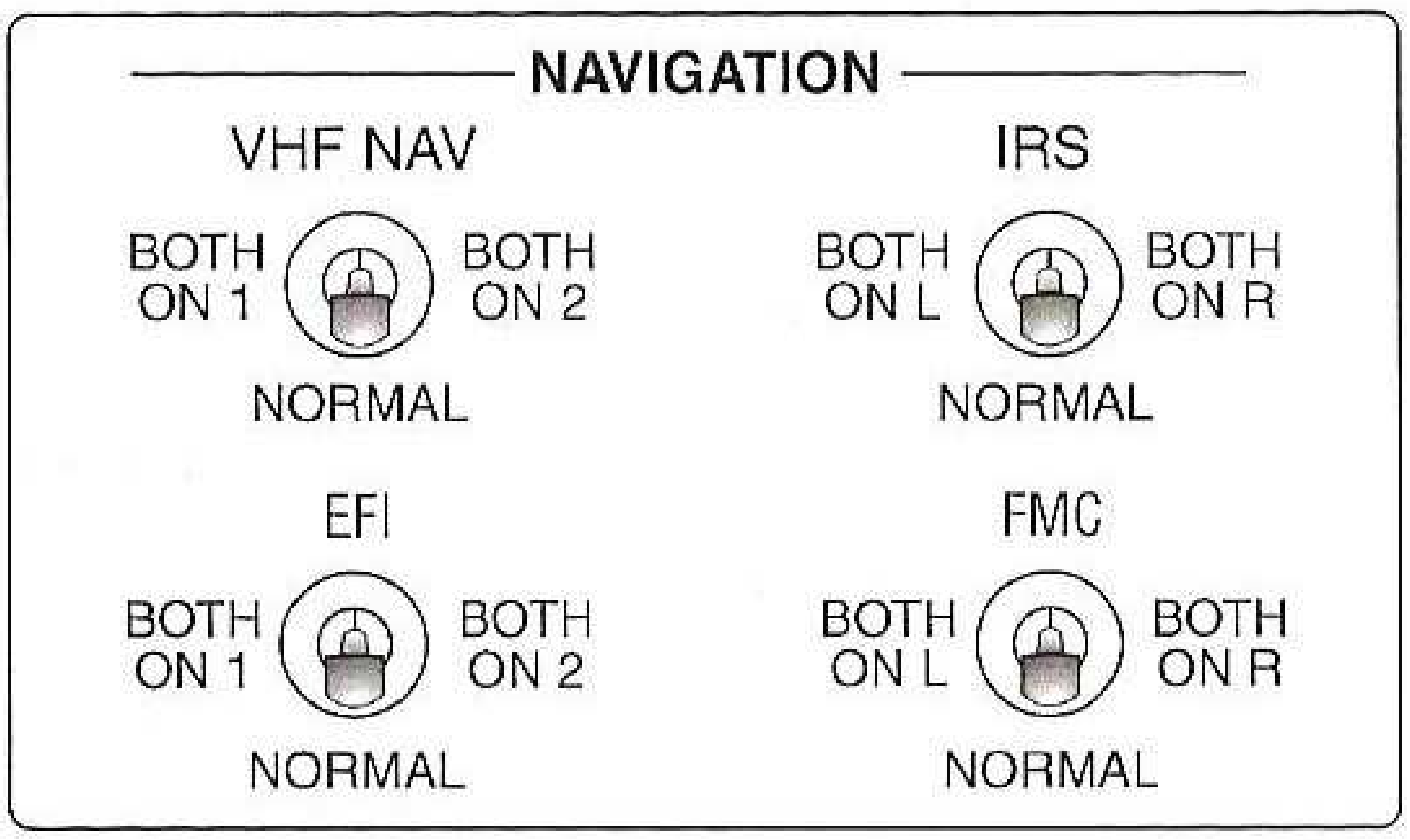
(NG)
- 6 panels each wing
  - 2 ground spoilers and
    4 flight spoilers



- ground spoilers
  - when the speedbrake lever is more than 29°, ground spoilers 6 and 7 move 52° and ground spoilers 1 and 12 move 60°.
- flight spoilers
  - numbered from left to right, 1 through 12
  - when the speedbrake lever is at the FLIGHT detent, flight spoilers 2, 3, 10, and 11 move 20° and flight spoilers 4, 5, 8, and 9 move 22.5°
  - w/winglets: flt spoilers 2, 3, 10, 11 = 8.75°; flt spoilers 4, 5, 8, 9 = 12.75°
  - when the speedbrake lever is full up, flight spoilers 2, 3, 10, and 11 move 33° and flight spoilers 4, 5, 8, and 9 move 38°

18. Minimum Drag Trim Technique
    - check for thrust asymmetry and adjust N1 as necessary
    - check for fuel balance (fuel imbalance will appear as a roll input)
    - verify rudder and aileron trim is zero
  - to correct an out-of-trim condition with autopilot engaged (preferred method)
    - stabilize aircraft on constant heading with HDG SEL
    - trim the rudder in the direction of the control wheel displacement (down wing)
      - aircraft is properly trimmed when bank angle is zero as displayed on the ADI sky pointer
      - if the a/c is properly rigged, this should result in an approximately neutral wheel
    - disengage the autopilot. With the autopilot disengaged, hold the wings level with the control wheel using the ADI for reference. Trim out any control wheel forces using aileron trim. Ailerons may not be trimmed while the autopilot is engaged
  - to correct an out-of-trim condition with the autopilot disengaged (alternate method)
    - hold the wings level with the control wheel using the ADI sky pointer for reference
    - use rudder trim to correct (stop) heading drift. Display heading on the ISDU, if equipped. Use the tenths of a degree window to zero heading drift
    - use aileron trim to remove any control wheel force
  - Drag factors due to trim technique
    - if the control wheel is displaced more than approximately 1.5 units, spoiler deflection will be initiated and an increase in aerodynamic drag will result
19. (NG) stall strip (spin strip) installed on inboard leading edge
  - acts as a barrier to the airflow at high angles of attack
  - causes the flow to separate at the leading edge at an angle of attack somewhat below the normal stall angle
  - causes the root to stall prior to the tip
  - an airfoil with a stall strip attached behaves exactly like an airfoil with a sharp leading edge
20. Compensator cartridge
  - maintains return fluid pressure of 40-70 psi to the aileron, rudder, and elevator PCUs when the hydraulic system is off
  - this provides wind gust protection for the control surfaces

TRANSFER SWITCHES



VHF NAV SWITCH

- enables selection of opposite VHF NAV receiver / FCC in the event of receiver failure

BOTH ON 1 - both the Captain and FO on #1 VHF Nav (wide needles in RDMIs are inop)

NORMAL - Captain's navigation instruments (narrow needle in RDMI), (E)HSI, VOR, LOC, and GS deviations on #1 VHF Nav; FO (same items as Capt except wide needle in RDMI) on #2 VHF Nav

BOTH ON 2 - both the Capt and FO on #2 VHF Nav (narrow needles in RDMIs inop)

Caution: if BOTH ON 2, the Captains instruments are now referenced to the FO's selected course and Nav receivers; if both on 1, then the opposite is true

- when BOTH ON 1 or 2, the respective VOR RMDI needles will not transfer (i.e. if both on 2, the narrow VOR needles on both RMDIs are inop)
- this transfer switch has nothing to do with ADF's. ADF #1 always drives narrow needles in RMDIs; #2 always drives wide needles in RMDIs

EFI SWITCH (3-4-5 EFIS)

- Electronic Flight Instrument (EFI) switch provides a means of manually switching to the operating Symbol Generator (SG) should one of them fail or to restore one or more inoperative displays
- there are two Symbol Generators (overtemp / shutdown at 105°C)
  - with lose of all generators, the Captain's EFIS system may or may not be inop depending on your carrier's option as his SG may be on the AC Standy bus
  - the First Officer's SG is powered by 115V AC Transfer Bus #2
- the left SG receives data from ADC-1; the right receives data from ADC-2
  - takes inputs and generates the visual displays
- repositioning this switch will kick off autopilot(s)

BOTH ON 1 - both the Captain and FO EFIS displays on #1 SG (#2 turned off)

NORMAL - Captain's EFIS displays on #1 SG; FO's on #2 SG

BOTH ON 2 - both the Captain and FO EFIS displays on #2 SG (#1 turned off)

IRS SWITCH (3-4-5 EFIS / NG)

- replaces the Attitude and Compass Transfer switches found on non-EFIS aircraft
- enables selection of the opposite Inertial Reference System (IRS) in the event of attitude or compass failures (see Attitude and Compass Switches)
- repositioning this switch will kick off autopilot(s)

BOTH ON L

- switches the gyro source (attitude, heading, and V/S) to left IRS

NORMAL

- left flight instruments source is left IRS
- right flight instruments source is right IRS

BOTH ON R

- switches the gyro source (attitude, heading, and V/S) to right ADIRU
- INSTR SWITCH message
  - displayed when the IRS switch is not in the NORMAL position
  - indicates both Captain's and FO's displays are using the same source of ADIRU data
  - appears on PFD at lower right / EFIS display - above both altimeters

(MEL) Instrument Transfer Switch Sys - ATA 34

- may be inop provided associated instruments operate normally from isolated sources and inop switches are not moved during flight

FMC SWITCH
- this switch is only used on aircraft with two FMCs
- with only one FMC, the FMC Transfer switch will be deactivated
- basic operation with dual FMC's is identical to single FMC operation

NORMAL
- dual operation is enabled, meaning the right FMC is synchronized with the left FMC
- both CDU's are controlled by the left FMC
- each FMC provides inputs for its respective FCC, EFIS map, autopilot, and navigation radio tuning
- the left FMC controls the autothrottle
- guidance/map position and velocity are derived from inputs from both FMC's
- guidance commands and map position and track are monitored by the right FMC

BOTH ON L or R
- operation is identical to single FMC operation. All functions are controlled by the selected FMC
- the second FMC will become a navigation monitor. Information will continue to be transmitted from the selected FMC to the second FMC
- the offside map will annunciate "FMC L" or "FMC R" according to the transfer switch position
- moving this transfer switch will cause LNAV to disengage to CWS ROLL and VNAV disengages to ALT HOLD

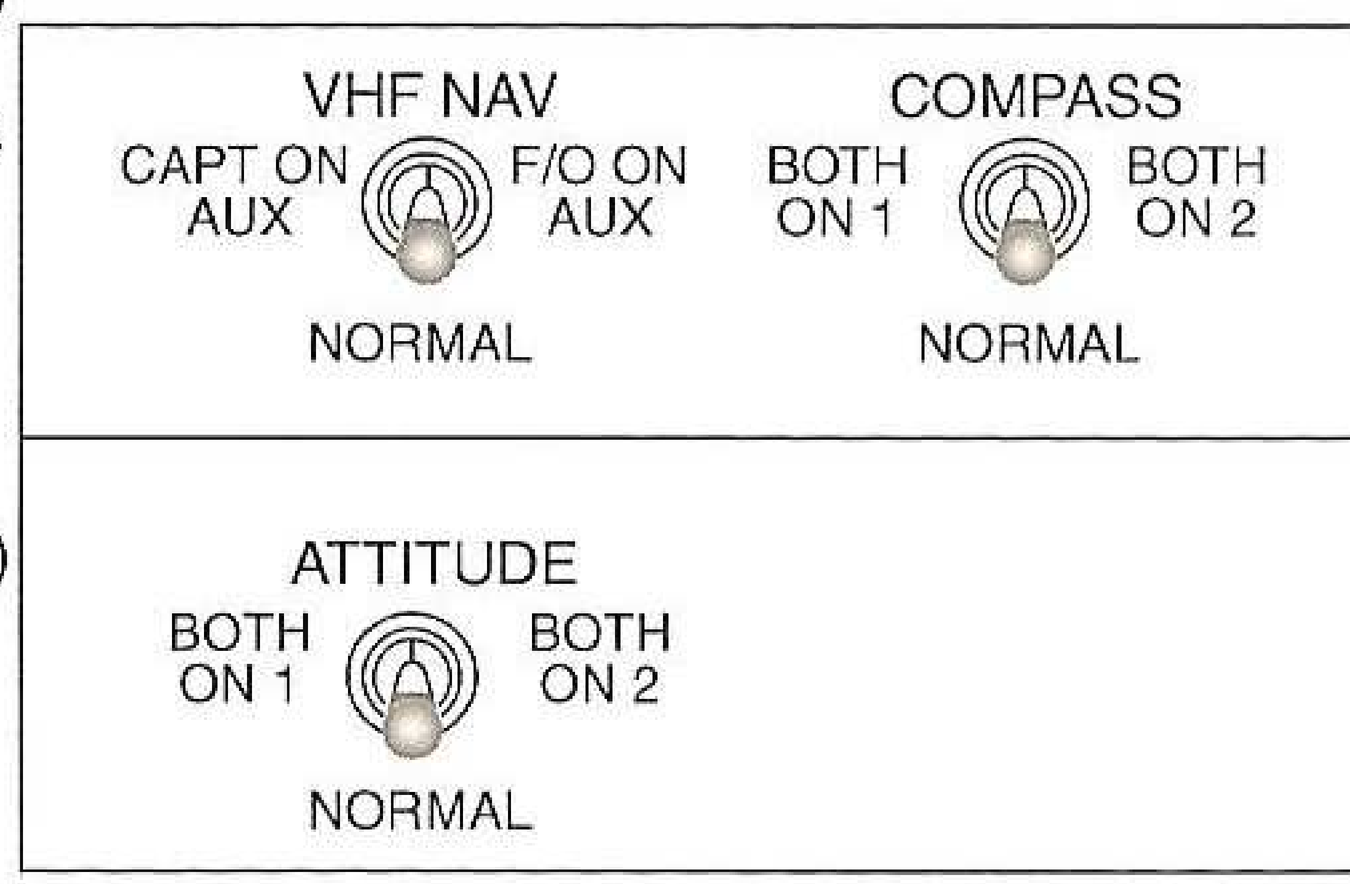
(QRH) Excessive IRS Drift (Dual Installation)
- place FMC Transfer switch to BOTH OF L if left IRS is most accurate; BOTH ON R if right IRS is most accurate. Removes bad IRS from position solution.

COMPASS SWITCH (3-4-5 non EFIS)
- enables selection of opposite compass system in the event of a compass failure
- the IRS's provide heading information

BOTH ON 1 - both the Captain and FO on left IRS

NORMAL - Captain (HSI and RDMI) on left IRS; FO (HSI and RDMI) on right IRS

BOTH ON 2 - both the Captain and FO on right IRS
- incorporated in the IRS switch on EFIS series airplanes



ATTITUDE SWITCH (3-4-5 non EFIS)
- enables selection of the opposite Inertial Reference System (IRS) in the event of attitude failure
- the IRS's provide attitude information

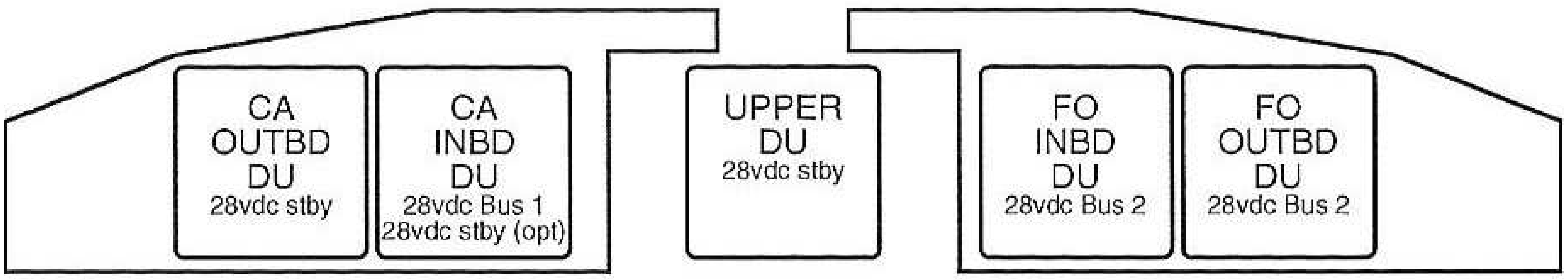
BOTH ON 1 - both the Captain, FO and A/P on left IRS for attitude

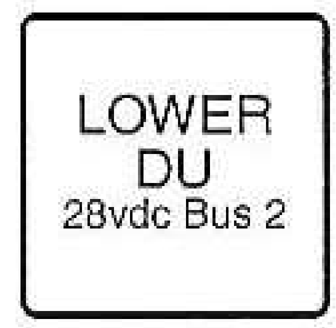
NORMAL - Captain's ADI on left IRS; FO's ADI on right IRS
- A/P A: pitch is on left IRS; roll is on right IRS
- A/P B: pitch is on right IRS; roll is on left IRS

BOTH ON 2 - both the Captain, FO and A/P on right IRS for attitude

Note: BOTH ON 1 or 2 does not provide switching of the vertical speed indicators
- incorporated in the IRS switch on EFIS series airplanes

COMMON DISPLAY SYSTEM - CDS





- Common Display System (CDS) shows primary flight, nav, and engine information on six interchangeable 8" x 8" x 10" flat panel Display Units
  - fragil glass matrix surface, expensive ($45,000) and susceptible to scratches or cracks
- CDS components are:
  - two Display Electronic Units (DEUs)
    - #1 is 28 vdc Stby Bus, #2 is 28 vdc Bus 2
  - six Display Units (DUs)
  - two EFIS Control panels (glareshield)
  - two Display Select panels (front panels)
  - an Engine Display Control panel (front panel in center)
  - a Displays Source/Control panel (overhead)
- Common Display System can show the data in two optional formats
  - EFIS / MAP (round gauges similar to (3-4-5) display Ref: EFIS Display
  - PFD / ND (similar to 767-400 / 747 / 777) Ref: PFD/ND Display
- Common Display System can show engine information in two optional formats
  - primary and secondary engine display on upper DU (side-by-side)
  - primary engine display on upper and secondary engine display on lower (over-under)
- there are three fault annunciations associated with the CDS

CDS Abnormals
- location - on the PFD below speed tape / on EFIS option above both altimeters
- all annunciations on the DUs are displayed at the same intensity (brightness) as the DU itself; if the intensity is low, the caution annunciation will also be low

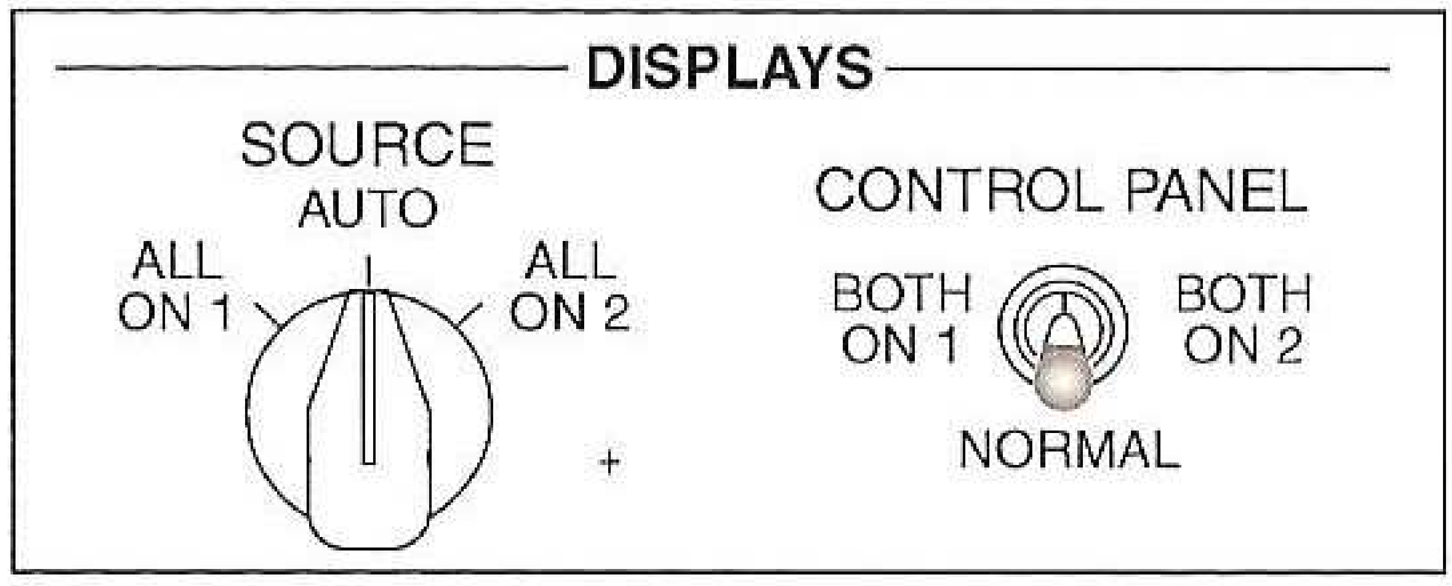
CDS MAINT message (white)
- displayed when one of these circuit cards fails in either DEU
  - a graphic generator, discrete I/O, or analog I/O circuit card
- displayed only on the ground, prior to second engine start

(MEL) CDS MAINT - ATA 31
- may be dispatched if Captain's inboard DU operates normal, CDS OPS P/N 3111-HNP-01A-05 or later is installed, and repairs are made within one day (check your MEL)

CDS FAULT message (amber)
- indicates a total DEU failure, or both DEUs have a partial failure, or
  - incompatible s/w or h/w or Hot Battery bus not available during initialization, or
  - miscompare of N1, N2, or EGT data between DEU1 or DEU2, or
  - data loader switch is in DEU1 or DEU2
- total failure is when the I/O controller, power supply, or processor fail
- partial failure is when two or more of these circuit cards fail in a DEU or one fails in both
  - a graphic generator, discrete I/O, or analog I/O circuit card
- non dispatchable fault
- displayed on ground (inhibited after second engine start)

(FIX) CDS FAULT/MAINT
- cycle DEU1 PRI and DEU2 PRI (P18-2 D5 and P6-1 D11)
- DUs will remain blank for a couple of minutes after re-instatement of CBs.

DISPLAYS CONTROL PANEL

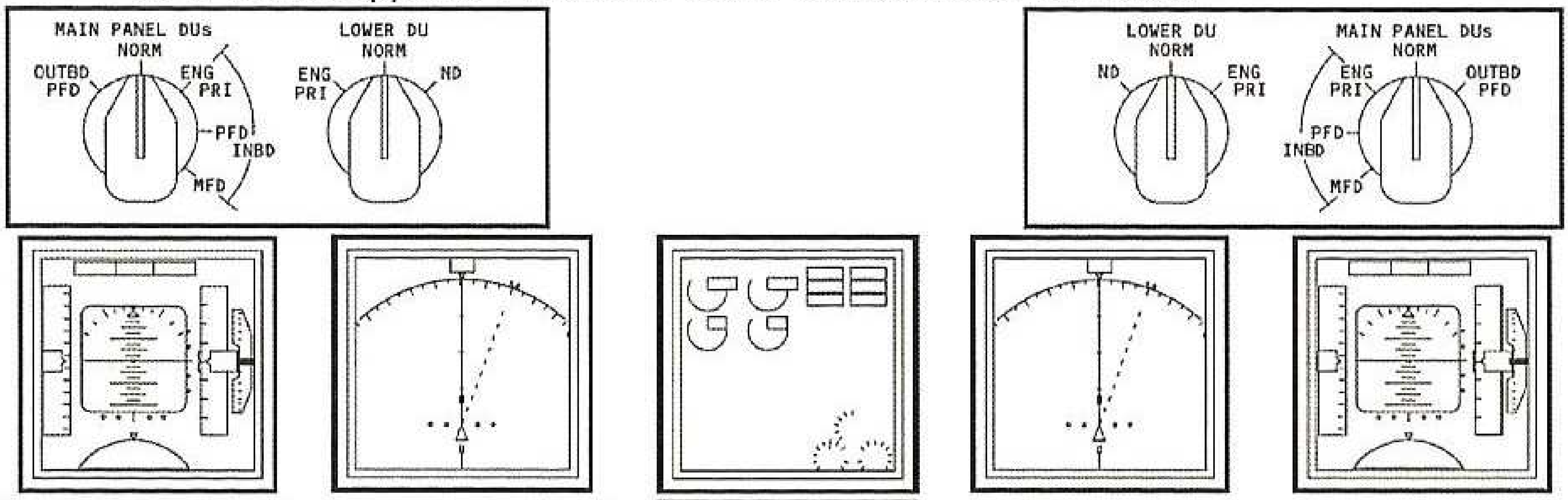


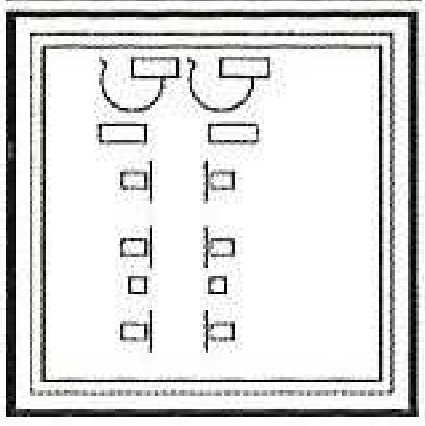
SOURCE

- controls the Display Electronic Units (DEUs)
- there are two DEUs
- allows selection of either DEU1 or DEU2 for all six Display Units (DU)

AUTO
  - DEU 1 controls Capt outboard, inboard, and upper DUs
  - DEU 2 controls FO outboard, inboard, and lower DUs
  - when a DEU fails the other DEU supplies data to all 6 DUs

ALL ON 1 / ALL ON 2
  - provides a means of manually switching to a single DEU as the source of information for all six DUs
  - DSPLY SOURCE appears PFD-lower left/EFIS-above both altimeters





DSPLY SOURCE message (amber)

- displayed above Captain and FO altimeters
- indicates a CDS fault
  - displayed if a DEU failure has caused all 6 DUs to get data from one DEU
  - moving the Display Source Select switch to the failed side will lead to loss of all flight instruments
- displayed only while on the ground and both engines running
  - on the ground with the engines off, the message CDS FAULT replaces the DSPLY SOURCE message
- this also occurs when the Display Source Select is in the ALL ON 1 or ALL ON 2 position
- this is a non dispatchable fault
- MASTER CAUTION and ENG annunciator illuminates
- dual autopilot approach is not available
- DSPLY SOURCE does not replace CDS FAULT when the data load switch is left in the DEU 1 or DEU 2 position because the DEUs will only load software on the ground with at least one engine not running. If you have this fault and start both engines, the DEUs ignore the data loader and become operational
- a failed DEU can be identified by
  - both EECs go to ALTN mode (both EEC ALTN lights illuminate)
  - the absence of hydraulic pressure indication on failed side
  - the speed limit flag visible on failed side
  - the minimum maneuver speed and stick shaker band removed from airspeed indicator on failed side

(FIX) DSPLY SOURCE

- a complete power down for 1 minute may clear the fault

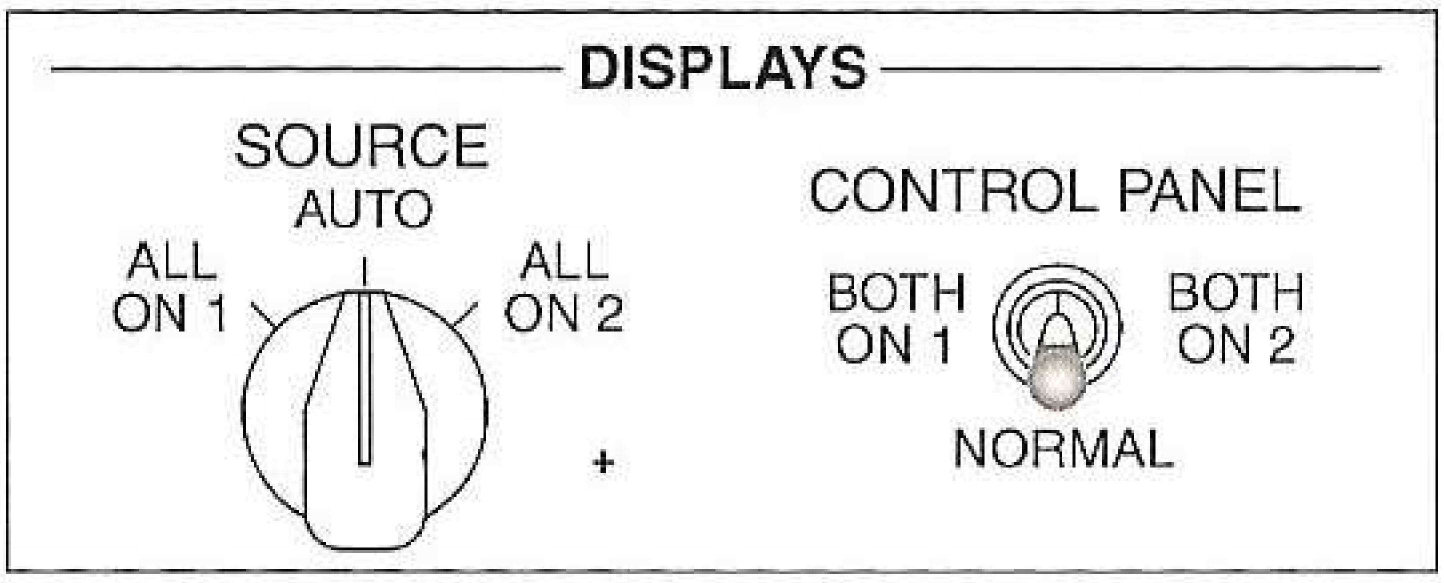
CONTROL PANEL

- controls EFIS Control Panels

BOTH ON 1
- Captain's EFIS control panel controls Captain's and FO's DUs

NORMAL
- left EFIS control panel controls Capt DUs and right EFIS control panel controls the FO DUs

BOTH ON 2
- First Officer's EFIS control panel controls Captain's and FO's DUs



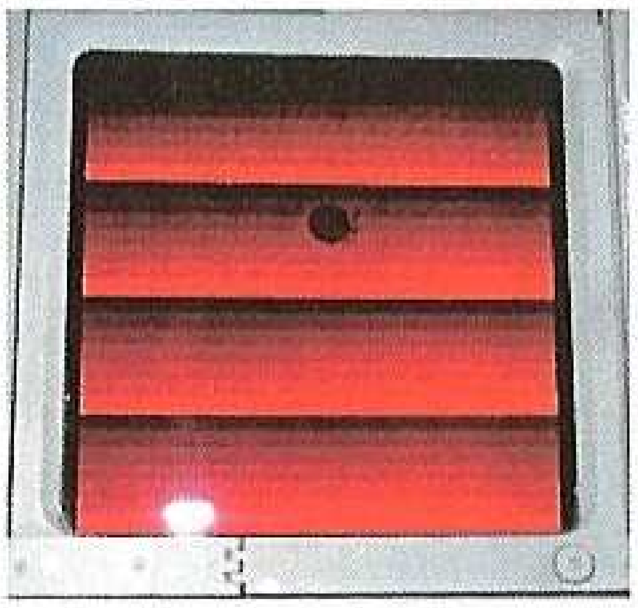
(QRH) Displays Control Panel

- DISPLAYS CONTROL PANEL message indicates failure of the related EFIS Control Panel
- this message appears in the center of the altimeter and the ALT flag appears just below it
  - other indications include the wx radar defaults to on and on-side A/P clicks off
- the altimeter blanks because you've lost baro correction input
- on early production NGs, the pressurization system AUTOFAIL will also illuminate if the failure is in the Captain's panel because baro corrections to the auto and alternate controllers are lost

  CONTROL PANEL SELECT SWITCH................ BOTH ON 1 / BOTH ON 2

Common Display System Notes

1. Display Units (DUs)
   - these DUs show primary flight, navigation, and engine information
   - there is a bezel light sensor at the bottom edge of the face plate
   - each DU has internal temp detectors
     - if the temp gets too hot, the power supply shuts down the display unit
       - when the DU cools, it comes on again
2. Display Electronic Units (DEUs)
   - DEUs are mounted on the aft rack of the EE compartment
   - DEUs
     - collect data from airplane systems,
     - change the data to a video signal to show on the display units, and
     - send data to other airplane systems
   - each DEU has 9 circuit card assemblies
     - failures in the cards cause some messages to show on the DUs
3. DU screen test
   - DUs can be screen tested by following these steps...
     - start with any page that has an < INDEX prompt displayed and press INDEX
     - next, select MAINT > / < CDS / < DEU 1 or 2 / < GROUND TESTS /
       < DU OPTICAL TEST / < RED, BLUE, GREEN, or STRIPE
     - damaged pixels can be seen in these modes
     - finger prints are a contributor to screen damage
       - keep DUs clear of fingerprints
     - if the MFD ENG switch is selected and the crew desires to regain the compact display on the upper DU, the crew can perform this procedure to recover the compact display on the upper DU only on the ground and without an engine running



   - exit the test by pressing the < INDEX prompt twice
     - terminating the test blanks all displays for approx.10 sec, then restores the compact display of primary and secondary engine indications on the upper DU, and hydraulic quantity and pressure information on the lower DU
     - the altimeters re-set to 29.92 and the green altimeter bug goes to 200 ft

FUEL PANEL

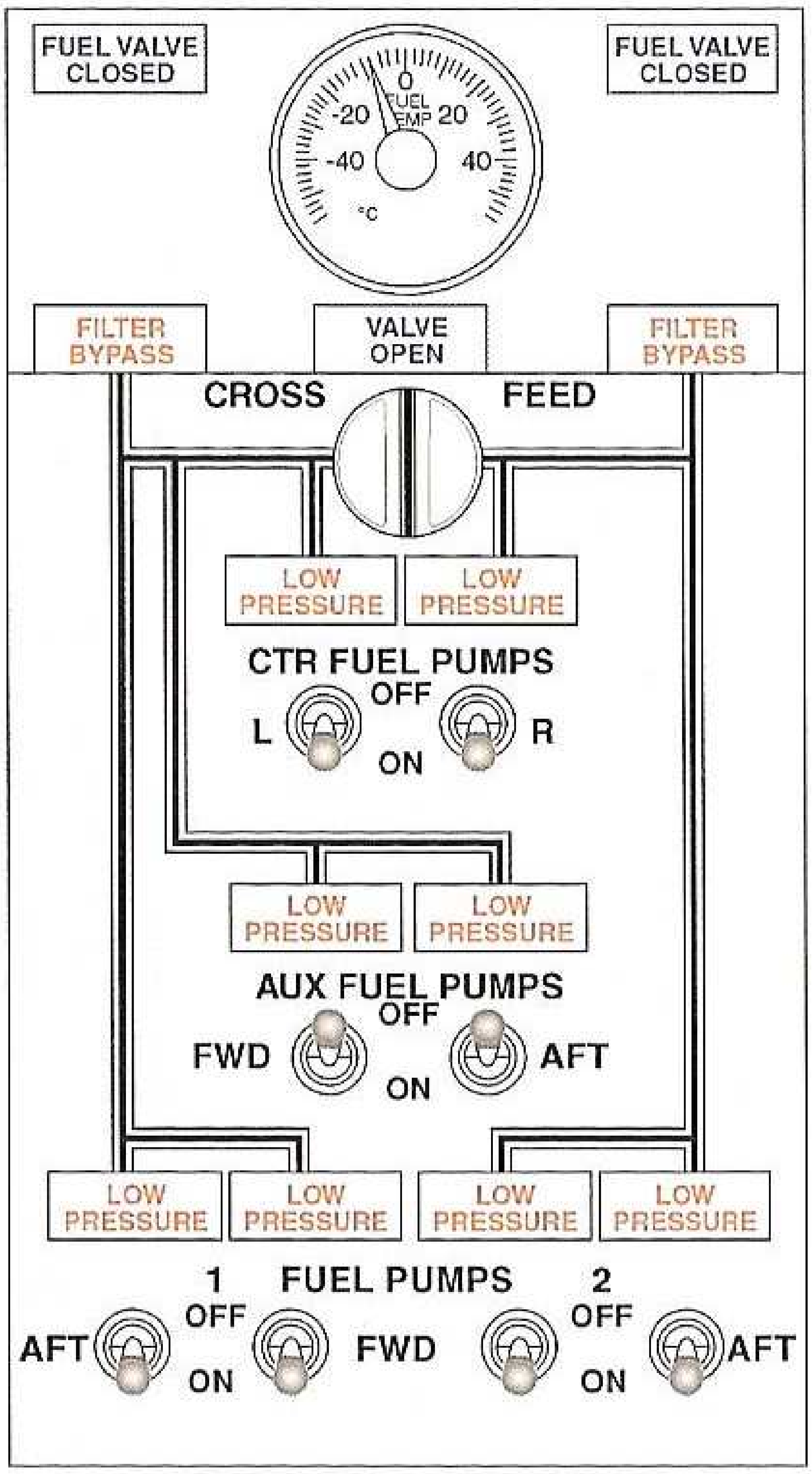
FUEL VALVE CLOSED lights (3-4-5) (blue)
- extinguished = the spar fuel valve is open
- bright blue = fuel valve is in transit, or valve position and engine start lever or engine fire handle disagree
- dim blue = the spar fuel valve is closed
- closed by start lever or fire handle
- during engine start, goes bright to out

SPAR VALVE CLOSED lights (NG) (blue) and **ENG VALVE CLOSED lights (NG) (blue)**
- extinguished
  - related spar or engine fuel valve is open
    - engine fuel valve is the HPSOV on the HMU
- bright blue
  - related spar or engine fuel valve is in transit, or valve position and engine start lever or engine fire handle disagree
- dim blue
  - related spar or engine fuel valve is closed
- controlled by start lever or fire handle
- during engine start, goes bright to out
- spar valve mounted on the wing spar
- engine valve located on engine
- spar valve has backup nicad battery to make sure it always has power to close

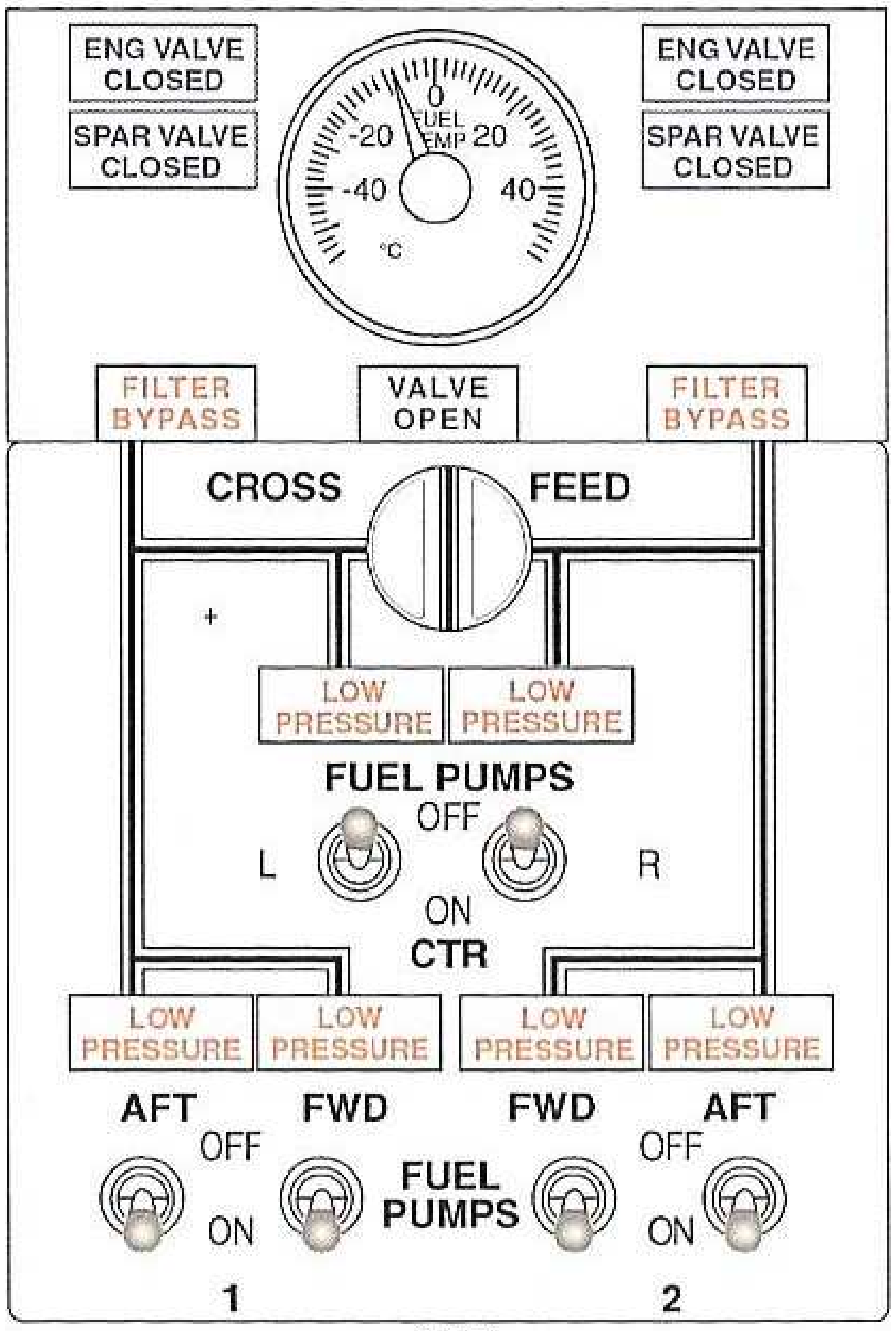
(MEL) Engine Valve Closed Lights
- may be inop provided the associated valve is verified to operate normally
- start the engine. Open the circuit breaker for the associated engine Fuel Spar Valve.
  (NG) place start lever to cutoff. (3-4-5) without rotating, pull the fire handle. Verify the engine immediately decelerates.
  Close the circuit breaker. (3-4-5) push the fire handle back in. Open the circuit breaker for the associated Engine HPSOV Indicator.

FUEL TEMPERATURE INDICATOR
- indicates fuel temperature in the tank 1 (left)
- when fuel approaches fuel freeze point limit
  - descend, divert to warmer air, or increase mach; this should warm the fuel

(L/OP) Fuel, Max & Min Temps
- max fuel temp 49°C
- minimum fuel temperature -37°C
  - freeze point for Jet A is -40°C
  - for Jet A1is -50°C



-300 FUEL PANEL WITH AUX TANK



(NG)

FILTER BYPASS lights (amber)

- indicates impending fuel filter bypass due to a contaminated filter
  - pressure differential across the bypass filter has exceeded limits
    - 11.5 psi for light, 15 psi for bypass valve
  - some or all fuel is bypassing the filter
- may not be ice (fuel heat is automatic)

(L/OP) Fuel Pump Circuit Breaker

(3-4-5) do not reset any tripped fuel circuit breaker
(6-7-8-9) all fuel pump CBs are in the EE compartment

CROSSFEED VALVE OPEN light (blue)

- extinguished = the crossfeed valve is closed (the normal situation)
- bright blue = crossfeed valve in transit or valve position and crossfeed selector disagree
- dim blue = crossfeed valve is open

CROSSFEED SELECTOR (valve)

CLOSED - isolates engine #1 and 2 fuel lines
OPEN - connects engine #1 and #2 fuel lines

(QRH) Crossfeed Selector Failed

- in the closed position, vary thrust to maintain fuel balance
- in the open position requires, maintained balance by selective use of the fuel pumps

MAIN TANK FUEL PUMP LOW PRESSURE lights (amber)

- illuminated = fuel pump output pressure is low, or the pump switch is off
- extinguished = fuel pump output pressure is normal
- main (wing) tank lights always armed
- main pumps are Fwd and Aft
- two LOW PRESSURE lights illuminated in the same tank will light the MASTER CAUTION and FUEL annunciator lights
- one LOW PRESSURE light will cause the MASTER CAUTION and FUEL annunciator lights to illuminate on RECALL

CENTER TANK FUEL PUMP LOW PRESSURE lights (amber)

- illuminated = fuel pump output pressure is low and pump switch ON (< 22 psi)
- extinguished = fuel pump output pressure is normal or pump switch is off
- center tank lights armed with pump switch on; i.e. center pump off = no light
- center pumps are Left and Right
- with both center tank pump switches ON, the illumination of both LOW PRESSURE lights will light the MASTER CAUTION and FUEL annunciator lights
- (revised Master Caution sys) with both center tank pump switches ON, the illumination of either LOW PRESSURE light will light the MASTER CAUTION and FUEL annunciator lights
- one LOW PRESSURE light will cause the MASTER CAUTION and FUEL annunciator lights to illuminate on RECALL
- with one center tank fuel pump switch OFF, illumination of opposite center tank LOW PRESSURE light illuminates the MASTER CAUTION and FUEL annunciator lights
- (option & new a/c) auto pump shutoff system; either center pump operating at low output pressure for 10 seconds will cause the respective LOW PRESSURE light, the FUEL annunciator and MASTER CAUTION lights to illuminate; 5 seconds later that center tank pump will automatically shut off
  - the auto shutoff system can be reset by placing the pump switch OFF then ON if needed
- in climb, one of the center pump's fuel probe's will run out of fuel first, causing its LOW PRESSURE light to come on. If you turn just that pump off, you will get a fuel imbalance
  - immediately shut off any pump that has an illuminated LOW PRESSURE light
  - be alert for imbalance condition

AUX TANK FUEL PUMP LOW PRESSURE lights (amber)

- illuminated = fuel pump output pressure is low with pump switch on
- extinguished = fuel pump output pressure is normal or pump switch is off
- aux tank lights armed with pump switch on; i.e. aux pump switch off = no light
- aux pumps are Fwd and Aft
- with both aux pump switches on, the illumination of both LOW PRESSURE lights will light the MASTER CAUTION and FUEL annunciator lights
- one LOW PRESSURE light will cause the MASTER CAUTION and FUEL annunciator lights to illuminate on RECALL

FUEL PUMP switch

ON - activates the fuel pump

- two pumps for each tank (center, aux if installed, left wing, right wing)
- it is desirable to use the left center fuel pump to supply the APU, so you won't get a main tank imbalance

FUEL TANK CAPACITY

(3-4-5)

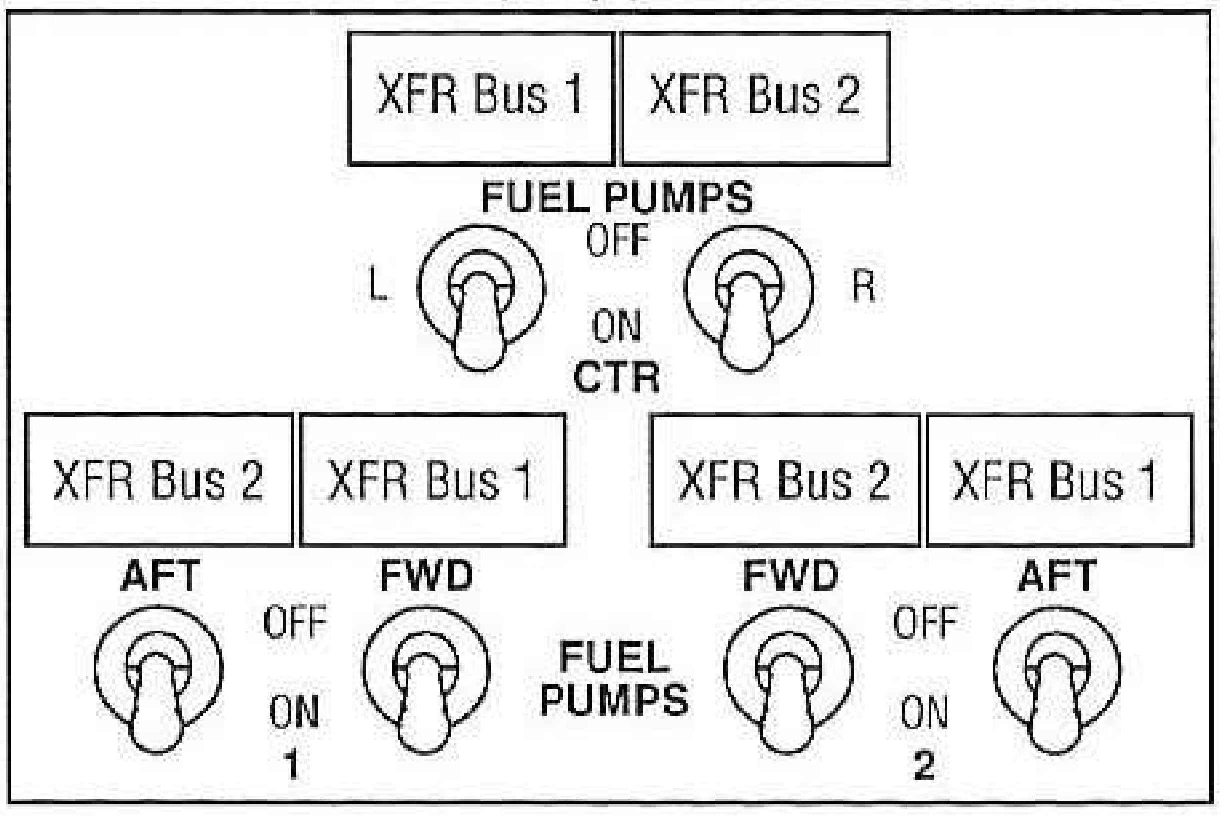
Tank	Useable gals	Useable lbs	Max Allow lbs	Useable liters	Useable kgs
Wings	1,499 each	10,043 each	10,643 each	5,674	4,555
Center	2,313	15,497	16,422	8,755	7.029
Aux	390	2,613	2,776		
Aux (Rob)	496	3,323		1,876	1,507
Totals	5,311	35,583	37,708	20,104	16,140

NG

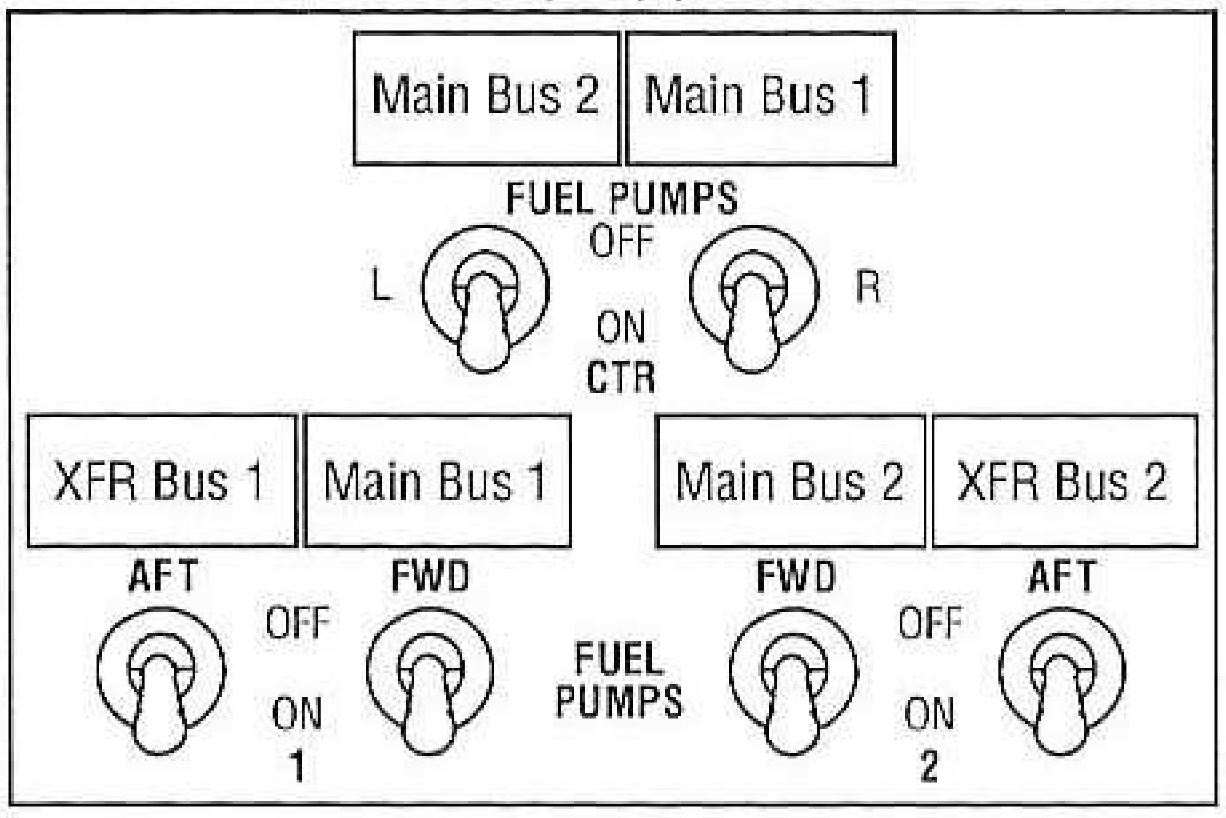
Tank	Useable gals	Useable lbs	Max Allow lbs	Useable liters	Useable kgs	Max kgs
Wings	1,288 each	8,630 each	8,967 each	4,876	3,915	4,076
Center	4,299	28,803	29,685	16,273	13,066	
Totals	6,875	46,063	47,619	26,025	20,896	

Useable fuel at level attitude, fuel density 6.7 pounds per US gal / 0.8029 kg per liter

NG Boost pump power sources

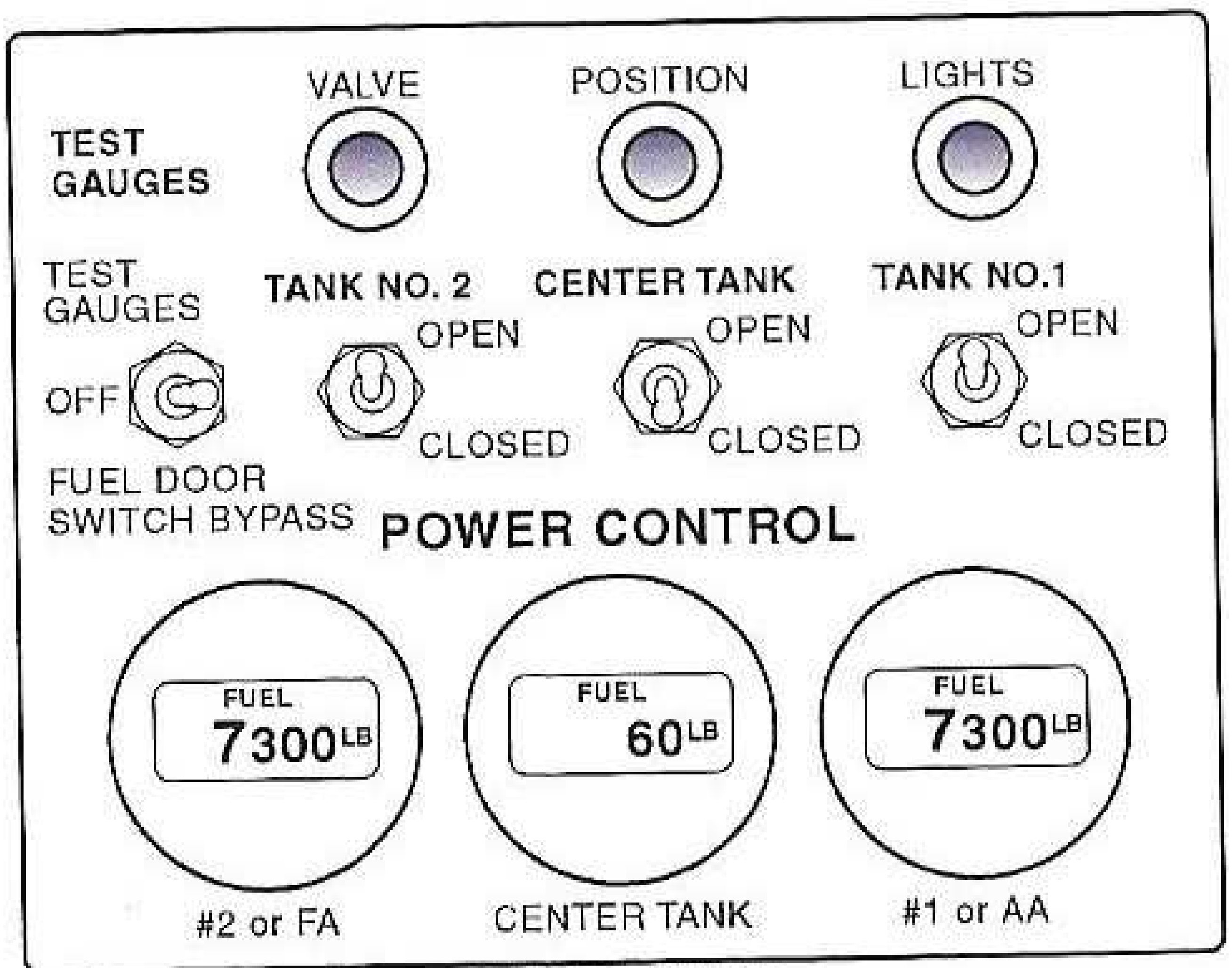


Classic boost pump power sources

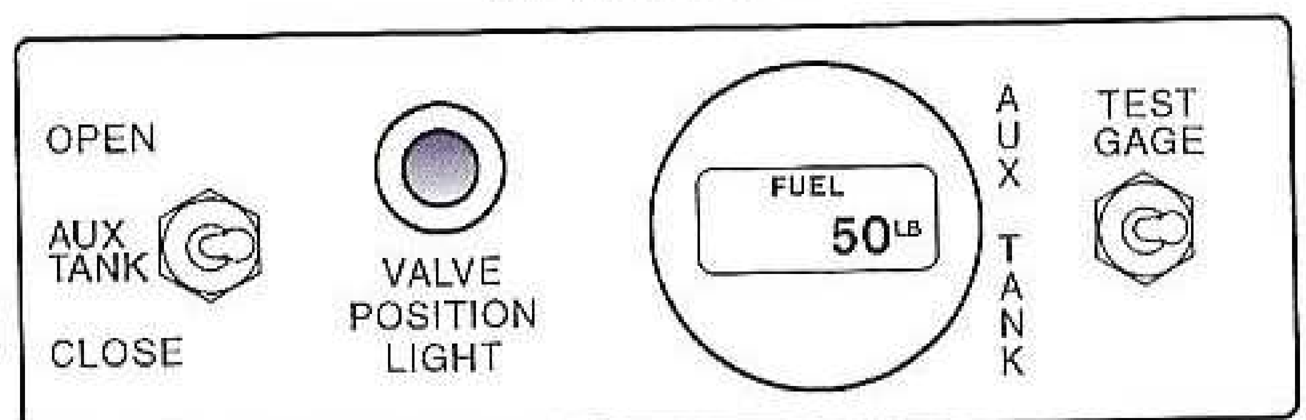


FUELING STATION (P15)

- used to fill, defuel, or transfer between tanks
- opening door actuates fueling power control relay (28v dc hot bat bus) and panel lights illuminate
- refuel with external power (on or off electrical system buses), APU, or battery (BAT switch must be ON)
- (3-4-5) refuel panel gauges are repeaters from cockpit gauges
- (NG) Fuel Quantity Processor gets inputs from each tank and sends it to the refuel panel
- plunger on each valve permits manual operation
- AUX FUELING POWER CONTROL (3-4-5) / FUEL DOOR SWITCH BYPASS (NG)
  - grounds fueling power control relay
    - normally grounded through fueling power control switch (via magnet near switch)
- fueling stops automatically when tank(s) is full
  - float switch removes power to the fuel valve when tank is full. Spring loaded closed
  - indicators will blink if capacity is exceeded
- to fuel aux tank (3-4-5 - optional equipment)
  - open the manual defueling valve (outboard right engine) and the AUX TANK fueling valve switch - opens the crossfeed valve and the aux fueling valve. Fuel has to go through defueling manifold and crossfeed valve to get to the aux tank
  - all pumps must be off to avoid inadvertent fuel transfer
  - CROSSFEED disagree light illuminates if the CROSSFEED selector is closed in the cockpit since the AUX TANK switch overrides the CROSSFEED selector in the cockpit
  - if fueling aux with the APU on and the L center boost pump on, boost pump pressure pushes center tank fuel into aux tank (see schematic)
- over-wing refuel procedure (3-4-5)
  - available to main tanks only
    - if electrical power is not available, use the fuel measuring sticks
    - quantity is limited due to location of over-wing filler port
- refueling with battery only
  - BAT switch ON, STANDBY POWER switch BAT (Manual Stby Power relays - R328 close)
    - connects DC standby bus to battery bus and AC standby bus to inverter
  - valves are 28v DC from hot battery bus
- refueling with no AC or DC power (no APU, dead battery, and no external power)
  - attach fuel nozzle. Press and hold solenoid override button (red) for desired tank (wing or center). Releasing the override button allows the spring in the valve to close the valve. Do not overfill - no automatic fuel shut-off
- max refuel rate 2,025 lbs/min
- max pressure is 55 psi (379 kPA) (approx. 300 US gal/min)



REFUEL PANEL



-300 AUX TANK REFUEL PANEL

Fuel System Notes

1. controls, indicators and general
   - (3-4-5) gauges are standby AC
     (NG) gauges are 28v DC
   - tanks may be loaded in any sequence
   - (3-4-5) cockpit gauges get quantity directly from their respective tank units
     - refuel panel gauges are repeaters from cockpit
     - FMC gets its fuel quantity from the Fuel Summation Unit
   - (NG) cockpit and refuel panel fuel gauges and FMC all get their fuel quantities from the Fuel Quantity Processor, which gets inputs from the individual tank units
   - no fuel dump capability since takeoff weight is not much greater than landing weight
   - cannot transfer fuel inflight
     - you can transfer on the ground using refuel panel and defuel valve
   - normal operations
     - before start - fuel valve closed lights should be on and fuel filter lights out
     - use aux and center fuel equally until aux fuel is depleted

   (3-4-5) each fuel pump is housed in its own dry bay in the wing tanks
   (NG) all fuel pumps are housed in the center tank (except APU pump; inside tank 1)
2. main (wing) pumps
   - No. 1 tank pumps and left center pump normally feed No. 1 engine; and the same on the right side for No. 2 engine
   - boost pump power sources are arranged to ensure that in the event of a single generator failure, at least one pump in each tank will remain powered
   - main tank aft pumps are powered from the transfer busses so that at low fuel level, if a generator is lost, both aft pumps remain powered
   - all main fuel pumps put out same fuel pressure (min 10 psi, rate 20,000 pph / 9,071 kgph)
3. center fuel pumps
   (3-4-5)
     - same pressure as the main pumps
     - opening pressure for center tank check valves is approximately 1.3 psi.
     - opening pressure for the wing tank check valves is approximately 12 psi
       - this makes main boost pump check valves stay closed until center tank is empty
     - aux tank pumps over power the center tank to feed No. 1 while center feeds No. 2.
       - when aux empties the center L opens to feed No. 1

   (NG) center fuel pumps put out higher pressure than the main pumps
     - min 23 psi and min flow rate of 20,000 pph / 9,071 kgph
4. aux pumps
   - override the wing and center tank pumps with higher pressure
     - same pumps, but different impeller blade angle
5. suction feed (bypass valve)
   - tanks 1 and 2 have a bypass valve (suction valve) in case there are no electric pumps
     - may get flameout if trying to suction feed above 30,000'
   - bypass valves also used in defueling operation
   - center tank and aux tank have no bypass valves - therefore there is no suction feed from these tanks
   - APU fuel suction feed from No. 1 tank
6. jet pump (center tank)
   (3-5) when both boost pumps in the center tank are turned off, the fuel scavenge shutoff valve is opened, and a 20-minute timer is started (wing tank pumps must be on)
     - the fuel scavenge jet pump causes a low pressure in the fuel scavenge transfer line when the fuel boost pumps for the No. 1 tank puts fuel through the fuel scavenge jet pump.
     - this drains about 15 gallons of fuel out of the center tank to No. 1
     - if you turn the center pumps ON then OFF just before pushback (with fuel in the center tank), you will have a slight imbalance in 20 minutes because you activated the jet pump

(NG) begins to operate when No. 1 main tank is about 1/2 full and main tank No. 1 FWD pump is operating: it continues for remainder of the flight
- transfers remaining fuel from center tank to No. 1 main tank
  - approximate rate of 177 lb/hr (80 kg/hr), depending on altitude

7. water scavenge jet pumps (4)
   - each center tank pump and each aft wing pump has a scavenge jet pump to remove water from low points of each tank to prevent corrosions (not shown in drawing)
8. aux tank
   (3-4-5) located in the forward end of the aft cargo hold
   - supplies the left engine with the center tank supplying the right engine until the aux tank is depleted, then center tank supplies both engines (see schematic)

   (3-4-5) Rogerson aux tank
   - tank capacity is 1,498 kgs (3,302 lbs)
   - aux tank is filled from left fuel manifold, so crossfeed must be opened to refuel
   - no pumps - bleed air from packs pressurize the aux tank
   - fuel flows from aux tank through two transfer valves into center tank
   - ON / OFF switch controls the bleed air SOV and the transfer valves
9. dripsticks / measuring sticks
   (3-4-5) five fuel dripsticks /measuring sticks (floatsticks) in each main tank; center tank does not have any sticks
   (NG) six fuel measuring sticks in each main tank and four in the center tank
   - allow a comparison of fuel quantity or weight determined from the stick reading with the fuel weight indicated by the fuel quantity indicators
   - a dripstick reading is obtained by withdrawing the dripstick from the tank until a steady drip of fuel commences at the drip hole near the base
   - measuring sticks latch magnetically to an internal float. The fuel depth is read where the stick passes through the wing skin
   - to obtain reading use the 2 inclinometers in the left wheel well
     - pitch on the keel beam (max pitch is -1.0°) & roll on aft bulkhead (max roll is 0.0)
     - fuel depth is read where the stick passes through the wing skin then converted to pounds using the 737 Fuel Quantity Verification Tables

FUEL QUANTITY VERIFICATION TABLE - NG
Fuel in pounds - based on 6.7 lb. per gal

Stick	Center Tank		Wing Tank					
	#1	#2	#3	#4	#5	#6	#7	#8
1.8					5842	6844	7629	8282
2.0		12956	1362	3671	5887	6880	7658	8305
2.2	1762	13138	1403	3732	5932	6918	7689	8328
2.4	1875	13322	1445	3793	5976	6955	7718	8351
2.6	1988	13506	1487	3853	6021	6990	7748	8374
2.8	2103	13691	1530	3913	6065	7027	7776	8397
3.0	2219	13877	1574	3972	6108	7063	7806	8419
3.2	2336	14063	1618	4031	6152	7098	7834	8440
3.4	2454	14249	1663	4089	6195	7133	7863	8462
3.6	2572	14437	1709	4148	6237	7168	7890	8484
3.8	2690	14625	1755	4205	6280	7203	7918	8505
4.0	2810	14812	1802	4263	6321	7237	7945	8526
4.2	2931	15001	1849	4320	6363	7271	7973	8546
4.4	3053	15189	1898	4377	6405	7305	7999	8566
4.6	3176	15378	1947	4432	6445	7337	8025	8587
4.8	3299	15568	1996	4489	6486	7371	8141	8607
5.0	3423	15757	2047	4543	6527	7404	8078	8626
5.2	3548	15946	2097	4599	6566	7435	8103	8645
5.4	3674	16136	2149	4653	6606	7468	8128	8662
5.6	3801	16327	2201	4707	6645	7500	8154	8680
5.8	3928	16517	2254	4760	6684	7532	8179	8697
6.0	4057	16707	2307	4814	6723	7562	8203	8714
6.2	4186	16898	2361	4866	6761	7593	8227	
6.4	4315	17089	2415	4919	6799	7624	8251	
6.6	4446	17279	2471	4970	6837	7654	8275	
6.8	4578	17471	2527	5022	6874	7684	8299	
7.0	4711	17662	2583	5073	6911	7714	8321	
7.2	4845	17852	2640	5124	6949			
7.4	4978	18043	2698	5174	6984			
7.6	5114	18235	2755	5224	7021			

10.inadvertent transfer of fuel into center tank
- caused by check valve that didn't seat
  - impeller in center tank pump will run backwards
- turn off main tank pumps (affected side) to keep pressure from running impeller backwards. Above 30,000 ft thrust deterioration may occur; consider descending to a lower altitude
- when main tank fuel pump LOW PRESSURE light illuminates, turn center pump ON
- when center tank fuel pump LOW PRESSURE light is extinguished, turn main pumps ON
- leave affected center tank fuel pump switch ON and crossfeed selector CLOSED for the remainder of the flight

11. fuel transfer - to transfer fuel from a wing or center tank,
- open the crossfeed valve and turn the fuel pumps on in the tank with the excess fuel
- at the refuel panel, open the desired tank valve to receive the fuel and open the manual defueling valve
- when the desired amount of fuel has been transferred, close the tank valve switch, the defueling valve, and refuel the main tanks
- close the external access door and close the crossfeed valve

12. defuel valve (right wing front spar)
- uses the fueling receptacle for removal of fuel from each tank
- to pressure defuel from any tank
  - connect refuel nozzle, open the defuel valve, open crossfeed if necessary, turn on desired aircraft fuel boost pumps; when defuel is complete, reverse process
- to suction defuel from tanks 1 or 2
  - connect fueling nozzles, open the defuel valve, open crossfeed if necessary, start to suction fuel with the ground source; fuel is drawn through the bypass valves
  - when defuel is complete, reverse process

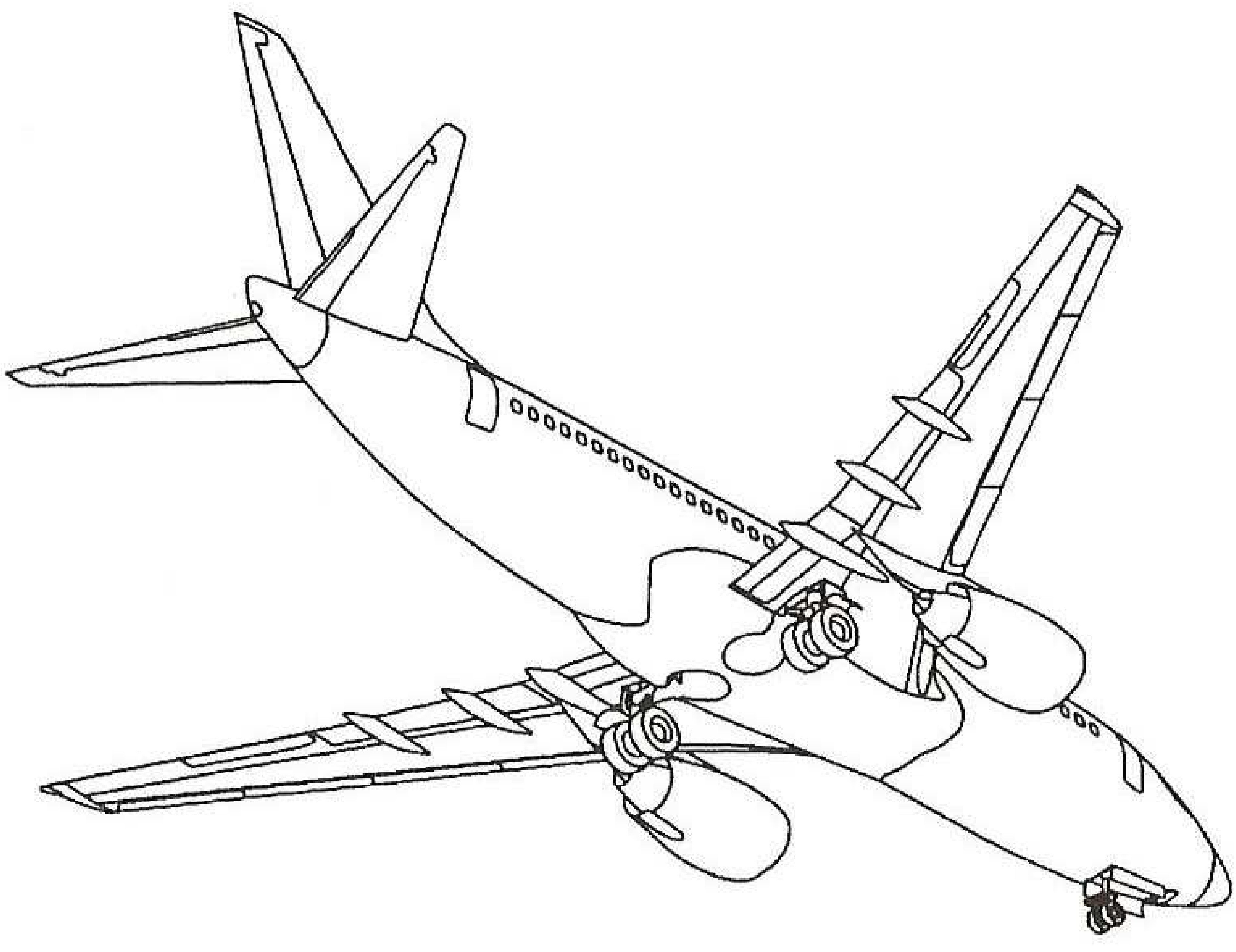
13. crossfeed valve
- located in the gear well and has a manual override lever
- during the last hour of ETOPS cruise on aircraft with single crossfeed valve, cycle the crossfeed valve. This verifies that the valve is operating so that on the subsequent flight if an engine fails, fuel feed will be available from both wing tanks

14. surge tanks
- located at the outer end of each wing tank
- collects any fuel overflow from the wing and center tanks and supplies tank venting
- capacity is (3-5) 30 gal each (NG) 35 gal each
- (3-5) surge tanks drain to the center tank; (NG) drains to respective wing tank
  - if the fuel level is high enough in the surge tank, fuel will drain out the vent scoop

15. fuel vent system
- prevents damage to tank structure by providing positive venting of all fuel tanks
- during flight, the system also helps to decrease fuel evaporation and assists the fuel boost pumps by providing a small positive head pressure

16. cavitating center boost pump
    - If the center tank fuel boost pump low pressure light(s) remains illuminated after putting fuel in the center tank, the center pump(s) is cavitating. Continued operation with low fuel results in a loss of prime to the pump. This may occur after maintenance or operational use where the pumps have been run for several minutes after the low pressure light becomes illuminated with a nearly empty tank.
    - Corrective action
        - when the low pressure light remains illuminated, turn the pump off. Do not run the pumps dry for extended periods of time. To reprime the pumps in place requires that 15,000 lbs of fuel be in the center tank. Alternately, the pump(s) may be primed by performing one of the following procedures:
            - put up to 15,000 lb of fuel in the center tank or until the low pressure light is extinguished, then use the center tank pumps to move the fuel to the main tanks.
            - dip the motor/impeller unit in fuel prior to installation.
            - wet the motor/impeller unit by adding fuel via the pump housing drain port (external to the tank).
            - after priming, put a minimum of 4,000 lbs of fuel in the center tank to cover the pump inlet
            - turn on the affected pump(s) and verify that pump(s) will transfer fuel. The low pressure light on the P5 panel will flash at different levels of fuel in the center tank depending on the attitude of the airplane. The pumps should be turned off when the low pressure lights remain illuminated. On the ground, typically the right boost pump inlet is uncovered first then the left pump.

        The loss of prime condition is not observed on 737 (3-4-5) models because the center tank boost pumps have a reprime line which allow the pumps to reprime during refueling operations. Unlike the 737 (3-4-5) airplanes, the (NG) models do not have a center tank boost pump reprime line.
17. servo fuel heater
    - raises temperature of fuel to eliminate ice in the fuel before it enters the control servos inside the (3-4-5) MEC (NG) HMU
    - fuel heat exchanger is between engine oil and fuel



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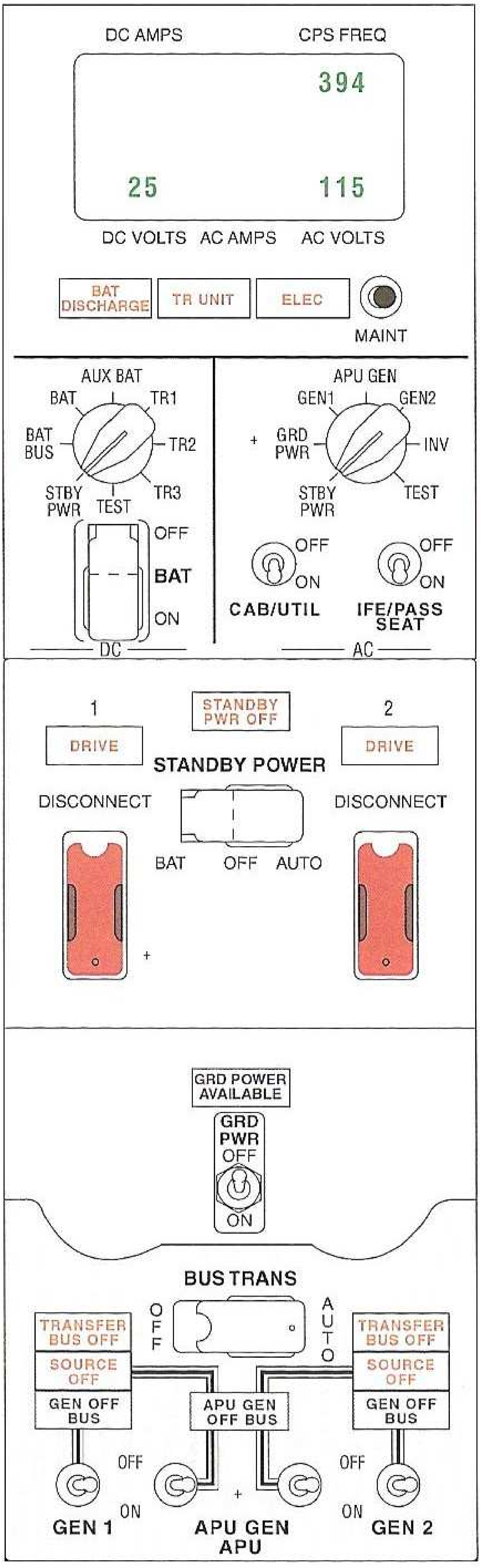
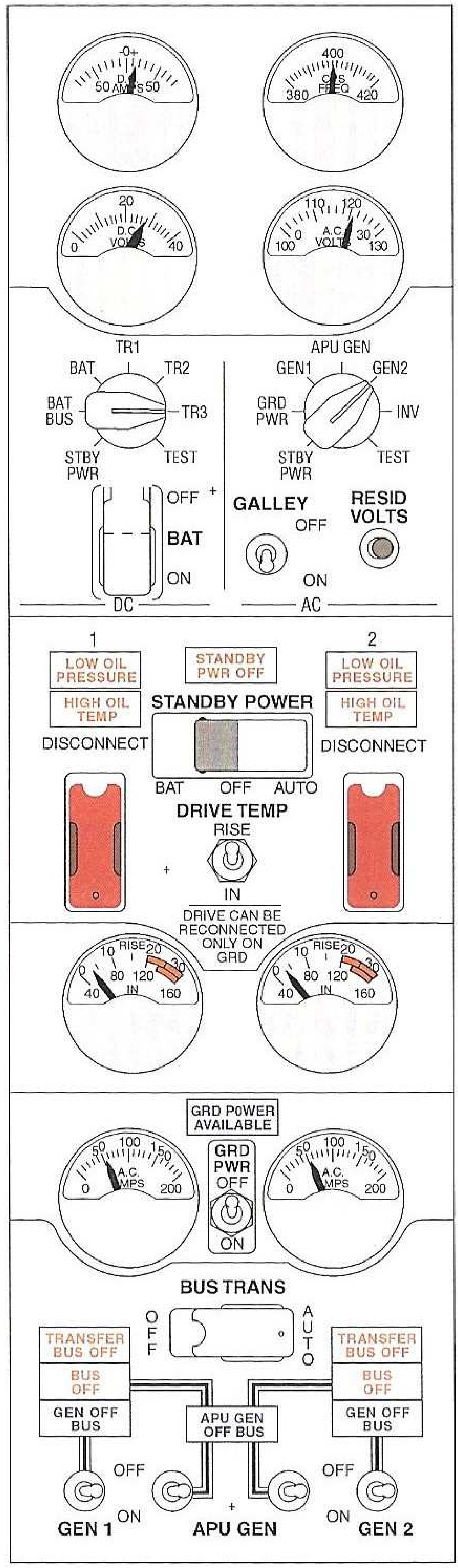
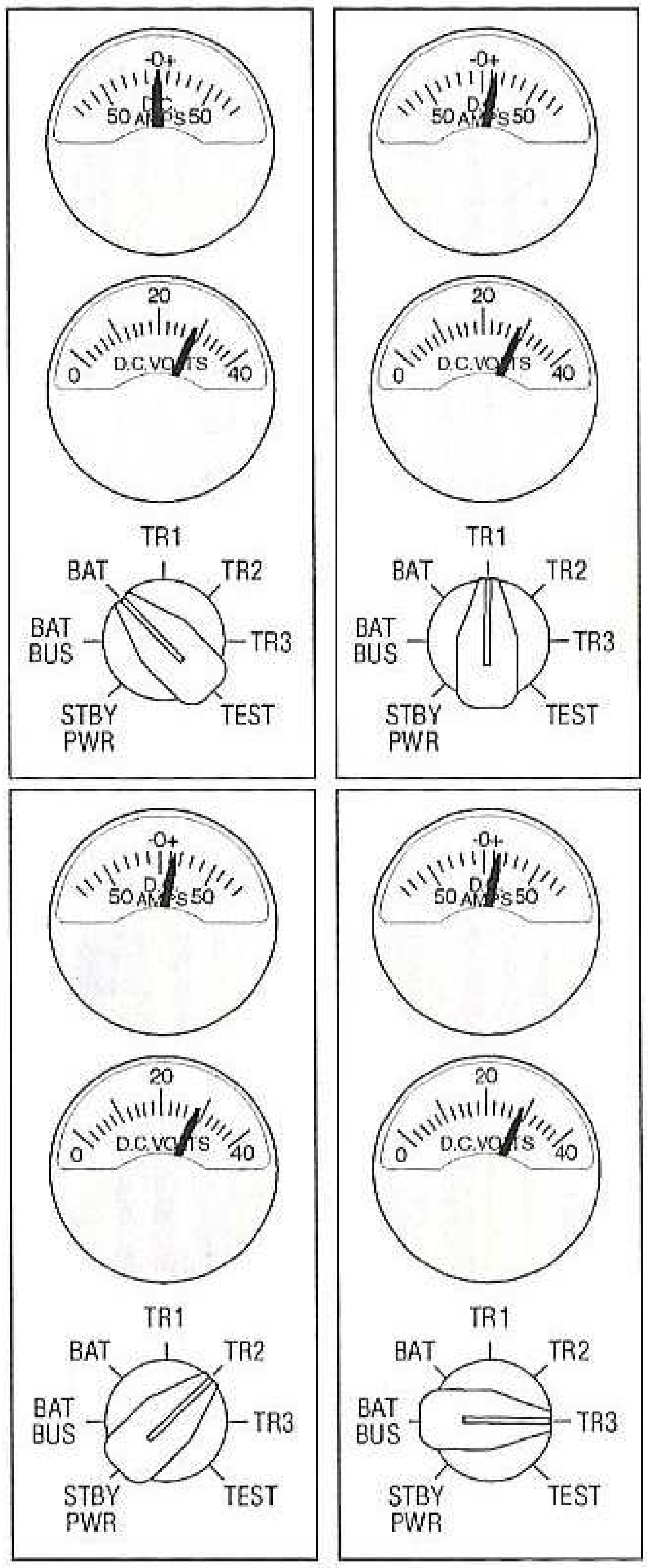

DC AMPS
CPS FREQ
394
25
115
DC VOLTS
AC AMPS
AC VOLTS
BAT DISCHARGE
TR UNIT
ELEC
MAINT
AUX BAT
BAT
TR1
BAT BUS
TR2
STBY PWR
TEST
TR3
OFF
BAT
ON
DC
APU GEN
GEN1
GEN2
GRD PWR
INV
STBY PWR
TEST
OFF
ON
CAB/UTIL
OFF
ON
IFE/PASS SEAT
AC
1
STANDBY PWR OFF
2
DRIVE
STANDBY POWER
DRIVE
DISCONNECT
DISCONNECT
BAT
OFF
AUTO
GRD POWER AVAILABLE
GRD PWR
OFF
ON
BUS TRANS
OFF
AUTO
TRANSFER BUS OFF
SOURCE OFF
GEN OFF BUS
APU GEN OFF BUS
TRANSFER BUS OFF
SOURCE OFF
GEN OFF BUS
OFF
ON
GEN 1
APU GEN
APU
OFF
ON
GEN 2


D.C. AMPS
C.P.S. FREQ
D.C. VOLTS
A.C. VOLTS
TR1
BAT
TR2
BAT BUS
TR3
STBY PWR
TEST
OFF
BAT
ON
DC
APU GEN
GEN1
GEN2
GRD PWR
INV
STBY PWR
TEST
GALLEY
OFF
ON
RESID VOLTS
AC
1
STANDBY PWR OFF
2
LOW OIL PRESSURE
HIGH OIL TEMP
STANDBY POWER
LOW OIL PRESSURE
HIGH OIL TEMP
DISCONNECT
DISCONNECT
BAT
OFF
AUTO
DRIVE TEMP
RISE
IN
DRIVE CAN BE RECONNECTED ONLY ON GRD
GRD POWER AVAILABLE
GRD PWR
OFF
ON
A.C. AMPS
BUS TRANS
OFF
AUTO
TRANSFER BUS OFF
BUS OFF
GEN OFF BUS
APU GEN OFF BUS
TRANSFER BUS OFF
BUS OFF
GEN OFF BUS
OFF
ON
GEN 1
APU GEN
OFF
ON
GEN 2

ELECTRICAL PANEL



DC METERS SELECTOR

- selects the DC source for the DC Ammeter and DC Voltmeter
- STBY PWR / BAT BUS = volts only; no amp indication since these are not sources of power
  BAT / AUX BAT (as installed) = volts and amps of battery or battery charger when charging
- TR1 / TR2 = volts from respective DC bus and amps from respective TR
- TR3 = volts and amps directly from TR3
- (3-4-5) leaving the selector in BAT position will cause slight drain but would take a very long time to drain a fully charged battery

DC AMMETER (top left)

- indicates amperage of source selected (BAT, AUX BAT (as installed), TR1, TR2, or TR3)
- STBY PWR and BAT BUS positions will not show amps
- may be inop provided it operates normally in the BAT position, the standby power test is accompllished daily, and procedure does not require its use
  - monitoring the TRs for autoland availability prior to engagement (isolated sources) will not be possible if the DC meters selector TR positions do not operate
  - check MEL - ATA 24

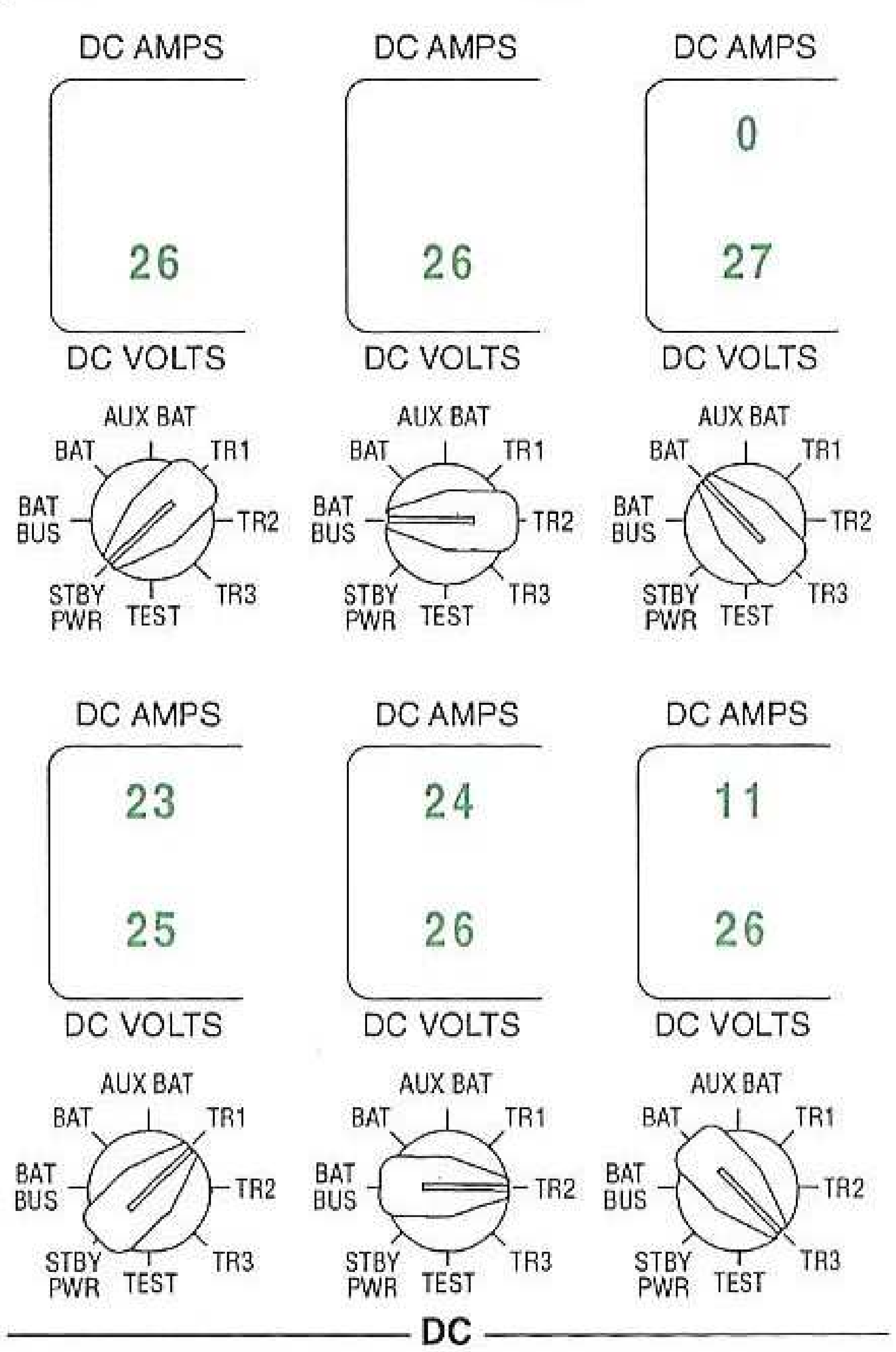
DC VOLTMETER (bottom left)

- indicates voltage of source or bus selected by DC Meters Selector (all positions)
- may be inop provided it operates normally in the STBY PWR position and the standby power test is accompllished daily
  - check MEL - ATA 24

(L/OP) Electrical, Voltage Range

- TR volt range - 24-30 volts
  (info only: 28-30 normal)
- Battery volt range - 22-30 volts
- Min Battery for APU start - 23 volts (your carrier may have different limit)
- 28-30 normal = shows charger operation

DC



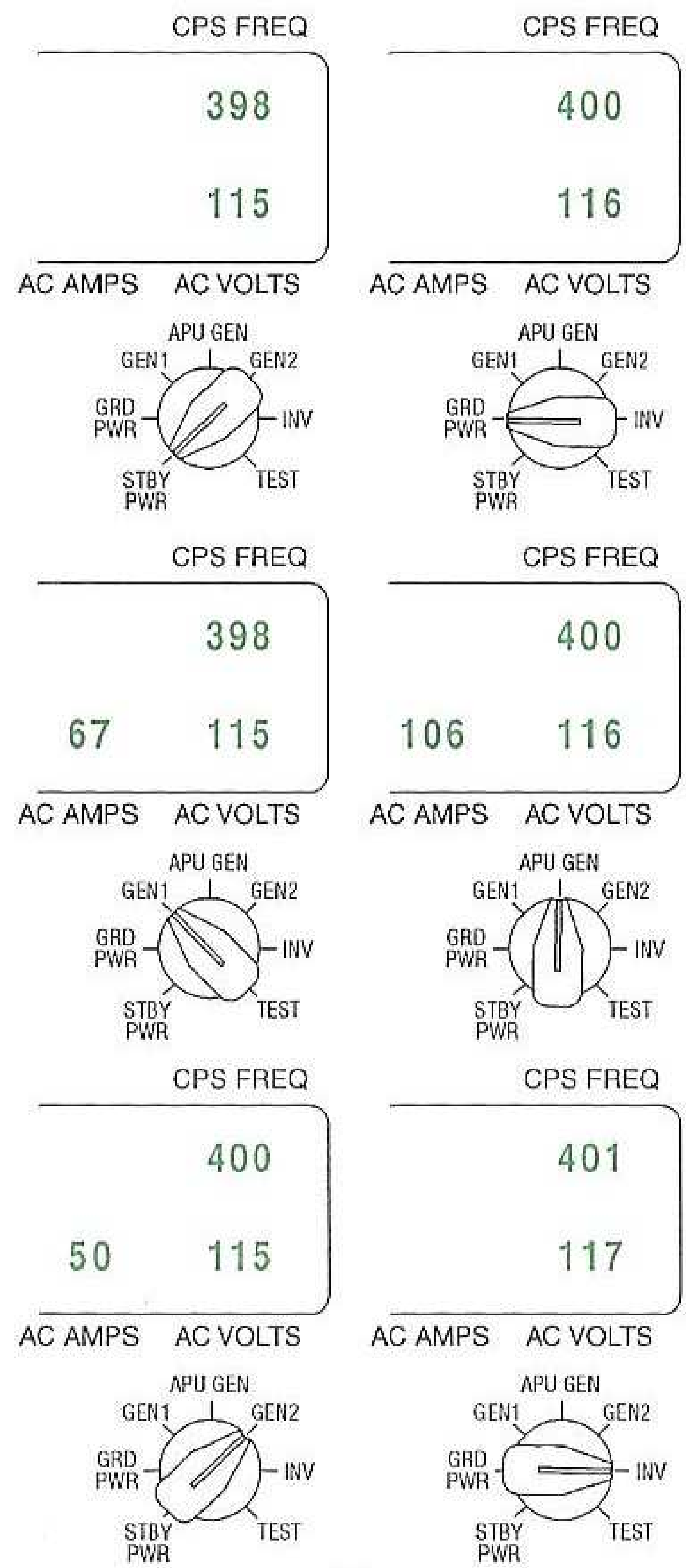
DC

AC METERS SELECTOR
- selects the AC source for the AC Voltmeter and Frequency Meter indications
- selecting STBY PWR displays the AC Standby Bus readings
- TEST: used by maintenance to monitor the selections of the power system test module in the P6 panel
- shows load current (phase B)

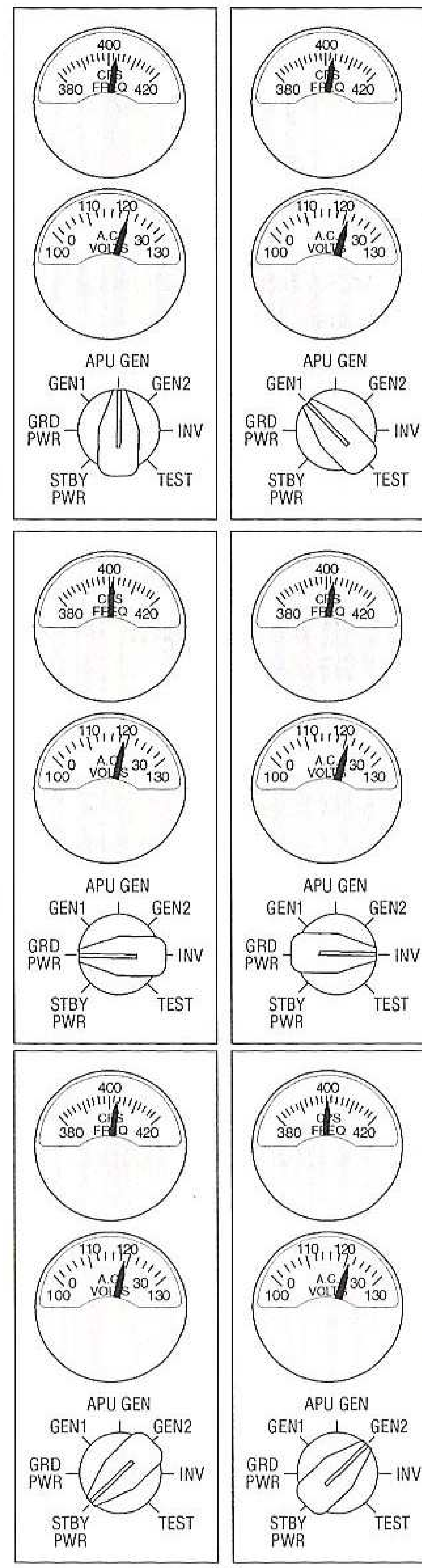
FREQUENCY METER (top right)
- indicates frequency of source selected by the AC Meters Selector
- frequency is a function of CSD speed

AC VOLTMETER (bottom right)
- 130V scale: indicates voltage of source selected
- 30V scale: indicates residual voltage of generator selected when Residual Volts switch is pressed
- may be inop provided it operates normally in the STBY PWR position and the standby power test is accomplished daily
  - check MEL - ATA 24

AC AMMETER (NG) (bottom center)
- indicates amperage of source selected by AC meters selector
- may be inop provided associated GEN OFF BUS lights operate normally
  - check MEL - ATA 24



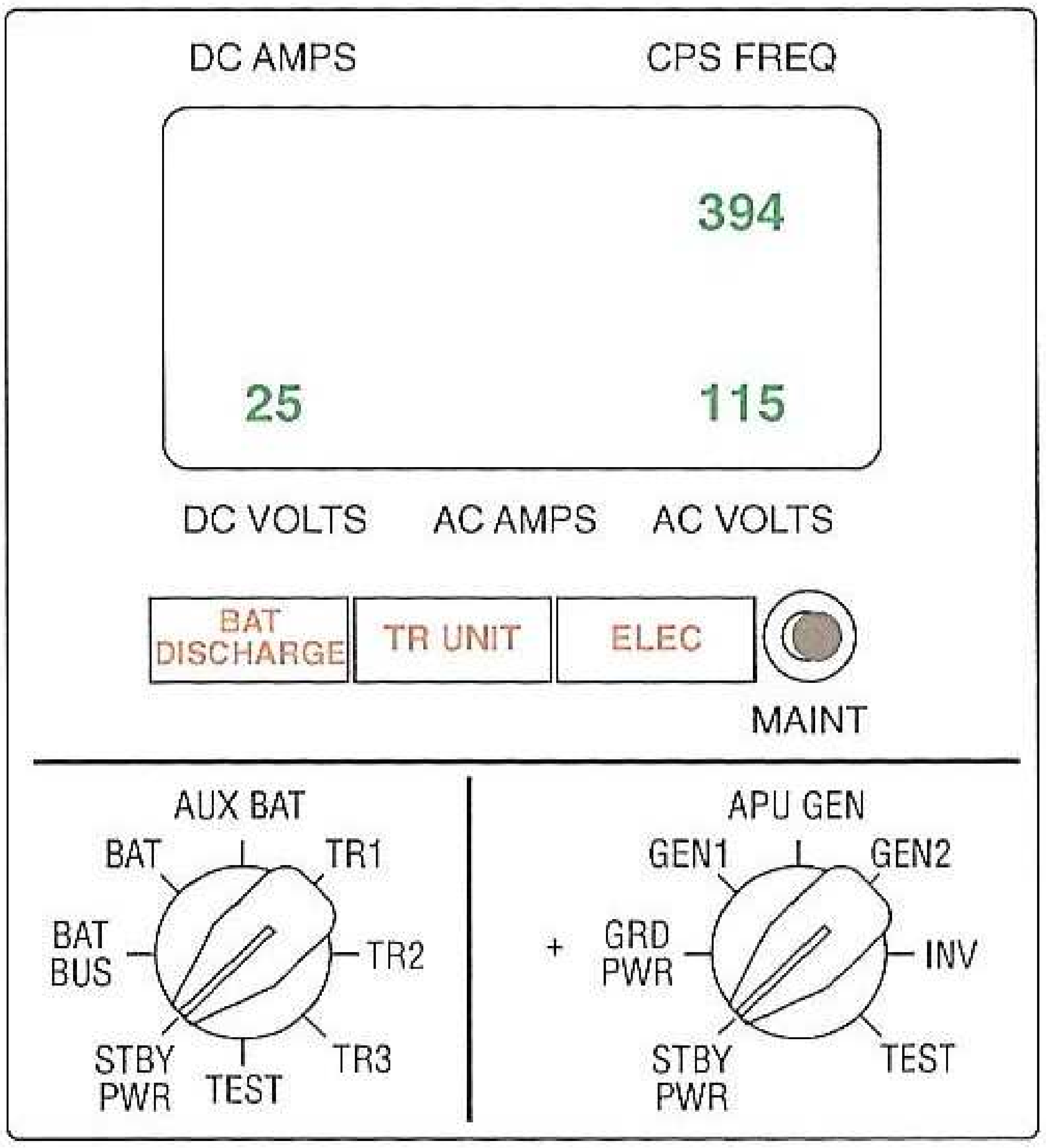
AC



AC

Test (NG) (DC and AC Meters selectors)
- used by maintenance to monitor the selections of the power system test module in the P6 panel
- shows load current (phase B)
- works on ground only
- connects to BITE for ELEC light fault
- with both DC and AC selectors on TEST, push MAINT button
  - each light module will illuminate (6) then message NO FAULTS STORED is displayed
- if a fault exists, to see the BITE message put the AC and DC selectors to TEST and push the MAINT button. The message will appear across the LED alphanumeric display:
  - PANEL FAILURE, INTERFACE FAILURE, BAT CHGR INOP, STAT INV INOP, SPCU INOP, TR3 XFR RLY INOP
  - the letter "I" may follow the fault message meaning that the fault is intermittent and that the fault is not set at this time
- push the MAINT button after each message to cycle through the messages
- holding the MAINT button clears the message(s)

BATT DISCHARGE light (NG) (amber)
- excessive battery discharge detected with BAT switch ON
- normal during APU start using DC power (battery)
  - does not come on if using AC power (#1 AC Transfer bus is powered)



TR UNIT light (NG) (amber)
- illuminates on ground if any TR has failed
- illuminates in flight if TR1 failed or TR2 and TR3 failed
- if TR1 failed
  - DC bus 1 and standby DC bus will be powered by TR2 if cross bus tie is closed
- if TR2 failed
  - DC bus 2 will be powered by TR1 if cross bus tie is closed
- autoland not available

ELEC light (NG) (amber)
- operates only on the ground if a fault exists in the DC or the standby power system
- to see the BITE message reference DC Meters - Test

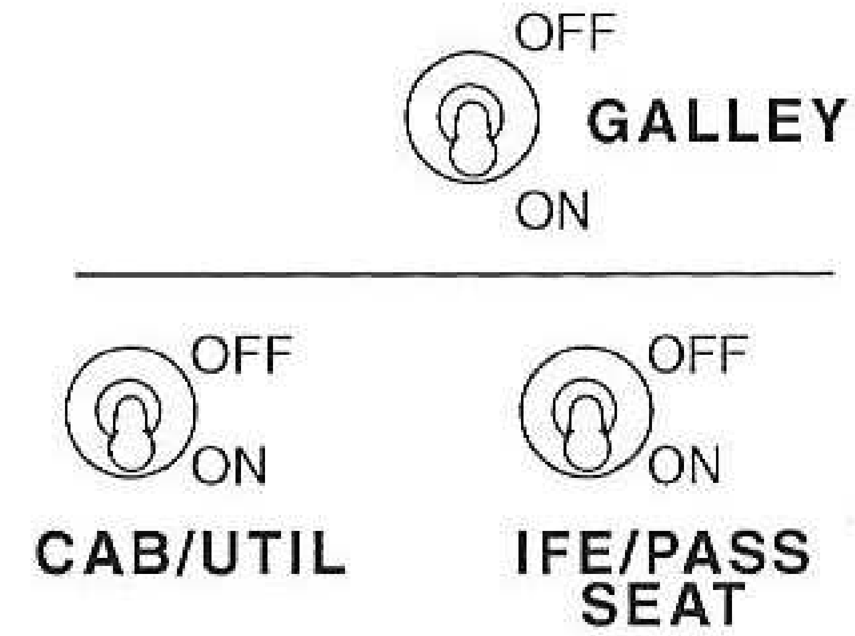
(MEL) ELEC light, Standby Power System - ATA 24
- airplane may be dispatched with faults that do not prevent a successful test of the Standby Power System

BATTERY switch (Battery Bus switch)

- the battery switch must be ON to power the battery bus except...
  - the battery bus can be powered with the BAT switch off by moving the standby power switch to the BAT position

OFF
  - removes power from the battery bus and switched hot battery bus when operating with normal power sources available (standby power switch in OFF or AUTO)
  - removes power from the switched hot battery bus, battery bus, static inverter, AC standby bus, DC standby bus when battery is the only power source

ON
  - energizes switched hot bat bus, bat bus, static inverter, AC and DC standby buses
  - (NG) energizes electrical meters module
  - energizes relays to provide automatic switching of standby electrical system to battery power with loss of normal power
  - TR3 is normal power to the battery bus



GALLEY POWER switch

ON - electrical power provided to the galleys

(3-4-5)
  - galley power is available only when both generator buses are powered

(NG)
  - galley power supplied from the transfer buses

CAB / UTIL switch (as installed)

ON - cabin utility switch powers left (8-9-B2) and right recirc fan(s), fwd and aft door area heaters, drain mast heaters, lav water heaters, ECS gasper fan, all 115v ac galley buses, 115v ac shaver outlets, logo lights and potable water compressor (installed equipment will vary by carrier)
- on the ground, the APU attempts to carry a full load
- if an overload condition is sensed, the bus power control unit (BPCU) sheds galley buses and main buses until the load is within limits
- manual restoration of galley and main bus power can be attempted by moving the CAB/ UTIL switch to OFF and back to ON

IFE / PASS switch (as installed)

ON - inflight entertainment and passenger seat switch powers 115v ac audio / video entertainment equipment, 115v ac airphone equipment, FAX machine, printer, 28v dc video equipment and passenger seat electronic outlets (installed equipment will vary by carrier)

RESIDUAL VOLTS switch (3-4-5)
- used to confirm a CSD disconnect
  - if CSD is disconnected, AC voltmeter should indicate 0 volts
  - may read up to 5 or 6 volts due to inaccurate meter or inductance
- press: 30V scale of AC Voltmeter indicates residual voltage of generator selected
- associated generator switch must be OFF
  - if it is ON, AC Voltmeter will drive off scale and residual voltage cannot be read
- normal residual volts for a spinning generator is 15-20
  - can be read after auto or manual generator trip, except if Over/Under freq trip

GEN DRIVE LOW OIL PRESSURE light (amber) (3-4-5)
- if illuminated, CSD oil pressure is below minimum operating limits
  - may have to disconnect CSD
- MASTER CAUTION and ELEC annunciator will illuminate

GEN DRIVE HIGH OIL TEMPERATURE light (amber) (3-4-5)
- if illuminated, CSD oil temperature has exceeded operating limits of 157°C
- MASTER CAUTION and ELEC annunciator will illuminate
- caused by low oil quantity or improper mechanical operation of CSD

(MEL) Generator High Oil Temp Light - ATA 24
- may be inop provided associated LOW OIL PRESS light and oil temp indicator operates

DRIVE light (NG) (amber)
- illuminates
  - if the IDG oil pressure is low (<165 psi)
  - if there is an under frequency fault with the engine running
  - if the IDG automatically disconnected due to high oil temperature
    - an automatic thermal disconnect occurs if the IDG oil temp exceeds 363°F/182°C
    - the IDG must be removed and disassembled to reset a thermal disconnect
  - if the IDG was disconnected through the generator drive DISCONNECT switch
- this light is controlled by the GCU

STANDBY POWER OFF light (amber)

(3-4-5) indicates AC standby bus is not powered

(NG) indicates AC or DC standby bus, or Battery bus (BAT switch ON) is not powered

(QRH) Standby Power Off light On
- place Standby Power switch to BAT until you can get a generator back on line

(3-4-5) if standby power off light is illuminated with external power on the airplane, may be a sensing problem. Bus is probably still powered. Discuss with maintenance

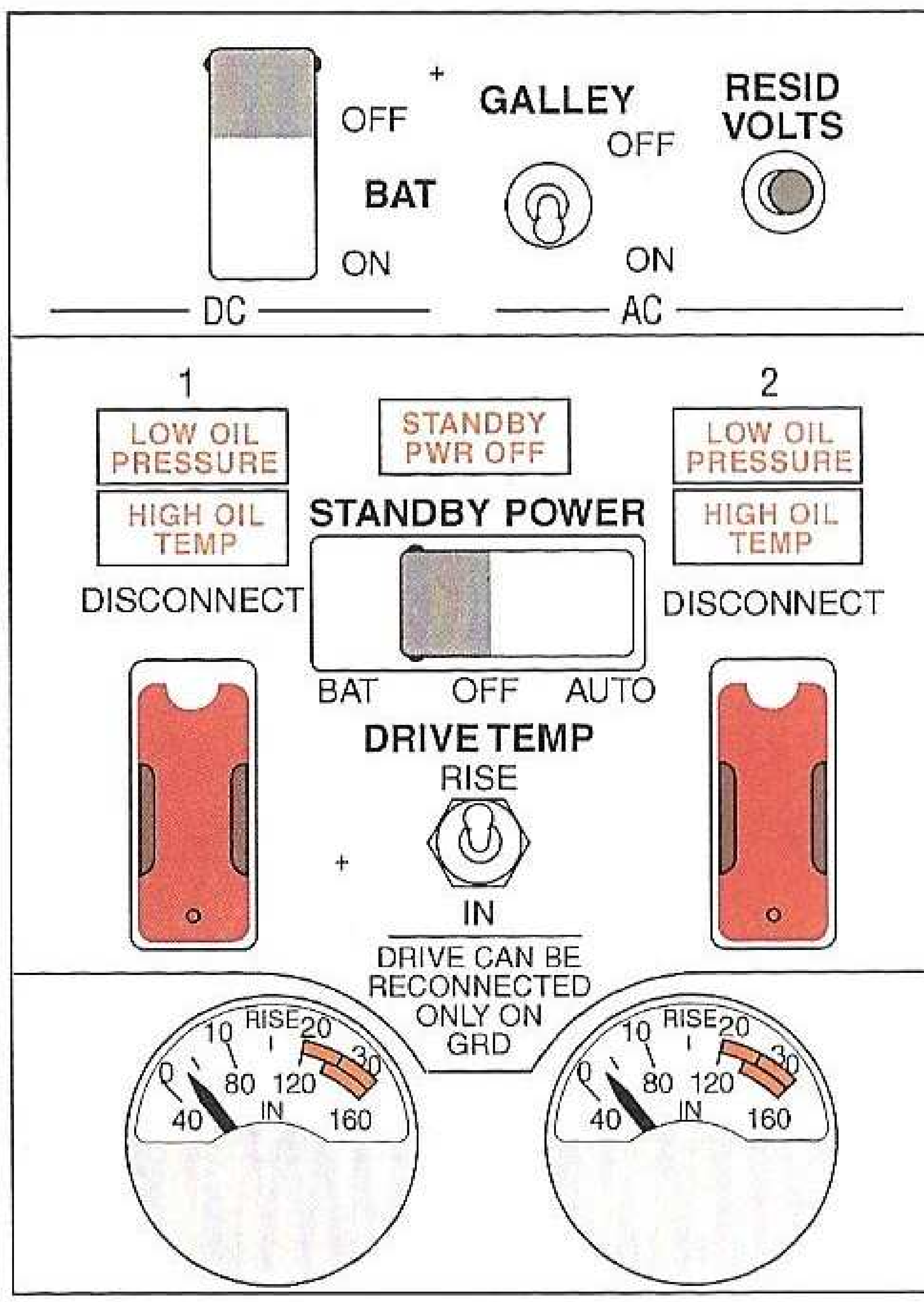
STANDBY POWER switch

- gives you automatic and manual control of the AC and DC standby power bus sources

AUTO (Guarded Position)

- arms the standby power system
  (3-4-5) inflight
    - voltage sensor receives power from DC bus 1 and senses power from transfer bus 1
    - when either power source fails (transfer bus 1 or DC bus 1) the sensor connects the AC standby bus to the inverter and the DC standby bus to the battery bus
    - auto transfer of power to standby buses does not occur on the ground
        - manually place standby power switch to BAT
        - for night takeoff, always place dome light to DIM for loss of both generators
    - AC standby bus is powered by transfer bus 1 or the inverter
    - DC standby bus is powered by DC bus 1 or the battery bus
    - the hot battery bus is powered by the battery charger, if operating, or the battery

  (NG)
    - transfer from normal power to standby power occurs with loss of transfer bus 1 or DC bus 1 power source
    - auto transfer functions the same on the ground as in flight
    - with loss of all AC power, AC standby bus is powered by the battery(s) through the static inverter
    - DC standby bus is then powered by the battery(s)



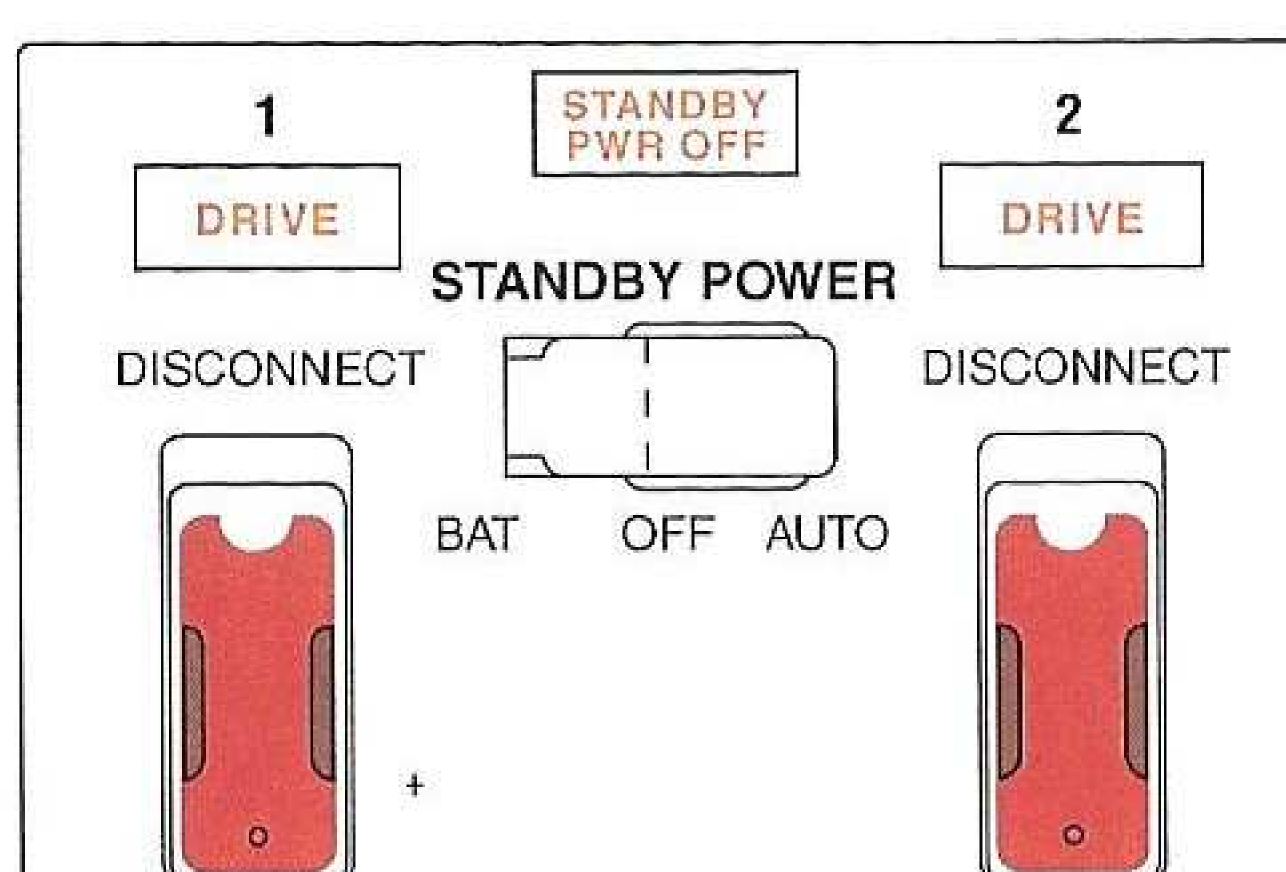
OFF (center position)

- deactivates the standby power system
    - STBY POWER OFF light illuminates
    - de-energizes the AC and DC standby buses and static inverter

BAT (unguarded position; works on ground and in flight)

- activates the standby power system
  (3-4-5)
    - the DC standby bus is powered by the battery bus
    - the AC standby bus is powered by the battery bus through the static inverter

  (NG)
    - DC standby bus and battery bus are powered directly from the battery(s) or charger(s)
    - AC standby bus is powered by the battery(s) or charger(s) through the static inverter



GENERATOR DRIVE DISCONNECT switch

- guarded and safety wired

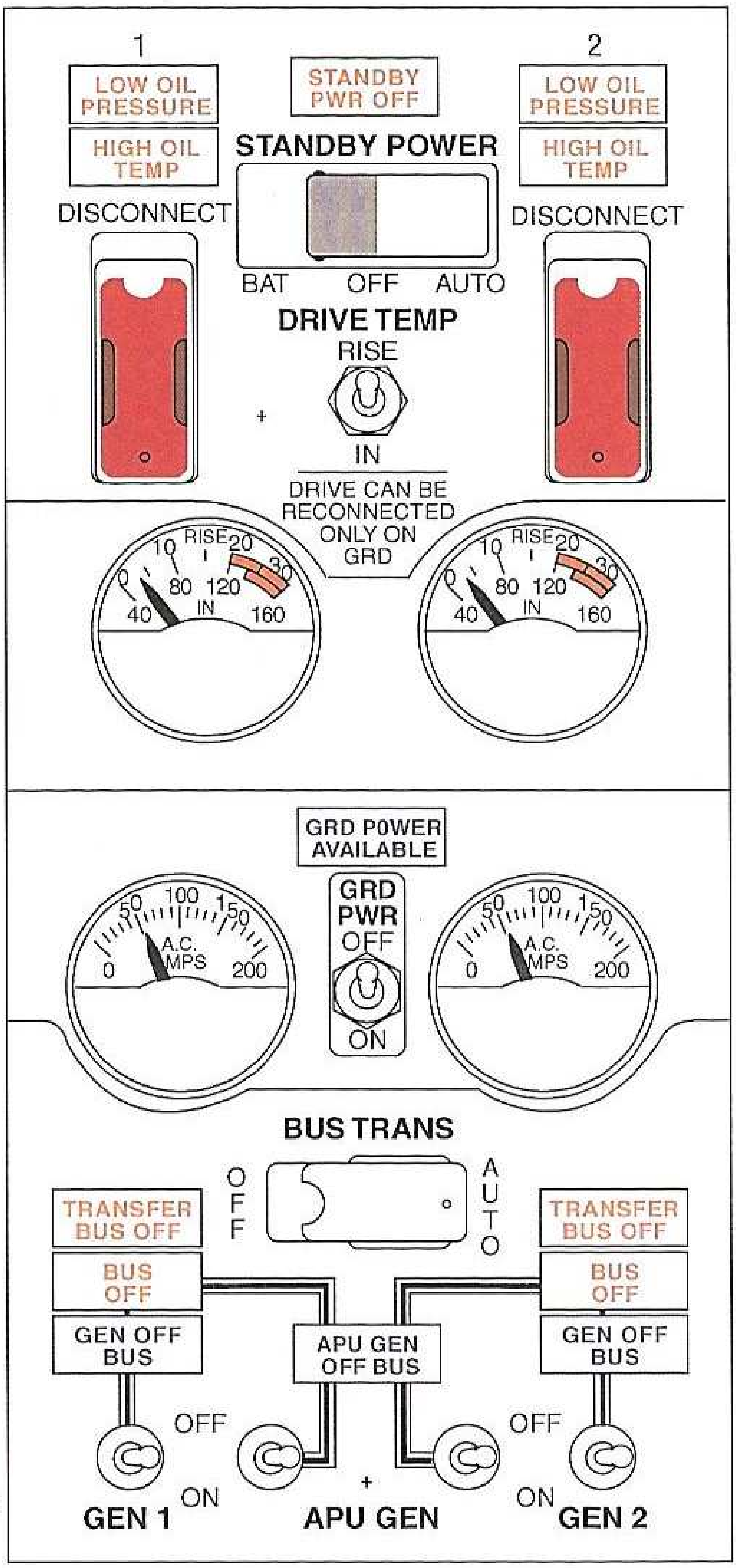
(3-5)

- disengages CSD
- if engine is not running, it will still send signal and disconnect when started, however, the CSD should not be disconnected unless the engine speed is at or above idle

(NG)

- disconnects IDG if engine start lever is in IDLE and ending is running

- can only be re-engaged on the ground by maintenance via a reset handle
  - the IDG vendor recommends that you do not reconnect an IDG that has been disconnected for any reason other than a functional test or an unintentional disconnect. Operation of IDGs that have had oil pressure problems may cause further damage to the IDG.



GENERATOR DRIVE TEMPERATURE switch (3-4-5)

- selects RISE or IN temperature displayed on the Generator Drive Oil Temp indicator
- IN is normal position

GENERATOR DRIVE OIL TEMP IND (3-4-5)

- displays the temperature of the oil used in the CSD
- RISE scale (outer) - displays the temperature rise within the CSD
  - differential between outlet and inlet
  - normal temp rise of the oil through the drive unit is about 10°C at continuous full load
- IN scale (inner) - displays temperature of oil entering into CSD
  - normal inlet temp is about 120°C at normal input speeds

(L/OP) Electrical, Max CSD Temps

- MAX CSD: 157°C; MAX CSD rise: 20°C

AC AMMETER (3-4-5)

- indicates engine generator load in amperes

(L/OP) Electrical, Load

- (3-4-5) Max engine driven generator load: 125 amps

GROUND POWER AVAILABLE light (blue)

(3-5) light indicates that ground power is connected to the external AC power receptacle
- if phase or frequency is wrong the switch won't engage and power won't go on line
- all the ground power light means is that ground power is plugged in

(NG) light indicates that ground power is connected to the external AC power receptacle and power quality is in limits
- External AC bus can only be powered by ground power
- when external power is plugged in but not selected ON
  - 1st Class lav mirror lights and cabin entrance light are powered
  - if the refueling panel door is opened, 28 VDC hot battery bus power is supplied to the refueling panel and powers the fuel valves and fuel quantity indicators at the fueling station

GROUND POWER switch
- 3 position switch, spring loaded to center/neutral provides manual control of the external power contactor

OFF - removes ground power from both (3-4-5) generator buses (NG) AC transfer buses

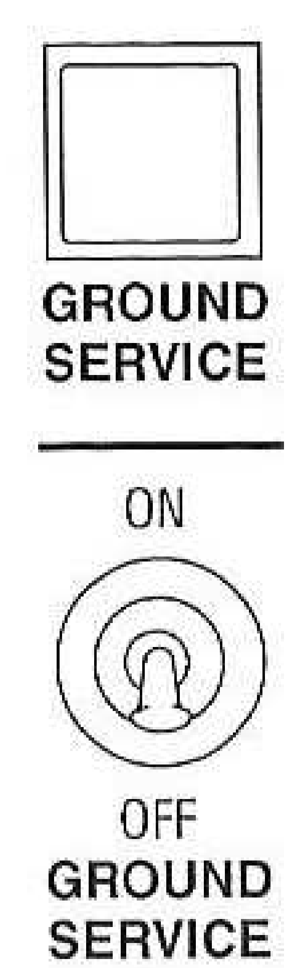
ON - if Bus Protection Panel (BPP) approves of quality, removes previously connected power from both (3-4-5) gen buses (NG) AC transfer buses

(3-4-5) battery switch must be ON to apply ground power to aircraft
- if you leave the aircraft with ground power on the buses and BAT switch ON, if the ground power is interrupted, the battery will discharge in a few hours

(NG) battery switch may be turned OFF and GRD PWR will stay ON
- if ground power is not interrupted, you can re-select GRD PWR with BAT switch OFF

(3-4-5)
- if another gen bus source comes on line, ground power will still power the other generator bus
  - automatically switches the ground service bus to the No. 1 generator bus, deactivating the ground service switch
- external power provides power to the lav mirror and entry lights, and the refueling panel
  - power to the lav mirror lights is from phase A of the external power receptacle
  - power to refueling panel is from the external power TR
  - external power is also connected to the fuel quantity gages
- if ground power is plugged in, the battery charger(s) is not powered until either the Ground Service switch or the External Power switch is placed to ON

GROUND SERVICE switch (at fwd FA panel)



- when the GRD PWR switch is ON, the GROUND SERVICE switch does not operate

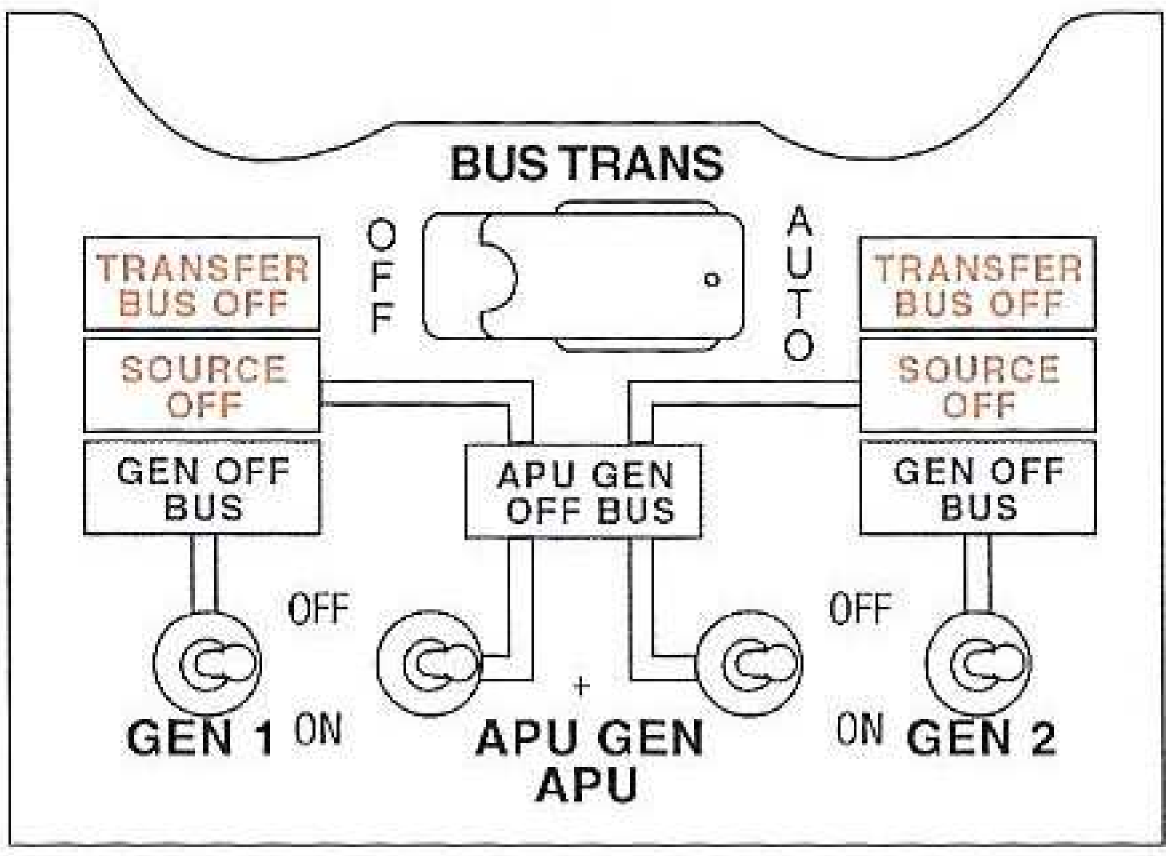
(3-4-5) two position, solenoid-held on, spring-loaded off (NG) push button
- lets you power the AC and DC ground service buses (NG has two ground service buses) for cabin servicing without going to cockpit
  - AC power goes through the two ground service relays
  - DC power goes through the ground service relay
- makes it unnecessary to energize the main airplane AC and DC buses

ON - connects external power to the 115-volt AC ground service bus (NG) buses
- this provides power to the battery charger, equipment cooling, cabin lights, and 115v AC outlets

3 steps
- GRD PWR switch OFF, GROUND SERVICE switch ON, BAT switch OFF
- putting BAT switch last in the sequence allows some lighting (dome) if needed
  - you do not have to hold the Ground Service switch while turning BAT switch OFF
  - the blue GRD POWER available light is the only light on overhead left illuminated

OFF
- disconnects external power from ground service buses
- also trips OFF when AC XFR buses are powered

BUS TRANSFER switch



AUTO (guarded position)
- (3-4-5) transfer relays (NG) BTBs, the DC bus tie relay, and the TR3 xfr relay work automaticaly
- if one power source fails, the other power source automatically furnishes power to both transfer buses
- energizes (closes) the DC bus tie relay; TR1 and TR2 operate in parallel

(3-4-5) allows Battery charger to switch to alternate source (#2 Main Bus)

OFF
- gives you manual control of the (3-4-5) transfer relays (NG) BTBs, the DC bus tie relay, and the TR3 xfr relay
- (3-4-5) transfer relays (NG) BTBs open, isolating the transfer buses which prevents auto-transfer of the transfer buses
- DC bus tie relay cannot energize (isolates DC bus 1 from DC bus 2)
- (NG) TR3 transfer relay cannot energize
- resets the BTB trip circuits

(3-4-5) prevents the batt charger from switching to its altn. source of power, Main Bus 2

TRANSFER BUS OFF light (amber)
- illuminated means transfer bus is not powered (illuminates MASTER CAUTION and ELEC)
- actually looks at transfer relay position, not the bus power
- try turning BUS TRANSFER switch OFF, then back to AUTO

BUS OFF light (3-4-5) (amber)
- illuminated means generator bus is not powered (get MASTER CAUTION and ELEC)
- need to turn a generator back ON, or start up APU

SOURCE OFF light (NG) (amber)
- no source has been manually selected to power the related transfer bus, or the manually selected source has been disconnected
- if a source has been selected to power the opposite transfer bus, both transfer buses are powered
- does not indicate that the AC transfer bus is de-energized

  example: in flight, left SOURCE OFF light comes on when GCB 1 trips, however, the bus transfer function lets IDG 2 power AC transfer bus 1

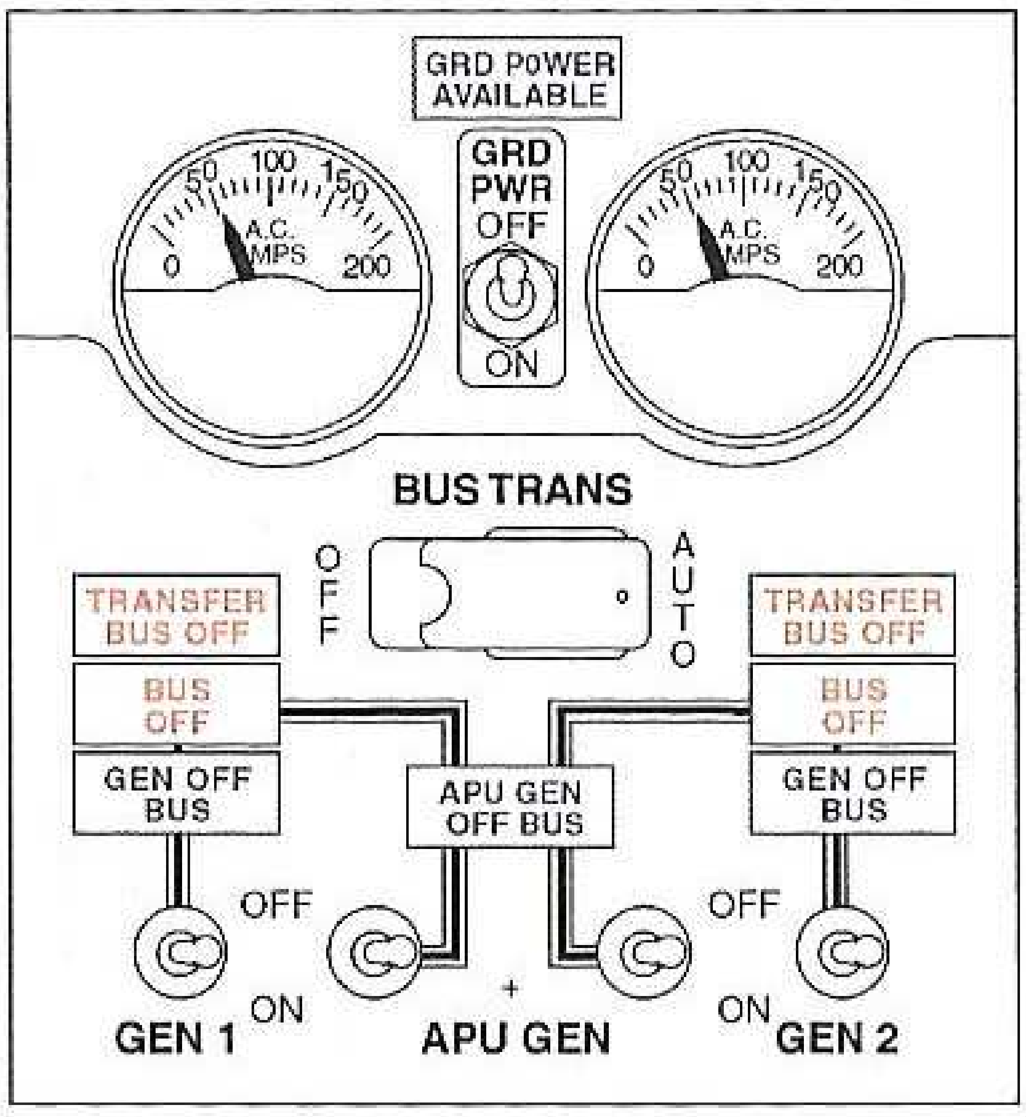
GEN OFF BUS light (blue)
- illuminates when engine generator control breaker (GCB) is open

(3-4-5) illuminated means generator is not supplying the respective generator bus

(NG) illuminated means IDG is not supplying power to related transfer bus

APU GEN OFF BUS light (blue)
- illuminated means APU is up to speed (95%) and ready for load, however, the APU is not a power source in use; aux power breaker (APB) is open

(QRH) APU Gen Off Bus Light Fails to Illum.
- the start cycle may take as long as 135 seconds
- if after the starter engagement, the APU GEN OFF BUS light fails to illuminate within the time limit of the starter motor, the APU may have failed to attain starter cutout speed
- if ignition has occurred, a hung start may be in progress
- if there are multiple aborted start attempts, 5 minutes cooling is required between the second and third start attempt
- a wait of 1 hour is required after the third start attempt



GENERATOR control switch

- 3 position switch, spring loaded to center position

OFF - opens Generator Control Relay (GCR) and GB and disconnects it from the (3-5) generator bus (NG) transfer bus

ON - if power quality is good, the electrical power system will first remove the present power source (opens its GB), the GB for the generator or IDG will close and the the generator output is then connected to the (3-5) generator bus or (NG) transfer bus

(MEL) Engine Driven Generator

- may be inop provided APU generator operates normally and is used throughout the flight

(QRH) Loss of Both Generators

- both electric hyd pumps........... OFF
- Bus Transfer switch.................. OFF
- both generators .... ON
  - if both source off lights extinguish, restore power and continue normal operation
  - if one source off light remains illuminated, start the APU and power that bus
  - if both source off lights remain illuminated
    - land at nearest suitable airport (30 min battery power)
    - control pressurization using manual mode

APU GENERATOR switch (1 and 2)

- three position, spring loaded center
- two switches because there are two (3-5) generator breakers (NG) bus tie breakers

(3-4-5)

- preferable to turn on #2 first, to power #2 transfer bus (its light out), and to see if Gen Bus #2 will power the #1 transfer bus (its light out) and to insure that the battery charger is powered by #2 main bus (vs Ground Svc Bus); then turn on #1 APU Gen switch to check #2 Transfer relay in alternate position and that battery charger is still operating and is receiving power from its normal source

OFF

- disconnects APU generator from the generator bus

ON

- connects APU generator output to the generator bus when power quality is correct

(NG)

OFF

Condition: APU powering both AC transfer busses

- moving a single APU GEN switch to OFF illuminates corresponding SOURCE OFF light. APU continues to power both AC transfer busses
- subsequently moving the other APU GEN switch to OFF disconnects APU gen from the tie bus and removes APU power from both AC transfer busses

Condition: APU powering one AC transfer bus; IDG powering one AC transfer bus

- moving corresponding APU GEN switch to OFF disconnects APU generator from tie bus and AC transfer bus. IDG powers both AC transfer busses

ON

Condition: both transfer buses do not have power or ext. power is the only source

- a single APU GEN switch to ON connects both AC transfer buses to the APU generator; disconnects external power, if connected; opposite transfer bus SOURCE OFF light remains illuminated until the other APU GEN switch is moved to ON

Condition: both AC transfer buses powered by IDGs

- moving the APU GEN switch ON powers the related AC transfer bus from the APU generator; the other AC transfer bus continues to receive power from the IDG

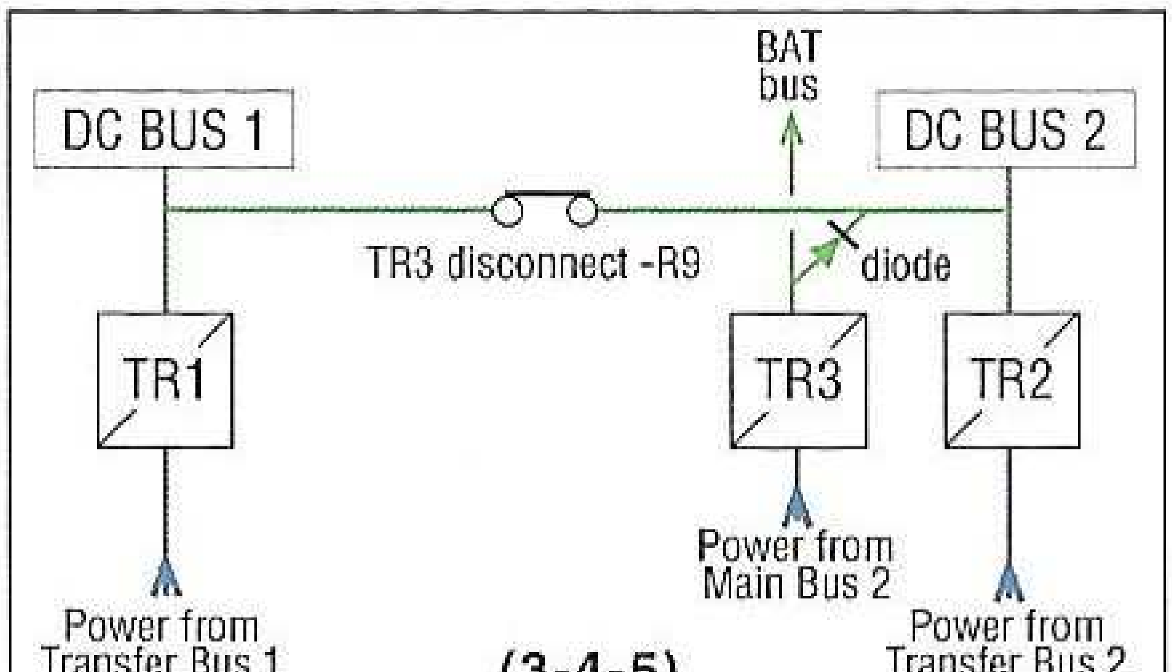
Electrical System Notes

1. DC bus power:
   - with ALL switches off the hot battery bus is the only bus powered, which powers fire protection and fuel valves
   - with Bat switch ON the battery and switched hot battery buses are powered
     - then with Standby power switch in AUTO or BAT position, standby AC and standby DC buses are powered
   - Quick reference to tell if Battery bus is or is not powered:
     - ask yourself: "does standby attitude have flag, or is N1 and EGT inop?"
2. AC power (4 main sources: 2 engine IDGs/generators, APU, and ground power) 115v, 400 cycle, three phase AC generators rated at:
   (3-4-5) eng gen - 45/50 kva, (NG) eng gen - 75 kva (215 amps) on gnd, 90 kva in air
     - (3-4-5) CSD maintains a generator speed of 6,000 rpm
     - (NG) IDG takes the variable input speed and changes it into a constant speed (24,000 rpm) for its internal AC generator

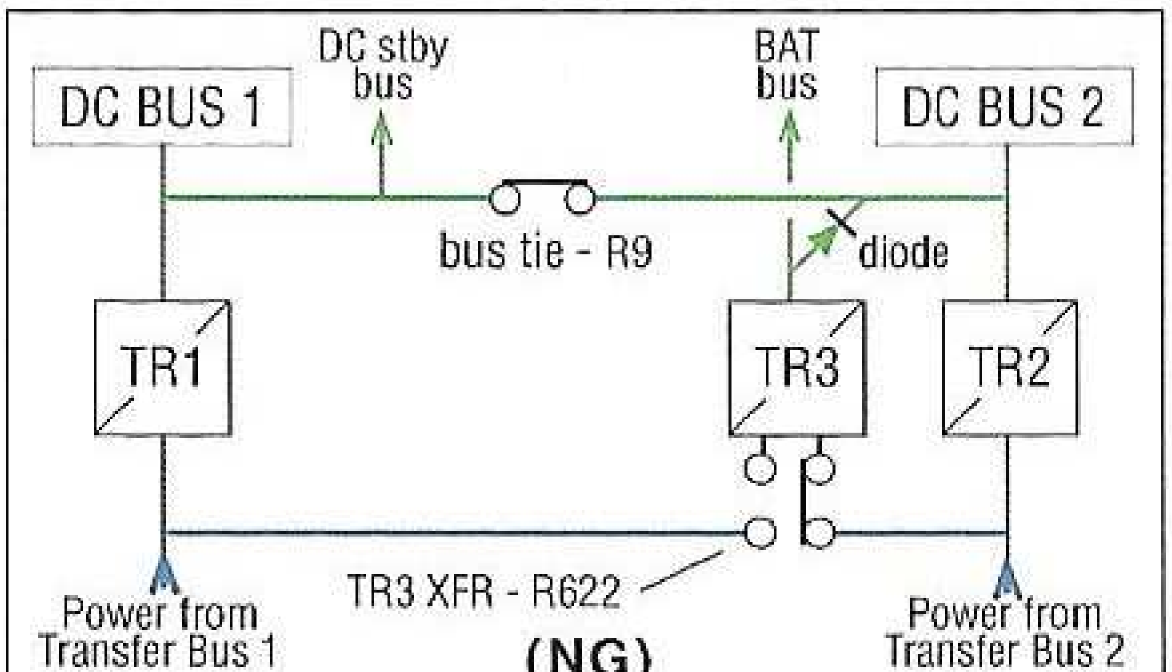
   (3-4-5) APU gen - 55/60 kva on gnd, 45/50 kva in the air
   (NG) APU gen - 90 kva below 32,000 ft, decreasing linearly to 66 kva at 41,000 ft
   - only one power source can power a gen/transfer bus at a time; non paralleling system
   - transfer buses have the essential equipment
   - (3-4-5) gen buses have the high load non-essential equipment
     (NG) IDGs supply power directly to transfer buses through Generator Control Breakers; APU or GPU supplies power to transfer buses through BTBs
   - if an engine shuts down or IDG/generator fails, the transfer bus automatically switches to the other generator/IDG through transfer relays
     (3-4-5) you lose the gen bus and main bus on that side
   - can use GPU or APU (on ground) to supply both generator buses at same time
     (NG) it is not possible to power one transfer bus with external power and one transfer bus with the APU. Whichever source is selected last will power both transfer buses
     (NG) however, whenever external power or APU is powering both transfer buses, and engine generator power is applied to its onside transfer bus, external power or APU continues to supply power to the remaining transfer bus
   - generator control relay
     - to close or open a generator control relay (GCR), switch generator bus to ON or OFF
     - pulling the fire handle or disconnecting the CSD/IDG will also open a GCR
     - generator faults that will open a GCR are
       - over/under voltage or frequency, differential fault, over current
3. bus tie system (NG)
   - either generator or the APU can supply power to both transfer buses. If the BUS TRANS switch is in AUTO and the source powering the transfer bus is disconnected or fails, the source powering the opposite transfer bus will automatically pick up the unpowered transfer bus through the bus tie system
   - it is not possible to power one transfer bus with the APU and the other with ground pwr
4. Load shedding - engine generator (controlled by bus power control unit - BPCU)
   - load shed relays remove power to the galley (NG) and main buses when their loads exceed operating limits

   (3-4-5) if a generator bus is lost, galley power is automatically shed (switch stays ON)
   (NG)
     - the system will shed electrical load incrementally based on actual load sensing
     - pre Oct 2002: galleys on transfer bus 2 shed first; if an overload is still sensed, galleys on transfer bus 1 will shed; if an overload still exists, main buses 1 and 2 are shed
     - post Oct 2002: galleys and the main bus on transfer bus 2 are shed; if an overload is still sensed, galleys and main bus on transfer bus 1 will shed; if an overload is still sensed, the IFE buses are shed
     - when configuration changes to 2 generator operation, automatic load restoration occurs
     - manual restoration of galley and main buses can be attempted by moving the Galley Power/Cab Utility switch to OFF, then back to ON

5. Load shedding - APU generator
   (3-4-5) if the load exceeds 162.5 amps on each phase, the galleys are shed on the ground (NG)
   Configuration load shed
   - pre Oct 2002: if an overload condition is sensed, the APU sheds galley buses and main buses until the load is within limits
   - post Oct 2002: in flight, if the APU is the only source of power, all galley buses and main buses are shed; if electrical load still exceeds limits, both IFE buses are shed
   - on ground, same as pre Oct 2002 design
   Command load shed
   - if APU begins to exceed EGT limits the ECU will load shed both galley buses
   - the main bus load shed relays will open if the overload continues
6. DC power
   - sources of DC power: battery charger, battery, 3 transformer rectifiers
     (3-4-5) has a DC external power receptacle in EE compartment that connects to battery circuit for APU start in case of dead battery (battery not required to be connected)
   - DC power source primarily from 3 TR's
     - TR converts 115v AC, 400 Hz, 3 phase, to 28v DC
     - range is 24 to 30 volts
     - (3-4-5) output rating of 50 amps at 28 vDC
     - (NG) output of 75 amps with forced air cooling, 50 amps with convection cooling
     - diode (one way check valve) prevents TR1 or 2 from back feeding the battery bus
     - TR1
       - fed from transfer bus 1 and provides power to DC bus 1
       - if cross bus tie relay is closed
         - operates in parallel with TR2 and 3 (shares load for DC buses 1 and 2)
         - picks up DC bus 2 if TR2 fails (± 35 amp load)
     - TR2
       - fed from transfer bus 2 and provides power to DC bus 2
       - if cross bus tie relay is closed
         - operates in parallel with TR1 (shares load for DC buses 1 and 2)
         - picks up DC bus 1 if TR1 fails (± 35 amp load)



(3-4-5)



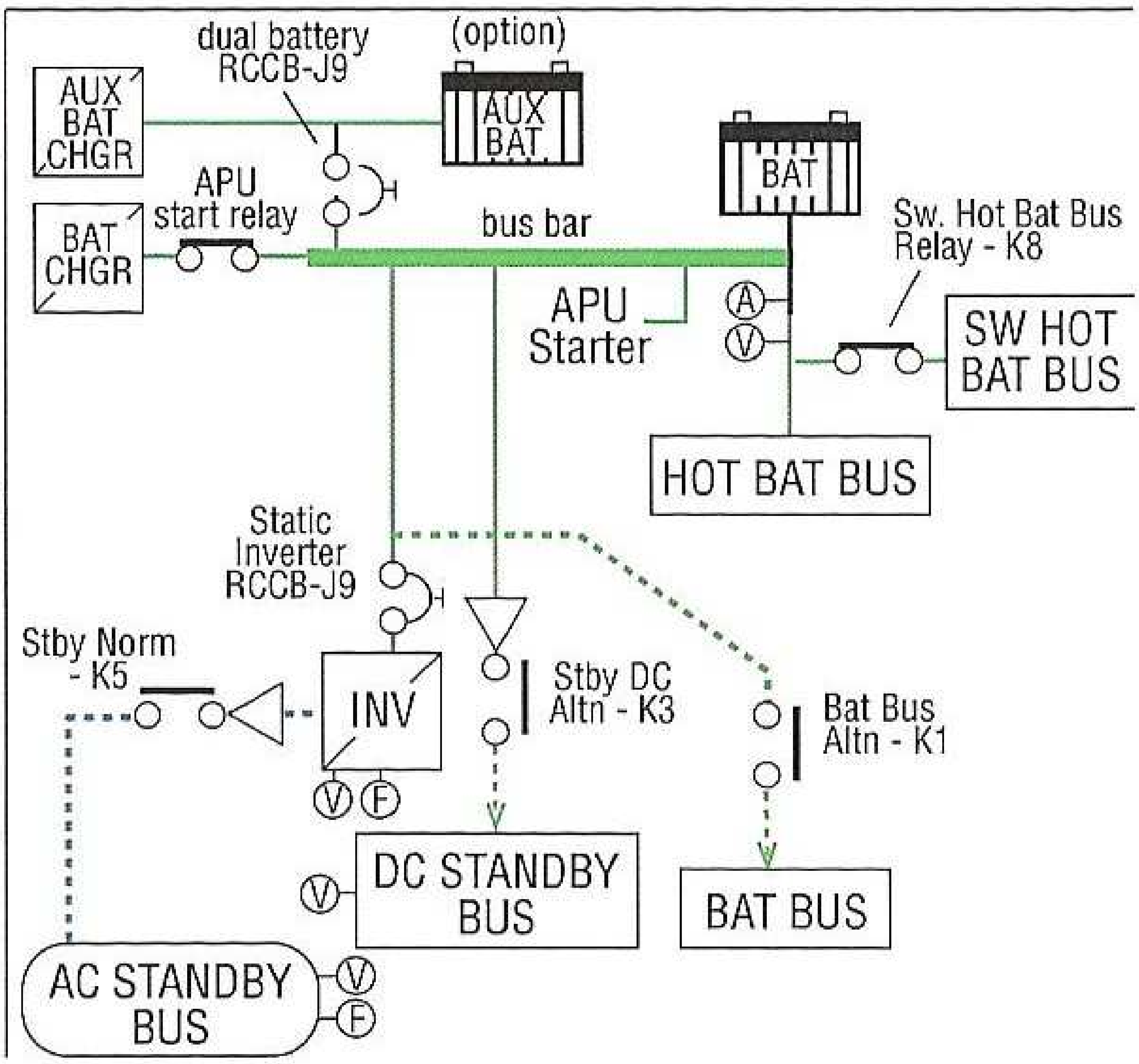
(NG)

     - TR3
       - normally fed from (3-4-5) main bus 2 (NG) transfer bus 2
       - (NG) if transfer bus 2 has no power, fed from transfer bus 1 thru TR3 transfer relay
       - TR3 is normal power for battery bus through battery bus relays
       - if TR1 or 2 fails, TR3 will share some of the load for DC buses 1 and 2 (± 20 amp)
       - provides power to DC buses 1 and 2 if both TRs 1 and 2 fail (± 50 amp load)
       - if TR3 fails the battery charger or the battery powers the battery bus
7. DC bus tie relay [also (3-4-5) TR3 disconnect relay]
   - normally energized to connect DC bus 1 and DC bus 2
     - TR1 and TR2 share loads for DC bus 1 and 2
       - if the bus tie relay fails open, TRs 1 and 2 will have different loads
   - energized with bus transfer switch in AUTO, either AC transfer bus powered and AFDS not in APP mode with GS captured

- two conditions opens this relay to isolate DC buses 1 and 2
  - AFC automatically opens the bus tie relay at GS capture on AP or FD ILS approach
    - this isolates DC bus 1 from DC bus 2 during approach
    - this prevents a failure on one DC bus from overloading the other DC bus, which would result in loss of power to the dual channel systems necessary during approach and landing
      - no loss of instrumentation, but Capt losses FD and AP

    (3-4-5) check TR1 prior to shooting an approach (NG) has the TR UNIT light
  - placing the bus transfer switch to OFF manually separates DC buses 1 and 2
- as long as the bus tie relay is closed, any one of the three TRs can supply DC bus 1 and 2, and the DC standby bus

8. Standby electrical system



- used to supply power to essential AC and DC systems, which must have power to maintain safe flight
- also supplies power for ground operations when there is no AC power
- fully charged battery can supply standby buses for 30 minutes
  - 60 minutes for Dual battery installation
- white dome, instrument flood, battery powered warning lights, and certain information lights are also powered on standby power
- (NG) the standby power control unit (SPCU) uses the battery and standby power switch positions to control the distribution of AC and DC standby power
  - these relays are inside the SPCU: K2, K1, K5, K3, and K8
  - the SPCU also controls R622 and R9

  (3-4-5)
  - on ground automatic transfer feature is deactivated
    - have to manually select standby power switch to BAT on the ground
  - STANDBY POWER OFF light sensed from AC standby bus
  - Transfer bus 1 and DC bus 1 supply AC and DC standby buses which supply primary flight instruments, #1 Nav, #1 Comm

  (NG)
  - auto transfer feature is enabled in the air and on ground
  - STANDBY POWER OFF light sensed from AC standby bus, DC standby bus, or Battery bus
- inverter (static inverter)
  - fed from the (3-4-5) battery bus (NG) battery circuit
  - energized whenever the battery switch is ON or standby power switch is in BAT
  - backup power source for AC standby bus (transfer bus 1 is normal power source)
    - converts 28-volt DC power to 115-volt AC, single-phase, 400-Hz, 115-volt power

    (NG) inverter RCCB connects battery power to the static inverter
      - closed when the battery switch is ON or standby power switch is in BAT
      - open when stby pwr switch is OFF or stby pwr switch in AUTO and bat switch OFF

    (NG) failure of inverter or SPCU will illuminate ELEC light on the ground

9. Battery Charger (operates in TR mode when not in charge mode)
   - in the charge mode, output voltage will vary with battery state-of-charge. After the charge cycle, charger reverts to a constant voltage TR mode. In the TR mode, the charger maintains battery charge and powers loads connected to the hot battery bus and the switched hot battery bus (NG) can supply up to 65 amps in TR mode
   - the battery charger will power the battery bus if TR3 fails
   - if battery charger is in TR mode, battery is charged (check zero amps before takeoff)

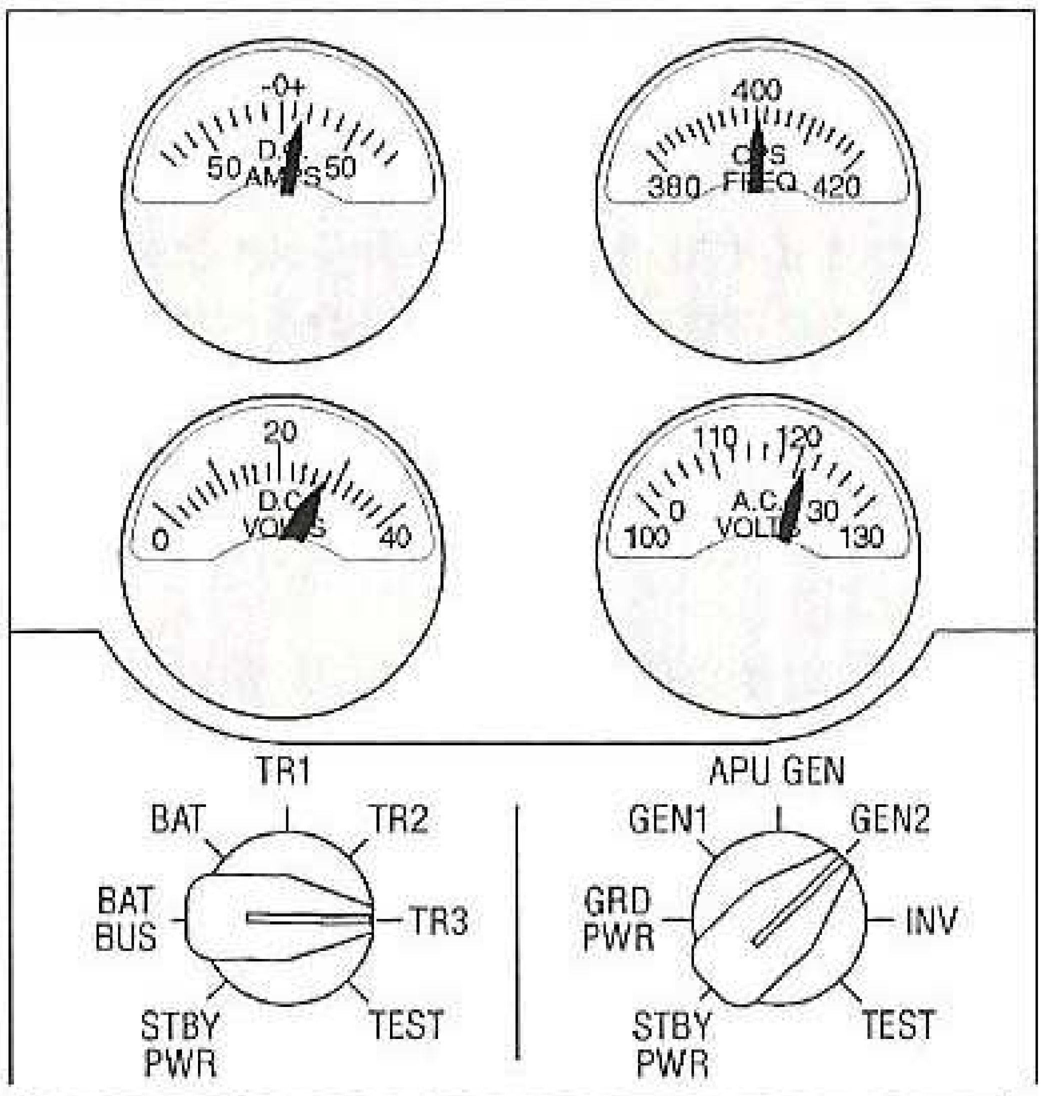
   (3-4-5)
     - normally powered by ground service bus
     - if ground service bus loses power, battery charger fed from main bus 2
     - battery charger goes into TR mode if loss of TR3 output, or Standby Power switch in BAT, ground power plugged in (refueling power relay energized)
     - input power to charger is cut if APU start motor is running or battery overheat

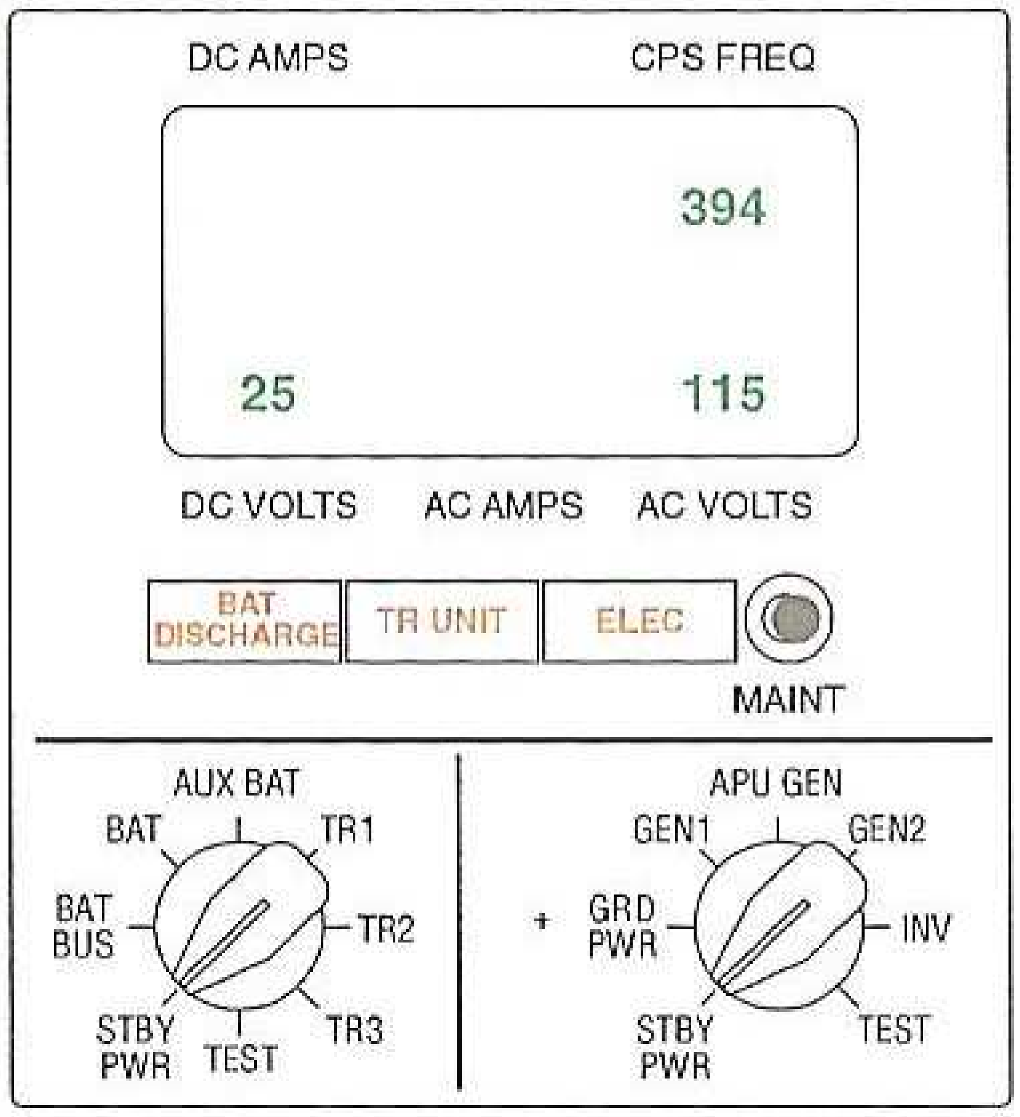
   (NG)
     - normally powered by ground service bus 2 which is off AC transfer bus 2
     - with loss of AC transfer bus 1 or the source of power to DC bus 1, the AC and DC standby buses are powered by the battery/battery charger
     - cannot go to charge mode if fuel door is open, during APU start, if standby power switch in BAT, or standby power switch in AUTO with BAT switch ON and DC bus 1 and AC transfer bus 1 do not have power, or battery overheat
10. CSD/IDG oil cooler
    - high oil temperature light on at 157° (temp probe after cooler, prior to CSD/IDG)
    - oil flows from the CSD/IDG to the air/oil cooler to the (NG) IDG fuel/oil cooler
    - the air/oil cooler uses engine fan air to decrease the temperature of the CSD/IDG oil
    - (NG) the fuel/oil cooler uses fuel from the engine fuel pump to decrease the temperature of the IDG oil and increase the temperature of the fuel

    (3-4-5) CSD oil cooler at 5 o'clock position in fan duct, looking up tail pipe

    (NG) IDG oil cooler at 6:30 position in fan duct, looking up tail pipe
11. CSD Operating Conditions (3-4-5)
    - operating conditions can be observed on the Generator Drive Oil Temp indicator
    - temperature measured as it enters and leaves the CSD
      - IN temperature is downstream of the fan air
        - normal IN temperature is about 120°C
        - poor cooling will cause a higher IN temperature, but since RISE measures the difference between the in and out temperatures, it should have no affect on RISE
      - RISE reflects how hard the CSD is working
        - normal RISE temperature is about 10°C
        - higher than normal temperature rise indicates excessive generator load or poor condition of the generator drive
12. Battery
    - primary purpose of the battery is to provide alternate DC power to the standby buses when normal DC power supply has been interrupted
    - secondary purpose is for starting the APU
    - fully charged single battery should provide power for 30 minutes + one APU start
    - battery options
      - 24 volt nickel cadmium single (36, 38, 40 or 48 amp-hour), or dual
      - the optional choices may extend your battery life from 30 minutes to an hour
13. Bus switching
    - putting buses on line strictly manual. No preferential switching. "System of last request", just select ON from whatever source you want

      Example: putting engine generator on line kicks APU off line
    - GEN OFF BUS light means no power on generator bus
14. dual battery installation (aux battery)
    - helps the main battery supply power to the AC and DC standby buses
    - dual battery Remote Control Circuit Breaker (RCCB) normally open





- closes to allow main and aux batteries or chargers to operate in parallel to power standby system
- closes if bat switch ON and AC transfer bus 1 or DC bus 1 have no power, or the standby power switch is in the BAT position, or TR3 fails

15. AC meters
    - all positions of the AC meter selector should read 400 cycles ± 10 and 115v ± 5 if everything is normal. If you see any other reading you have a problem
    - INV position lets you monitor the output of the static inverter
    - STBY PWR shows freqs and volts of AC standby bus
16. DC meters
    - in all meter selector positions you are reading a TR output so you should see 28v
      - normal range is 24 - 30v
    - loads indicated only on BAT, TR1, TR2, and TR3
    - BAT position
      - normal range is 24 - 30v
      - amps vary with the state of the battery charge
        - normal indication is zero, indicating a fully charged battery
        - dead battery can be charged in 60 minutes
      - after APU start, amp reading may be +20 to +40 for a short period
    - TRs put out 28v DC
      - amps vary which reflects load
      - the load on TRs 1 and 2 will be equal if the cross bus tie relay is closed because they share the loads for DC buses 1 and 2
    - TR failure
      - if TR1 or TR2 fails, displays 28v, 0 amp
        - voltage readings are off respective DC buses which should still be powered
      - if TR3 fails, meters show 0v, 0 amps
        - TR3 reads volts and amps off TR
        - TR3 indicator has its own CB
    - STBY PWR shows volts of DC Standby bus
    - DC Meters preflight
      - rotate DC Meters switch through TR3, TR2, and TR1, checking for a load on the DC AMPS gauge - each TR should be carrying a load and TR1 and 2 should be the same
        - BAT BUS and STBY PWR do not show load
      - place DC Meters switch to BAT and check for zero amps, indicating fully charged battery and ready for flight
      - to check bus tie relay in closed position
        - with DC Meters switch in TR1 or TR2, turn Bus Transfer switch OFF
        - check TR1 or TR2 load changes as this opens the bus tie relay
        - if the load on the selected TR does not change, the bus tie relay is stuck open
      - leave DC Meters switch in BAT or TR1 position
    - DC Meters in flight
      - leave in BAT position to monitor battery charger or (3-4-5) TR1

17. APU
    (3-4-5)
    - both APU GEN switches operate the same on the ground (i.e. you can power both Gen Buses). In the air, only one Gen bus can be powered by the APU generator. If you have a choice, choose to power the #2 bus since it will power TR3. If you takeoff with APU supplying both Gen Buses, APU will continue to power both buses

    (NG)
    - both transfer buses can be powered by the APU generator in the air
18. external power is the normal source of AC power when the airplane is on the ground
    - it also powers the battery charger
    - has three major components, external power receptacle, external power contactor (EPC) which connects 115v ac, 400Hz, 3 phase external power to the (3-5) transfer relays (NG) BTBs, and the bus power control unit (BPCU)
        - controls the use of external power through
            - external power contactor (EPC)
            - bus tie breaker (BTB) positions through the generator control units (GCUs)
            - ground service transfer relays (power to AC ground service buses)
            - ground service bus relay (power to ground service DC bus)

ALL GENERATORS INOP (3-4-5)

- battery is the only source of power
- this table assumes EFIS airplane without optional aux battery

AIRPLANE GENERAL	**AIR SYSTEMS**	**COMMUNICATIONS**	**ELECTRICAL**
Standby compass lt	A/C pack valves	Flight interphone	STBY PWR OFF lt
White dome lts	PACK TRIP OFF lts	Passenger address	APU gen cont
Emerg. inst. flood lts	BLEED TRIP OFF lts	Comm #1	Engine gen cont
Entry lights	Manual press cont		Ext power cont
Position lights	Altitude warn horn		
Flight crew oxygen			
Passenger oxygen			

ENGINE, APU	**FIRE PROTECTION**	**FLIGHT INSTRUMENTS**	**NAVIGATION**
N1, N2, EGT	APU fire bottle	Non-EFIS - Capt. ADI	Left IRS
Thrust reversers	Eng fire bottle	Non-EFIS - Capt. HSI	Capt. RDMI
Starter valves	APU detection sys	Standby airspeed	VHF #1
Right igniters	Eng detection sys	Standby altimeter	ADF #1
APU ops	Cargo fire bottle(s)	Standby ADI	Magnetic compass
LOW OIL PRESS lts		Clocks	Flight data recorder
Fuel flow ind			

FUEL	**HYDRAULIC POWER**	**LANDING GEAR**	**WARNINGS**
Crossfeed SOV	Engine hyd SOV	Inbd antiskid sys	Stall warning sys
Engine fuel SOV	Stby rudder SOV	ANTISKID INOP lt	Aural warnings
FUEL VALVE CLSD lts		Parking brake	Master caution sys
Fuel qty ind		Indicator lites	

ALL GENERATORS INOP (NG)

- battery(s) is the only source of power

AIRPLANE GENERAL
Standby compass lt
White dome lts
Emerg. inst. flood lts
Stby fwd int / ext lts
Flight crew oxygen
Passenger oxygen
Airstair

ENGINE, APU
Upper DU
N1, N2, FF, EGT
Oil press, temp & qty
Hyd press & qty
Fuel qty
Thrust reversers
Starter valves
Right ignitors
APU ops
Engine Cont Panel

ELECTRICAL
STBY PWR OFF lt

ANTI ICE
Capt pitot heat *

FUEL
Crossfeed SOV
Engine fuel SOV
Spar fuel SOV
FUEL VALVE CLSD lts
Fuel qty ind

AIR SYSTEMS
pack valves
PACK TRIP OFF lts
(6-7-B)
PACK lts (-8-9-B2)
BLEED TRIP OFF lts
Manual press cont
Altitude warn horn

FLIGHT INSTRUMENTS
PFD/ND
Capt outbd DU contains airspeed, altimeter, ADI, IVSI, heading/ track, loc and g/s.
PFD/ND:
Upper DU primary engine inst. with compact secondary engine inst. less vibration ind. No hydraulic qty or press.
(several options)
PFD/ND & EFIS w/ 48 amp bat or dual bat
Capt outbd, inner, and ctr upper DU
EFIS w/ 36 amp bat
Capt outbd LCD goes to compact
Capt inbd displays engine instruments

COMMUNICATIONS
Flight interphone
Passenger address
VHF Comm #1
Capt Audio Panel

FLIGHT INSTRUMENTS
Capt EFIS cont panel
Capt display sel panel
Clocks
FO clock - no light
Magnetic compass
Standby airspeed
Standby altimeter/vib
Standby ADI/ILS
Standby RDMI

HYDRAULIC POWER
Engine hyd SOV
Stby rudder SOV

LANDING GEAR
Inbd antiskid sys
ANTISKID INOP lt
Parking brake
Air/ground sys

FIRE PROTECTION
APU fire detection
APU fire bottle
Eng fire detection
Eng fire bottle(s)
Cargo fire detection
Cargo fire bottle(s)

NAVIGATION
Full HSI
RDMI
Left IRS
Left GPS
Marker beacon
ADF #1 *
Left FMC *
Left CDU *
Txp #1 *
Nav #1 control *
DME 1 *
IFF *

WARNINGS
Stall warning sys
Aural warnings
Master caution sys

* optional equipment

To check BUS TRANS control / bus tie relay

BUS TRANS .... OFF
APU .... Start
Left APU GEN switch .... ON
- APU GEN OFF BUS light is extinguished
- #1 and 2 GEN OFF BUS lights illuminated
- #1 TRANSFER BUS OFF and #1 BUS OFF lights extinguished
- #2 TRANSFER BUS OFF and #2 BUS OFF lights illuminated
- TR1 indicates 23-32 vdc
- TR2 and TR3 indicates 0 vdc, 0 amps

BUS TRANS switch .... AUTO
- #2 TRANSFER BUS OFF light extinguished
- All TRs indicate 28 vdc and positive amps

Right APU GEN switch .... ON
- #2 BUS OFF light extinguished

Standby Power Test (3-4-5)
- is a check of the Standby Power relays and a check of the battery charger
- IRS's should be aligned to check certain flags
- battery charger works throughout this check
- do not do this check if the coffee maker is in the brewing cycle

• BAT switch .... ON
• AC and DC meters.................. STBY PWR
• APU GEN 2 or GRD PWR.............. OFF
  - tripping GPU will dump FMC data
  - if using APU
    - check right TRANSFER BUS OFF light blinks, indicating gen bus 1, through the transfer relay, has picked up transfer bus 2
    - #2 BUS OFF light illuminates indicating gen bus 2 is de-powered, as well as main bus 2, and therefore TR3. The battery bus seeks its alternate power source, the battery
    - if APU quits, bat bus altn relay failed to close - call maintenance
• STANDBY POWER switch.............. OFF
  - de-powers AC and DC standby buses
  - check STBY PWR OFF light illuminates
  - check AC volts and freqs and DC volts on bottom of scale
  - MASTER CAUTION lights, ELEC and IRS annunciator lights, and left IRS ON DC light illuminated and red HDG flag on Capt RMI
    (on non EFIS aircraft, Capt ATT flag)
• STANDBY POWER switch.............. BAT
  - AC standby bus powered by inverter
  - DC standby bus fed from battery bus
  - check STBY PWR OFF light extinguished
  - AC volts and freqs normal
  - DC volts normal, (flags out of view)
• STBY POWER switch......OFF, then AUTO
  - pause at OFF to make sure the relays reset - don't simply flip switch to AUTO using the cap
  - verify AC volts and freqs normal, DC volts normal
  - STBY PWR off light extinguished, flags gone
• DC meter .... BAT
  - check 28V; if only 24V, then battery charger is not working
• APU or GRD PWR............................ON
  - check momentary spike in DC amps

Standby Power Test (NG)

Note: Certain operators specify this as a maintenance function, not a pilot function

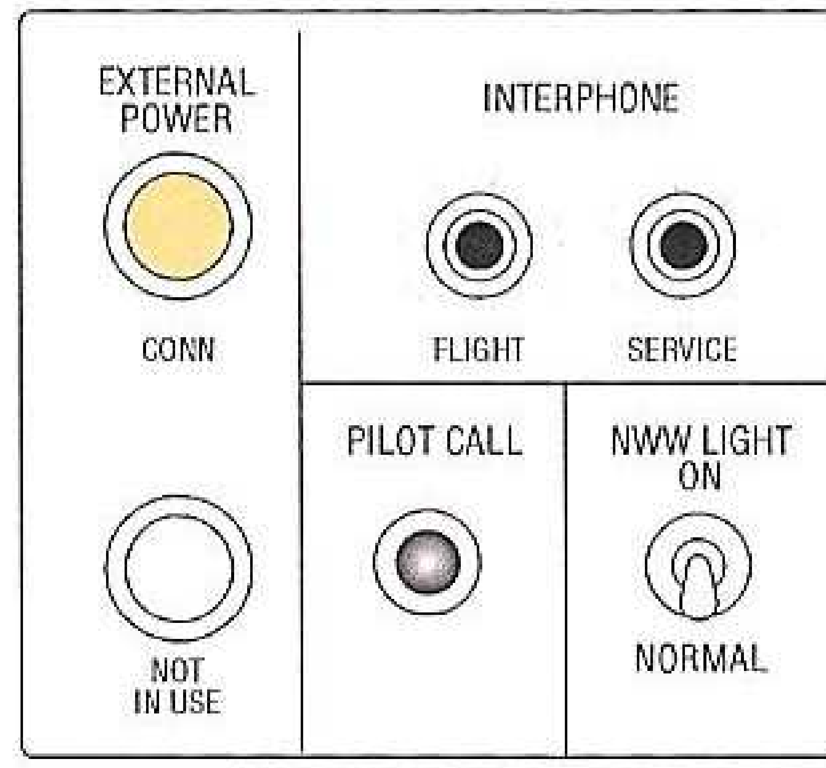
• BAT switch ....ON
• AC and DC meters.................. STBY PWR
  check STBY PWR OFF light extinguished
  check AC volts 115 ±5
  check freqs 400 ±5cps
  check DC volts 22-30
• if APU Gen is on line:
  APU Gen 1 .... OFF
  APU Gen 2 .... OFF
• if ground power is on line:
  GRD PWR switch .... OFF
• STANDBY POWER switch.............. OFF
  check STBY PWR OFF light illuminates
  check AC and DC volts zero
  when ac voltage goes below approx 12 vac, the CPS FREQ will blank
• STANDBY POWER switch.............. BAT
  check STBY PWR OFF light extinguished
  check AC volts 115 ±5
  check freqs 400 ±5cps
  A/c with single battery:
  check DC volts 22-30
  A/c with dual battery:
  check DC volts 22-28
• DC meter .... BAT
  check DC volts 24 ±2
  check DC ammeter for discharge *(negative value)*

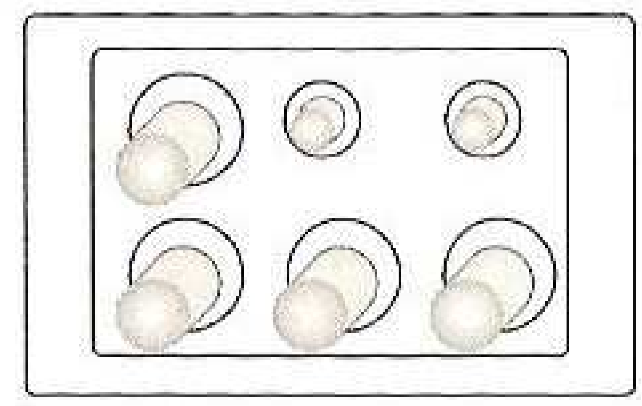
(Aircraft with dual batteries)

• *DC meter .... AUX BAT*
  DC volts 24 ±2
  DC ammeter for discharge
  (negative value)
• STANDBY POWER switch............ AUTO
• GRD PWR or APU GEN 1 & 2...........ON
  it may take up to 3 minutes for CDS displays to recover when power is interrupted for more than 2 seconds on the ground

The Standby Power check is not done on the NG unless required for a procedure as it introduces a fault in the CDS and takes 3 - 6 minutes to recover.
The standby power control panel also monitors the standby power and if there is a fault in the system, the ELEC light will illuminate.

EXTERNAL POWER RECEPTACLE (P19)





- External Power Receptacle Panel has 2 sections, the receptacle and the control and display section
- to apply power, connect the power cable then energize the cable
- to apply ground power to the buses
  - place BAT switch to ON, place GRD PWR switch to ON
- to remove ground power from the buses
  - place GRD PWR switch momentarily to OFF, place BAT switch to OFF
- four long pins, for connecting each power phase (A, B, C), and ground
- two short pins, for connecting the DC control interlock
- if external power is removed from the receptacle while energized, the interlock is opened and the electrical system is de-energized, preventing arcing at the panel
- when you de-energize the external power cable, the EXTERNAL POWER CONN and the NOT IN USE lights go out

EXTERNAL POWER CONN light (amber)

- comes on when the ground power plug is connected and power is present
- not an indication that quality within limits

NOT IN USE light (white)

- comes on when the external power is present but not in use by ground service buses or transfer buses
- extinguishes when the GND PWR or GROUND SERVICE switch is set to ON or when the fueling station access door is opened

FLIGHT INTERPHONE jack

- use to communicate with only the flight compartment
- use this jack when it is important that no other person talks over your communication

SERVICE INTERPHONE jack

- use to communicate with other areas inside and outside the airplane
- many people can use this at the same time
- (option) red parking brake light takes place of Service Interphone jack
  - illuminates when parking brake is set
  - powered from hot battery bus (if airplane is left without power and parking brake set, it would take a week to drain a fully charged battery but overnight for a weak one)

Electrical ground service equipment

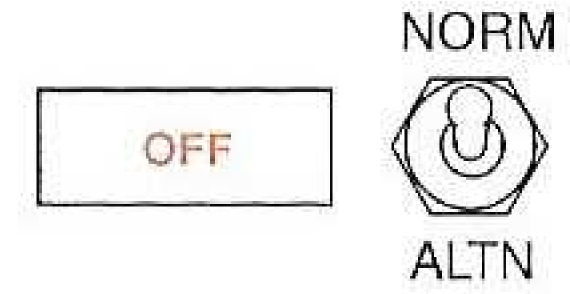
- Ground Service bus supplies battery charger(s), equipment cooling (Normal), service lights and 115vac outlets (vacuum cleaner)
  - if Gen 1 is lost you also lose the Ground Service Bus

(3-4-5)

  - if generator bus #1 is powered it becomes supply for ground service bus and trips off ground service switch on FA forward panel (i.e., solenoid holds "ON" if no power on Gen Bus #1)
- Three ways to power airplane for refueling:
  - ground power plugged in and switched on or off, or
  - APU power on buses, or
  - Bat switch ON
- External AC bus supplies ground fueling
  - powers re-fuel valves/gauges simply by plugging into a/c

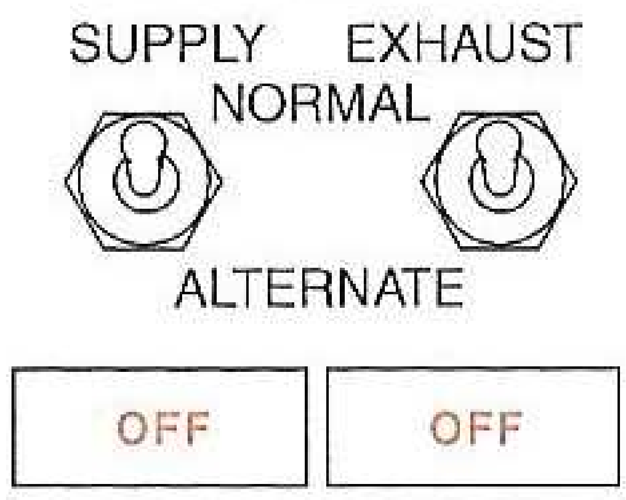
EQUIPMENT COOLING

EQUIP COOLING



(non EFIS 300)

EQUIP COOLING



EQUIPMENT COOLING switch

NORMAL - normal cooling fan activated
ALTERNATE - alternate cooling fan activated
- on EFIS series airplanes, two fan sets: SUPPLY and EXHAUST

EQUIPMENT COOLING OFF light

- illuminated OFF light if:
  - low airflow detected in the selected fan duct
    - in aircraft with supply and exhaust ducts, each duct has it's own low airflow sensor
  - failure of internal sensor BITE on power up
  - the sensor or filter is dirty, or

  (NG) overboard exhaust valve fails (exhaust OFF light only)
- (3-4-5) actuation of the low flow sensor by loss of airflow sends a signal to the EFIS symbol generators which removes the raster display from the EADI's and EHSI's
  - WXR DSPLY and EXCESS DATA annunciates
- (NG) if the EQUIP COOLING SUPPLY OFF light illuminates during flight indicating a subsequent failure of the remaining associated fan, continued flight beyond 30 min can result in loss of Captain's Display Units and the lower center Display Unit
- (NG) if the EQUIP COOL EXHAUST OFF light illuminates during flight indicating a subsequent failure of the remaining associated fan, continued flight beyond 30 min can result in loss of First Officer's Display Units and the upper center Display Unit

(MEL) Equipment Cooling - ATA 21

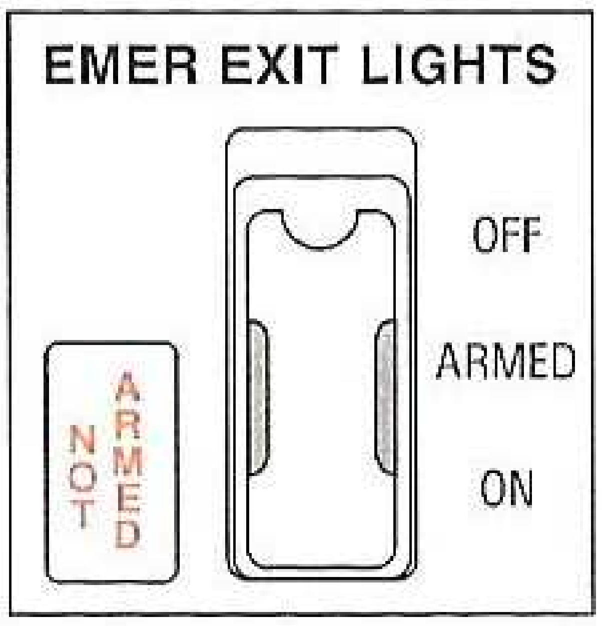
(non EFIS) except for ER ops one may be inop
(EFIS) except for ER ops one fan may be inop
(CDS) one fan may be inop provided all remaining fans operate and both low flow detectors operate normal

(QRH) EQUIP COOLING FAILURE

EQUIP COOLING SUPPLY OR EXHAUST.................................ALTERNATE
- the appropriate off light should extinguish within 5 seconds

Equipment Cooling System Notes

- supply system pulls air through a filter and pushes it through the:
  - EE racks, ADIRSs, FMC CDUs, and front instrument panels
- exhaust air is pulled from the:
  - EE racks, center aisle stand, FMC CDUs, front instrument panels, overhead instrument panels, circuit breaker panels, and IRUs/ADIRUs
- exhaust air flows around the forward cargo compartment and overboard through the (3-4-5) flow control valve – just aft of the EE access door
  (NG) overboard exhaust valve – just aft of the EE access door
- exhaust path for equipment cooling when the (3-4-5) flow control valve (NG) overboard exhaust valve is closed (in the air) is the forward cargo heat duct
- check airflow on walk around; if no airflow, sometimes a sharp knock on the skin just forward of the hole will free a sticky valve
  - this valve is open on the ground or inflight with low cabin differential pressure
  - in the air, air is kept onboard to heat the forward cargo compartment
- 5 standard equipment racks in the EE compartment: E1 thru E5
  - one rack also in the aft cargo compartment
- ground crew call horn activated by GRD CALL switch or ir flow sensors to IRU/ADIRU
  - ground crew call horn activated after 20 seconds if aircraft on the ground, one or both ADIRUs/IRUs are powered, and low air flow is detected to IRU/ADIRU, or IRU/ADIRU is on DC power
  - deactivate horn by setting the MSU mode selector switch to off



EMERGENCY EXIT LIGHTS

OFF - to turn off if they were on or keep from coming on
- batteries being charged if power is available (90 min full chg)

ARMED (capped position)
- all emergency lights come on with loss of #1 DC bus
- lights come on with loss of normal AC power, because the #1 DC bus is unpowered
- batteries charge whenever power is available

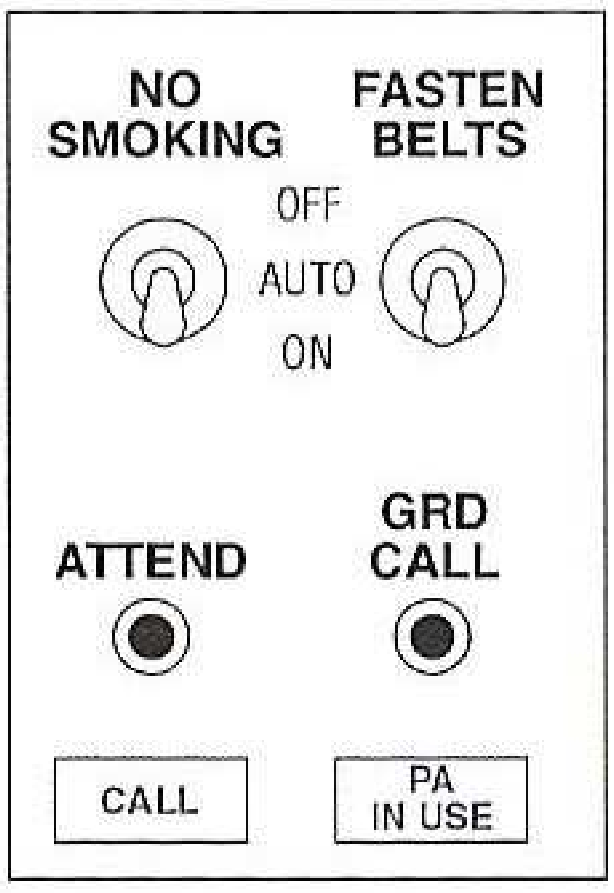
ON - lights on now
- batteries not being charged (last about 15-20 mins)

NOT ARMED light

- illuminates if Emergency Exit lights switch is not in the ARMED position
- illuminates MASTER CAUTION and OVERHEAD annunciator

Emergency Exit Lights Notes

- aft FA guarded switch (if not in normal) can override the cockpit switch
- open overwing hatch: overwing lights come on
- lights have own batteries: charged when FA switch NORMAL, power on aircraft, cockpit switch ARMED or OFF (i.e. they always charge unless on or no electricity)
- lights outside all entrances and overwing exits, and aisle illumination lights in overhead
- strip lights on floor or on passenger seats: "white" up to exit then "red"



NO SMOKING switch
FASTEN SEAT BELT switch

AUTO
- NO SMOKING sign and chime on when gear is extended
  - off when gear is up
- FASTEN BELT sign and chime on when gear or flaps are extended
  - off when gear and flaps are up
  - RETURN TO SEAT in lavs illuminate when seat belt sign comes on

(NG)
- if the passenger O2 system is either automatically or manually deployed, the FASTEN SEAT BELT sign will illuminate
  - the RETURN TO SEAT sign will not illuminate
- (option) seat belt sign auto illuminates as the aircraft descends below 10,000 ft

CALL BUTTONS

ATTENDANT CALL switch

- press - a two tone chime sounds in the passenger cabin and both pink Master Call lights illuminate (located on Fwd and Aft Exit lights)
- (NG) pressing #5 on new handset does same thing

CALL light (blue)

- illuminates when flight attendant or ground crew is pressing the PILOT call switch
- single tone chime when cockpit called

GROUND CALL switch

- press - a horn sounds in the nose wheel well until released
- same horn that sounds when external power is pulled because equipment cooling has been interrupted and IRS is operating

PA IN USE light (blue) (option)

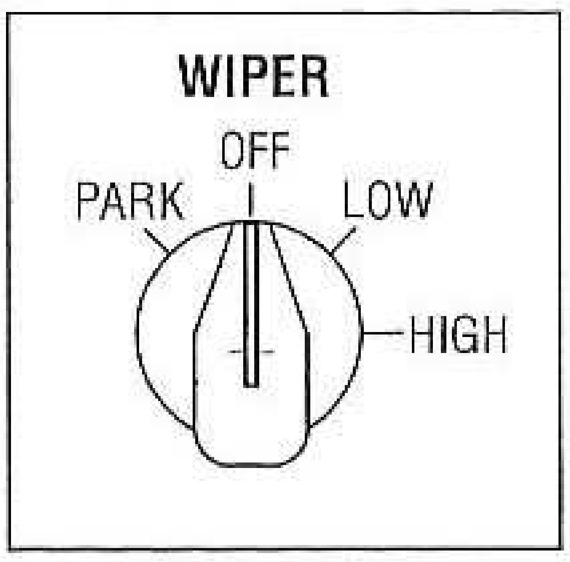
- illuminates when Passenger Address system is in use

RAIN REPELLENT and WIPERS

RAIN REPELLENT switch (3-4-5 option)
- press - each activation applies a measured amount of repellent on the associated No. 1 windshield
- repellent in can aft of captain; has sight gauge "level line"
- recommended use in moderate to heavy rain
- repellent harmful to environment and may be removed from aircraft

(L/OP) Ice and Rain, Wipers
(3-4-5) do not use rain repellent to clean windows
(3-4-5) use repellent on one windshield only, until determined OK to use

WINDSHIELD WIPER SELECTOR

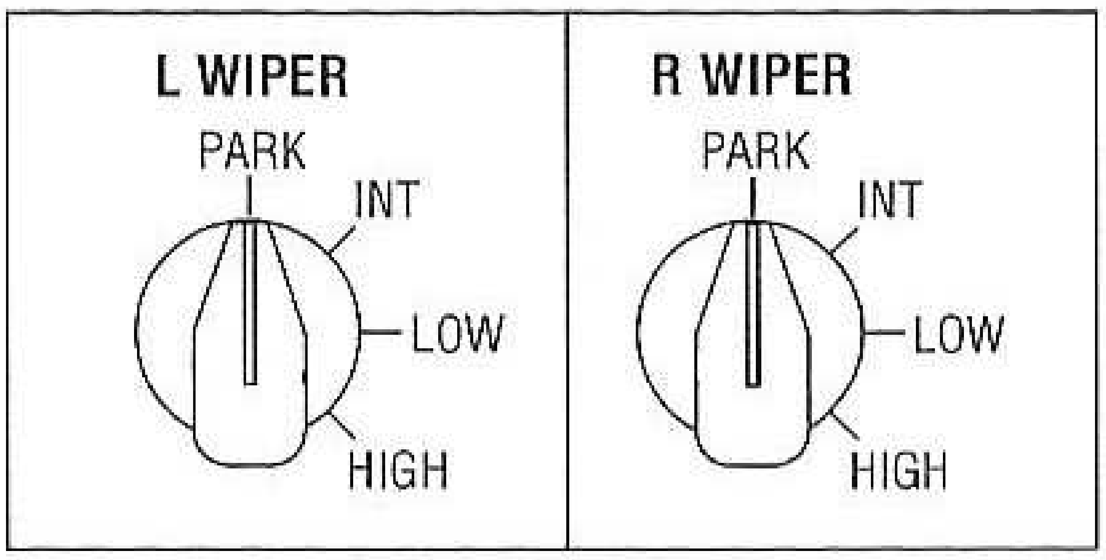


300/400/500

PARK
(3-4-5) momentary position used to stow wiper blades
(NG) turns off wiper motors and stows wiper blades
OFF (3-4-5)
- turns off wiper motors (spring loaded to OFF from PARK)

INT (NG)
- 7 second intermittent operation

LOW - low speed operation
HIGH - high speed operation
(NG) separate controls for each wiper so single switch failure does not disable whole system

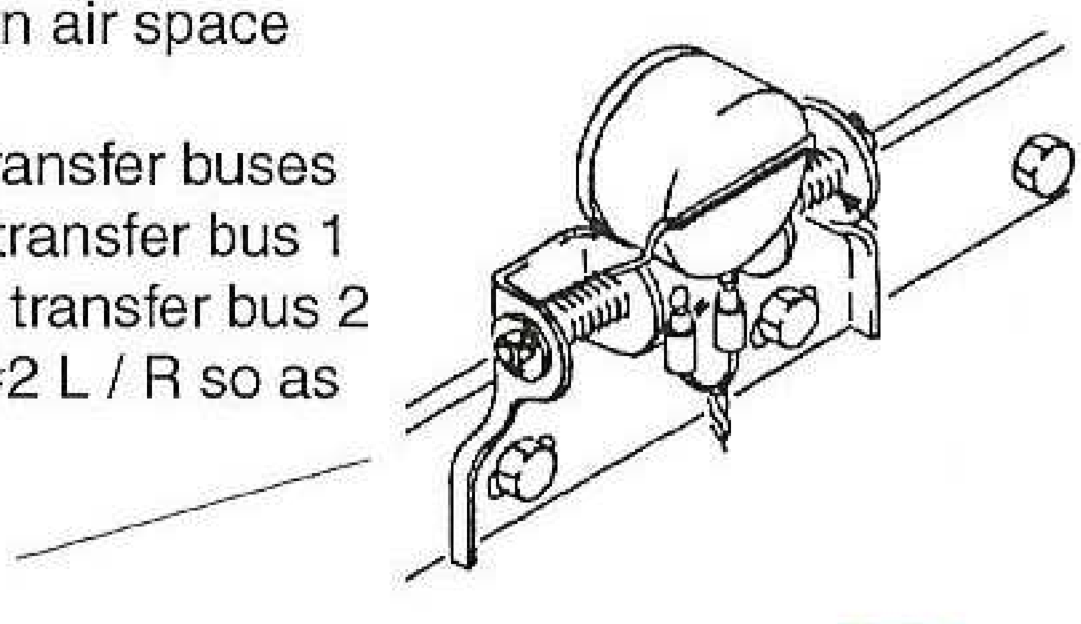


600 / 700 / 800/900

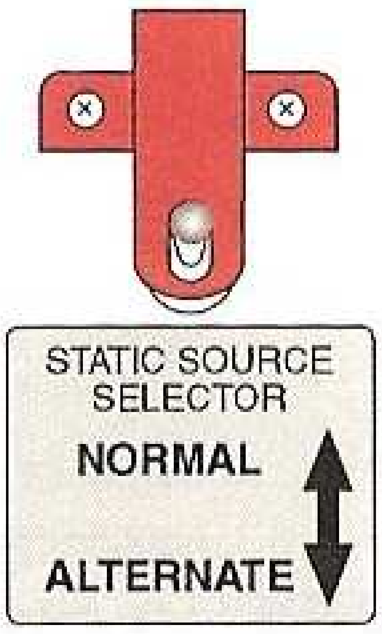
(L/OP) Ice and Rain, Wipers
- do not use wipers on dry windshields

Windshield Notes

1. (NG) hydrophobic coating
   - provides permanent rain repellent coating on the forward windshields (L1 and R1)
     - use proper chemicals when cleaning to preserve the coating
2. construction
   - #1 and #2 windows consists of glass panes laminated to each side of a vinyl core
     - the inner glass pane is the thicker and is the primary load carrying member
     - outer pane has no structural significance but provides rigidity and a hard, scratch-resistant surface
   - #3 consists of two acrylic panes separated by an air space
3. operation
   - window heat from (3-5) generator buses (NG) transfer buses
     - L1 and R2, 4L and 5L, (3-5) gen bus 1 (NG) transfer bus 1
     - L2 and R1, 4R and 5R, (3-5) gen bus 2 (NG) transfer bus 2
   - temp cont. applies voltage gradually to #1 and #2 L / R so as not to cause delamination
   - normal range is 100 to 114°F
   - 4 dovetails off of 5, which has a thermal switch



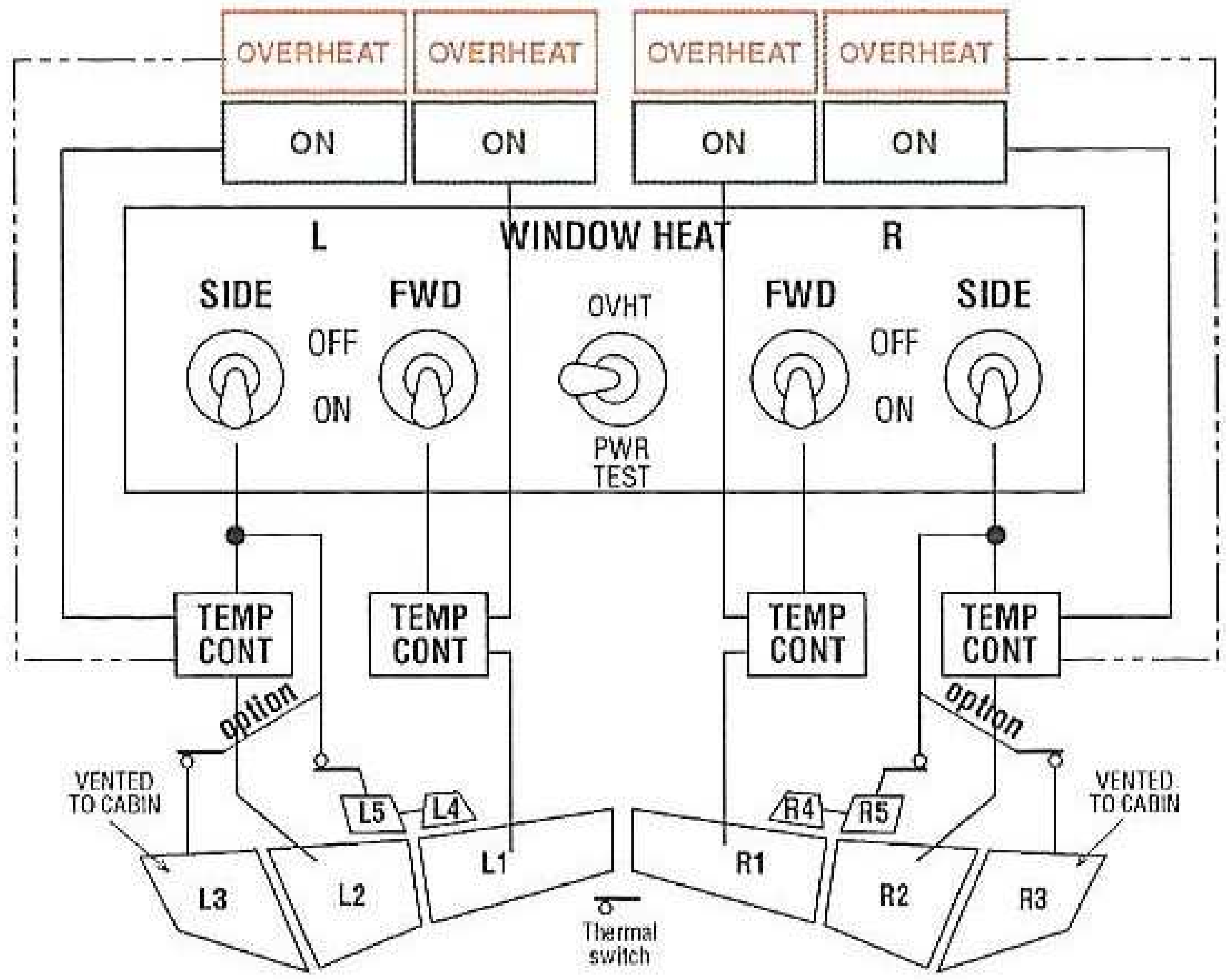
STATIC SOURCE SELECTOR (3-4-5) (option)



NORMAL
- normal pitot static system is providing static inputs to the respective pitot system

ALTERNATE
- the alternate static system is providing static inputs to the respective pitot system (Capt or FO)
- the alternate static system provides each pilot with a standby source of static preessure that may be selected with the respective static source selector
- the alternate static system cannot be connected to the auxiliary systems

WINDOW HEAT



WINDOW OVERHEAT lights 4 (amber)

- illuminated = window has overheated (145°F) or loss of electrical power
- power is removed from the window and ON light goes out
- window OVERHEAT light is accompanied by the MASTER CAUTION and ANTI-ICE annunciator
- reset by positioning the window heat switch to OFF then back ON after 2-5 minutes cooling

WINDOW HEAT ON lights 4 (green)

- illuminated = window heat controller is applying power to the associated window
  - the sun could heat the glass, which will cause the on lights to cycle on and off
- extinguished with switch OFF, or an overheat is detected, or a sys. failure has occurred
- if window temp is 100°F or more no power is applied and light remains off
- if ON light does not come on
  - use PWR TEST to check the ON light(s) that are not illuminated
- these windows also have a windshield air control
- #3 windows are not heated; they are vented to cabin (option provides electrical heat)
- windows 3 (option), #4 and 5 (discontinued 2005) do not cause ON lights to cycle on/off

WINDOW HEAT OFF lights 4 (amber) (option)

- extinguished = window heat controller is applying power to the associated window
- illuminated with switch OFF, or an overheat is detected, or a system failure has occurred
  - this would also illuminate the ANTI-ICE annunciator

WINDOW HEAT switch

L and R SIDE and FWD (takes 3 minutes to reach full voltage to reduce shock)

- FWD controls heat to # 1 window; SIDE controls # 2, 4, and 5 (option for #3)

ON - signals the window heat controller to apply power to the conductive coating on the outer glass panes of 1 and 2 and the inner glass panes of 4 and 5 (option for #3)

OFF - window heat not in use. Also resets the OVERHEAT light circuit

- turn off if window cracks or delaminates

WINDOW HEAT TEST switch

OVHT

- spring loaded to neutral, simulates an overheat condition to test overheat circuitry
- all overheat lights illuminate
- before test, place all WINDOW HEAT switches ON; after test, reset each OFF then ON
- ON lights may extinguish immediately, or remain illuminated for as long as 70 sec.
- MASTER CAUTION and ANTI-ICE annunciator lights come on

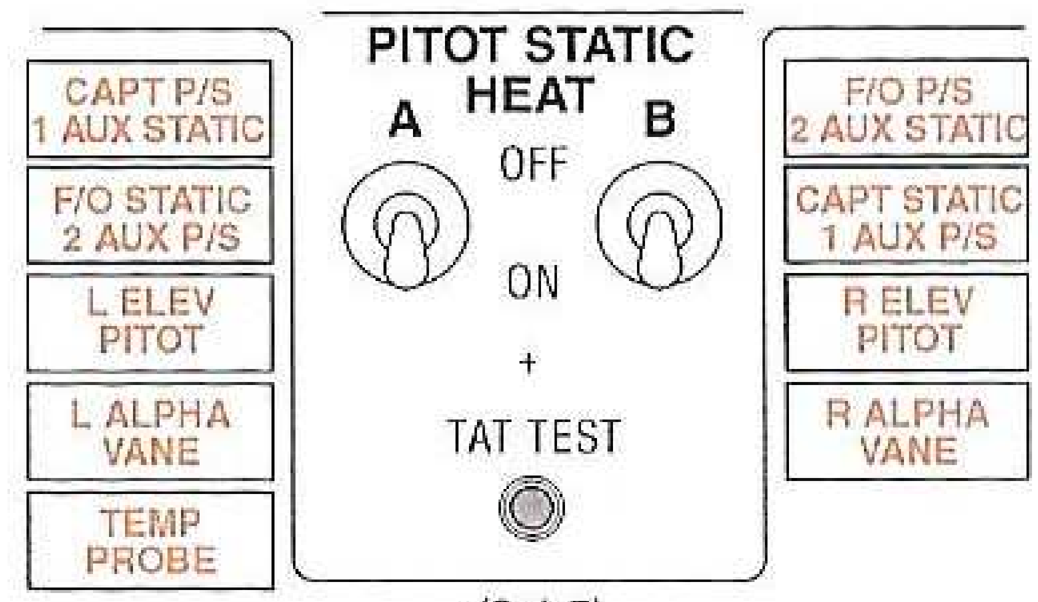
PWR TEST

- provides a confidence test with the WINDOW HEAT switch ON
  - no need to power test if all four green lights are illuminated
- green ON lights will illuminate signifying a successful test
- controller applies full power output regardless of window temperature
- hold only momentarily as you can overheat the window, even though window OVERHEAT protection is still available

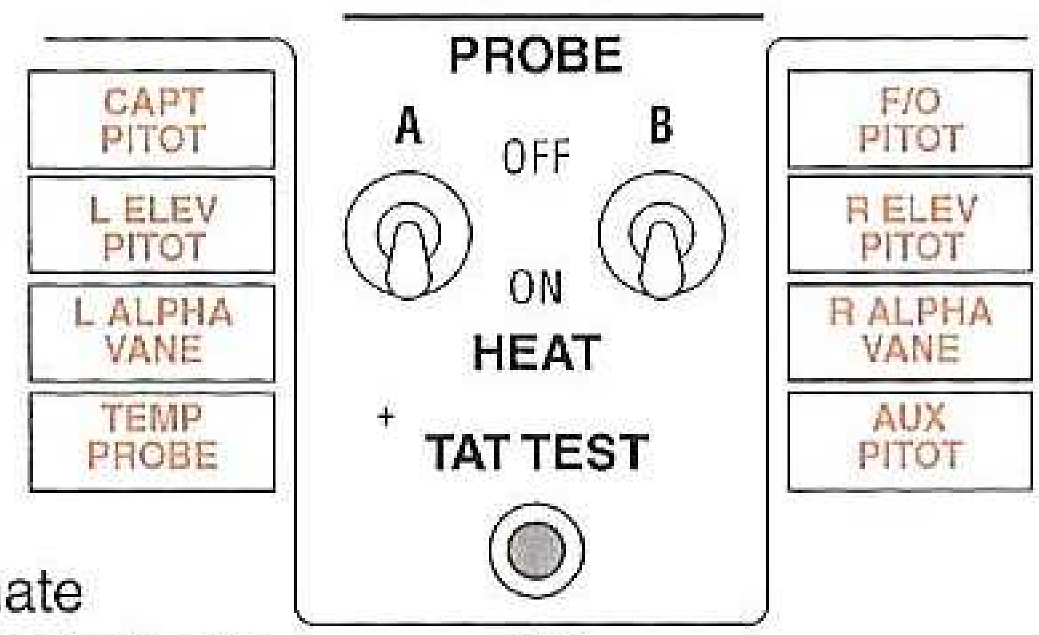
(L/OP) Ice and Rain, Window Heat

- window heat must be on 10 minutes before takeoff

PITOT STATIC



(3-4-5)



NG

PITOT STATIC / PROBE HEAT switches

(3-4-5) 9 systems / (NG) 8 systems

ON - power supplied to heat the respective sys
- all pitot probes, TAT probe, angle airflow sensor (AOA) are heated
- (3-4-5) static ports are heated since they are on the pitot probe
- (3-4-5) alternate static ports are not heated
- (NG) static ports are not heated

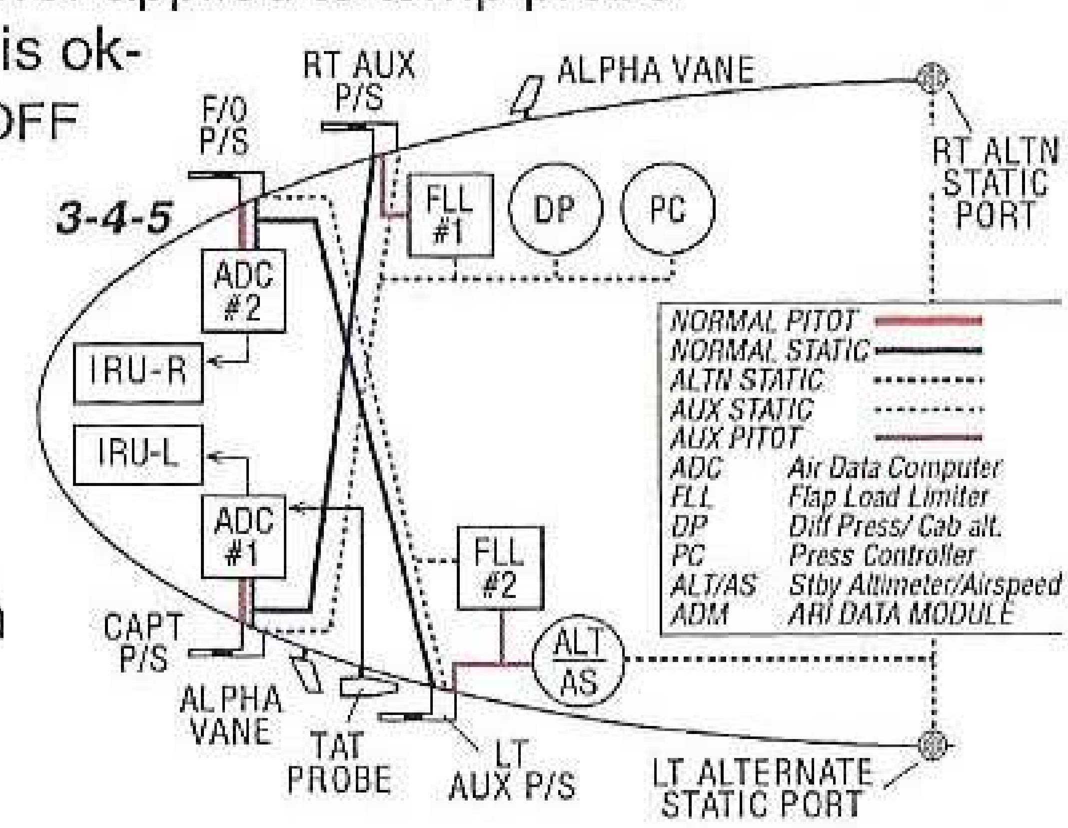
(NG) failure to turn ON for engine runs above 70% N1 will result in EEC entering soft alternate mode (possible N1 overspeed)

PITOT STATIC / PROBE HEAT lights (amber)

- illuminated = related probe not heated
- MASTER CAUTION and ANTI-ICE ann. lights illuminate
- if operating on stby power, probe heat lights do not indicate system status
- Capt pitot heated on stby power but CAPT PITOT light will not illuminate in case of failure

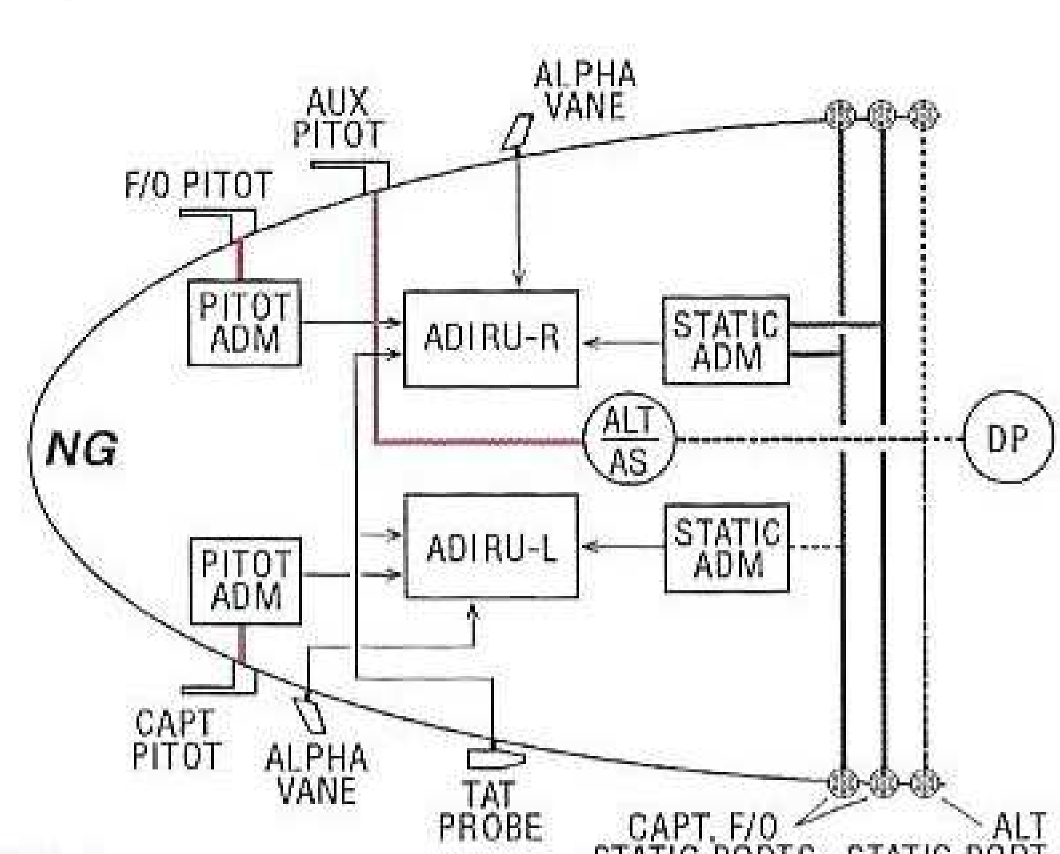
TAT TEST (option)

- normally, power removed from TAT on ground and amber light does not illuminate
- push TAT TEST switch with PROBE HEAT switch ON - power applied to temp probe
  - TEMP PROBE light remains out if the heat supply is ok; illuminates if defective
  - TAT will rise on the indicator and on any FMS CDU page where TAT is displayed
- push TAT TEST switch with PROBE HEAT OFF - power applied to temp probe
  - TEMP PROBE light out indicates the heat supply is ok- TAT will rise on the indicator and on the TAKEOFF REF page where TAT is displayed



Pitot-Static System Notes

1. 6 pitot probes on the (3-4-5); 5 on the (NG)
2. 5 static ports on the (3-4-5); 6 on the (NG)
   - static (ambient) press is sensed through ports on the combined pitot static probes and the flush static ports on both sides
3. The TAT probe provides air temp data to the digital ADCs and the flight data recorder
   - ADIRUs use TAT to modify altitude and airspeed calculations
4. angle-of-attack (AOA) provides the FCC's with a measurement of airflow angle
   - the left AOA provides the alpha signal to FCC A
   - the right AOA provides the signal to FCC B
   - used to modify pitot / static values, drive stall warn, stall margin on speed tape, and PLI
5. Air Data Modules change air press. signals
   - used to calculate airspeed and mach number
   - the air data instruments are the mach/airspeed indicators and altimeters
6. ADM gives the ADIRU static air pressure data
   - used to calculate altitude and airspeed
7. DEUs 1 and 2 give barometric correction to the ADIRUs
   - ADIRUs use barometric correction to calculate corrected barometric altitude



WING ANTI-ICE

WING ANTI-ICE VALVE OPEN lights (L and R) (blue)

- illuminated (bright)
  - corresponding wing anti-ice control valve is in transit, or
  - the position of the valve is contrary to the position of the wing anti-ice switch (disagreement lights)
- illuminated (dim) = corresponding wing anti-ice control valve is open (switch ON)
- extinguished = corresponding wing anti-ice control valve is closed (switch OFF); this is the normal scenario

WING ANTI-ICE switch

OFF - wing anti-ice control valves are closed

- VALVE OPEN lights are extinguished

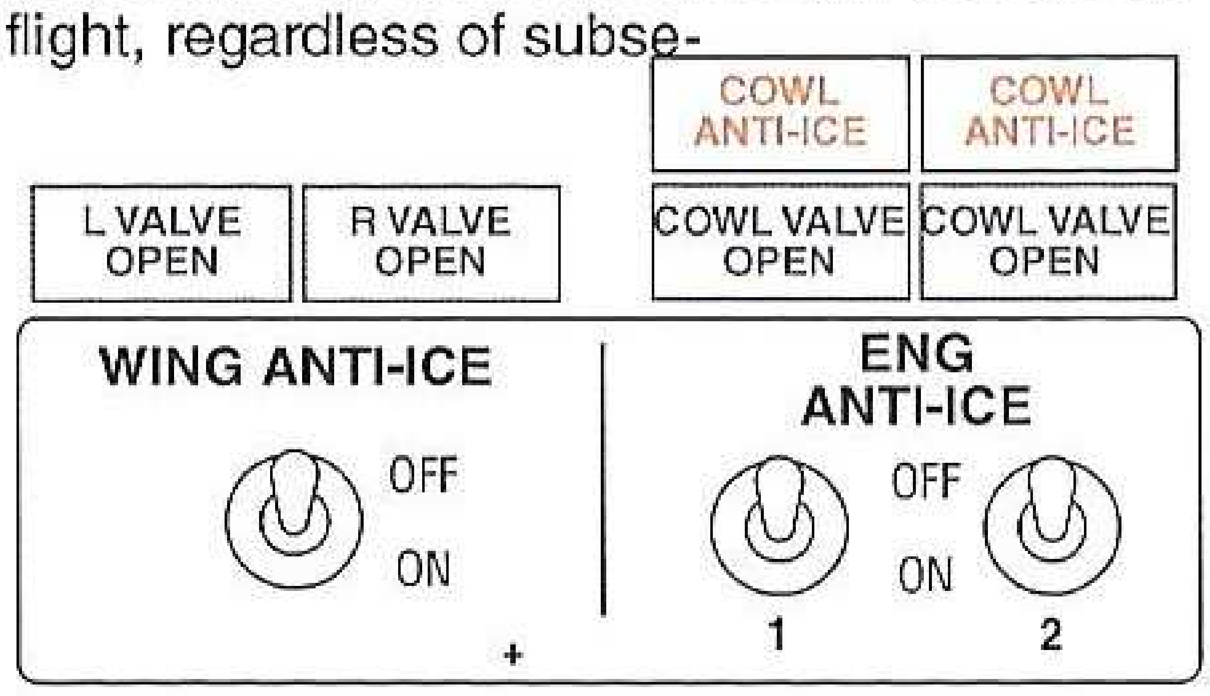
ON (in the air) - don't use above approximately FL350, may cause a dual bleed trip

- VALVE OPEN lights illuminate bright then dim
  - look for slight decrease in both duct pressure gauges
- 2nd segment clb consideration turn on after 800' AGL (altitude may vary by carrier)
- adjusts stick shaker and minimum maneuver speed bars on airspeed indicators
  - FMC displayed VREF is not automatically adjusted

Note: stick shaker and minimum maneuver speed bars on airspeed indicators remain set for icing conditions for the remainder of the flight, regardless of subsequent wing anti-ice switch position

ON (on the ground)

- Refer to *Anti-Ice System Notes*



ENGINE ANTI-ICE

COWL ANTI-ICE lights (amber)

- illuminated indicates:
  (3-4-5) an overpressure or overtemperature (no way to tell which one)
  - temp sensors in the duct downstream of the engine cowl anti-ice valve to the lip

  (NG) an overpressure only
- also get the MASTER CAUTION and ANTI-ICE annunciator
- retard throttle, flight conditions permitting

(NG) TAI (green) illuminates above N1 gauge (CDS) when EAI valves open

- TAI (amber) indicates valve is not in the commanded position indicated by the associated EAI switch

COWL VALVE OPEN lights (blue)

- illuminated (bright) = corresponding control valve is in transit, or if not in transit, the position of the valve is contrary to the position of the associated Engine Anti-Ice switch (disagreement lights)
- illuminated (dim) = corresponding control valve is open (switch ON)
- extinguished = corresponding control valve is closed (switch OFF)

(QRH) Engine Cowl Valve Fails Open

- if TAT is above 10°C, limit thrust on affected engine to 80% N1 if possible

ENGINE ANTI-ICE switch

OFF - engine anti-ice valve closes and the COWL VALVE OPEN light goes out

ON - opens corresponding engine anti-ice valve and illuminates the COWL VALVE OPEN light

(NG) stick shaker logic is set for icing conditions

Note: Adjusts stick shaker and minimum maneuver speed bars on airspeed indicators. FMC displayed VREF is not automatically adjusted.

Note: Stick shaker and minimum maneuver speed indications return to normal when engine anti-ice is positioned off if wing anti-ice has not been

(L/OP) Ice and Rain, WAI & EAI

- EAI must be on during all ground operations, including after landing, when icing conditions exist or are anticipated
- EAI must be on during all flight ops when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below -40°C SAT
- EAI must be on prior to and during descent in all icing conditions, including temperatures below -40°C SAT
- icing conditions exist when or TAT is 10°C / 50°F or below and:
  - visible moisture (clouds, fog with visibility less than 1 mile), rain, snow, sleet, ice crystals, etc.) is present, or
  - standing water, ice, or snow is present on the ramps, taxiways, or runways
  - do not operate EAI or WAI when the OAT (grd) or TAT (airborne) is above 10°C/50°F
- ignition must be selected to CONT prior to and during EAI operation
- WAI must be on during all ground operations between engine start and takeoff, when icing conditions exist or are anticipated
- do not use WAI as a substitute for ground de-ice / anti-ice

(QRH) Wing Valve Failure

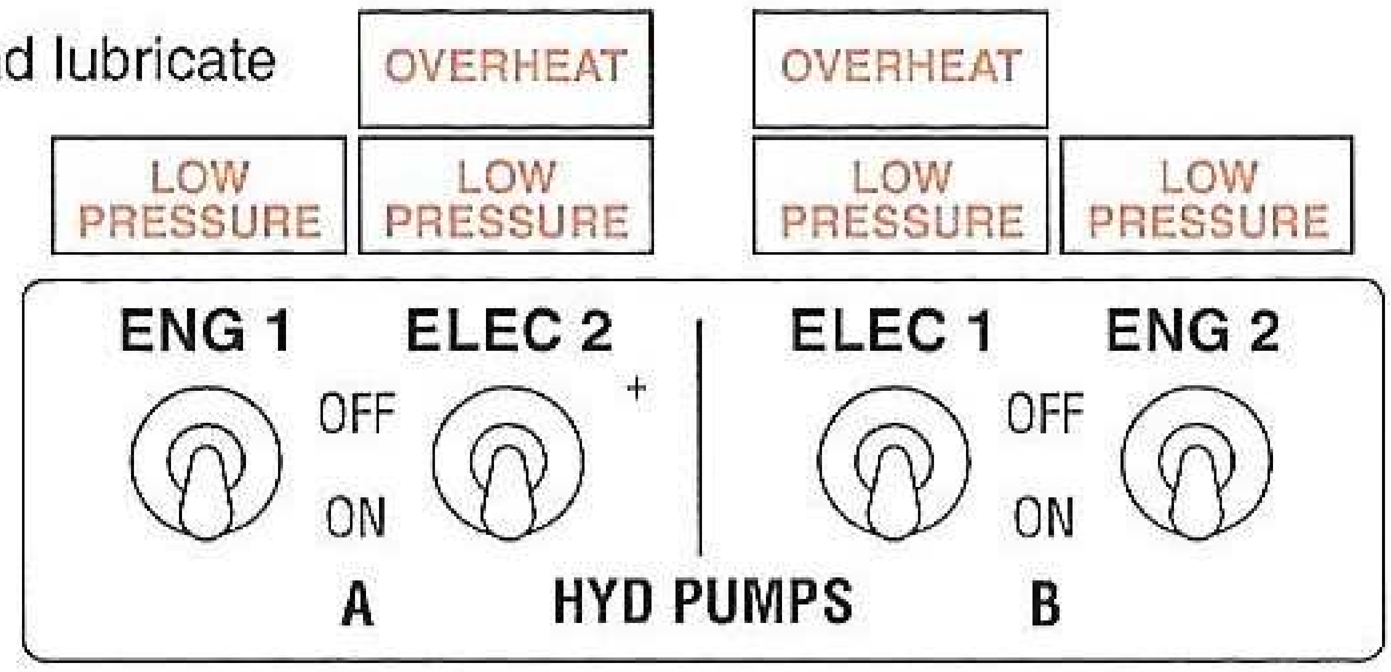
- L and / or R VALVE OPEN lights illuminated bright blue in flight (disagreement with switch)
- if failed open and TAT is above 10°C and no visible moisture
  - close isolation valve; prevents isolation valve from opening in the following step.
  - turn engine bleed switch off on affected side
  - much lower N2 during engine start as air will be leaking out the wing leading edge
- if failed closed, avoid icing conditions

Anti Ice System Notes

1. source is 5th stage bleed when power is high and 9th stage when power is reduced
   - do not need bleed valve open to operate engine anti-ice (ref fold-out schematic)
2. Engine anti-ice
   - anti-ices engine inlet cowls (lips); exhausts at bottom of lip
   - electrically controlled and pneumatically actuated butterfly valve (needs air pressure)
     - modulates to 50 psi; overpressure switch at 65 psi
     - can be locked open or closed
   - EAI valve is spring loaded to close with loss of normal DC power
     - loss of all generators (on battery power) you will not have engine anti-icing
   - fuel flow during cruise increased by approximately 400 pph/eng
3. Wing Anti-Ice (Kruger flaps not heated)
   - (3-4-5) all three LEDs are heated; each side from respective pneumatic manifold (NG) the three inboard LEDs are heated; the outboard slat is not heated
     - too thin for ducts and tests with artificial ice shapes didn't degrade handling/perf.
   - WAI can be operated on the ground (restrictions) and inflight (as anti-ice or de-ice)
     - on the ground, with WAI switch ON, both throttles less than takeoff warning position (30°) and duct temp less than the limit, both control valves open
       - both valves close if either throttle greater than takeoff warning position or duct temp greater than the limit, and you get disagree lights (will reopen if you pull throttles back and temp is below limit) Duct temp limit is 275°F/125°C
     - during takeoff the overhead switch trips off automatically (air mode on RMLG) and the disagree light goes out - must turn WAI switch back on manually
     - 2nd segment performance would take a big hit if these valves remained open
   - Non-ground ops option - may be armed on ground but does not come on until lift-off
   - WAI is AC motor valve - lose power and valve stays where it was
   - cannot operate the WAI with the APU (not powerful enough); but could use one engine bleed (isolation valve OPEN) to run both left and right WAI
   - fuel flow during cruise increased by approximately 600 pph/eng
   - use wing anti-ice as a de-icer by allowing ice to accumulate before turning on
     - this procedure provides the cleanest airfoil surface, least possible runback ice formation, and the least thrust and fuel penalty

HYDRAULICS

OVERHEAT lights (amber)



- hydraulic fluid that is used to cool and lubricate the corresponding electric motor driven pump has overheated, or the motor itself has overheated (235°F)
- temp activated switches in case return line and in the motor case
- may be contaminated EMDP filter
- (option) pump auto shutdown

HYDRAULIC PUMP LOW PRESSURE 4 lights (amber)

- indicates low pump output pressure from respective engine or elec pump (<1300 psi)
- ENG LOW PRESSURE lights inhibited with fire handle pulled
  - fluid flow to the associated engine driven pump is shut off

(MEL) Hydraulic A Sys Low Press Light - ATA 29

ENG 1 LOW PRESSURE lite inop
  - start #1 engine. Check ENG 1 pump switch on, ELEC 2 pump switch off. Verify system is pressurized 2900 - 3100 psi

ELEC 2 LOW PRESSURE light inop
  - ensure transfer bus #2 is powered. Switch ELEC 2 pump switch on, ENG 1 pump switch off. Verify system pressurized 2900 - 3100 psi

(MEL) Hydraulic B Sys Low Press Light - ATA 29

ELEC 1 LOW PRESSURE light inop
  - ensure transfer bus 1 is powered. Switch ELEC 1 pump switch ON, ENG 2 pump switch OFF. Verify system pressurized 2900 - 3100 psi

ENG 2 low press lite inop
  - start #2 engine. Check ENG 2 pump switch ON, ELEC 1 pump switch OFF. Verify system is pressurized between 2900 - 3100 psi

ENGINE DRIVEN PUMP switches (EDP)

ON
  - the depressurization valve is de-energized and the pump outlet port is open
  - normally keep this switch in the ON position to prolong solenoid life
  - loss of electrical power to the control circuit does not affect the output of the pumps
  - depressurization valve powered by opposite DC bus

OFF
  - energizes the depressurization valve to block fluid flow from the pump
    - re-routes fluid to case drain, air/oil heat exchanger and reservoir
  - with loss of electrical power, the depressurization valve opens and the engine pump returns to a switch "on" condition supplying hydraulic pressure to its respective system
  - by "feathering" the pump with the EDP switch, the pump is lubricated
    - not so if you pull the fire handle which closes the EDP supply SOV to block fluid flow to the pump

ELECTRIC MOTOR PUMP (EMDP) switches

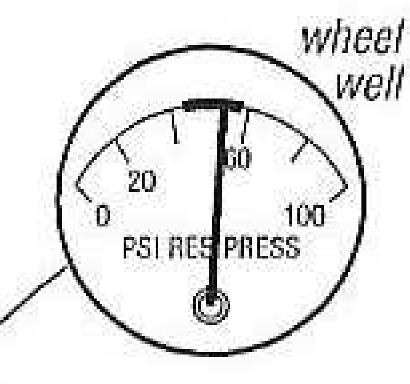
ON - provides power to corresponding electric motor driven pump
  - in a 5 min. period do not make more than 5 starts of any one pump (30 sec. interval)

(L/OP) Hydraulics, Min Qty & Min Press

- Min fuel to operate electric pumps on ground is 1676 lbs fuel in respective tank
- Max 3500 psi, Min 2800 psi

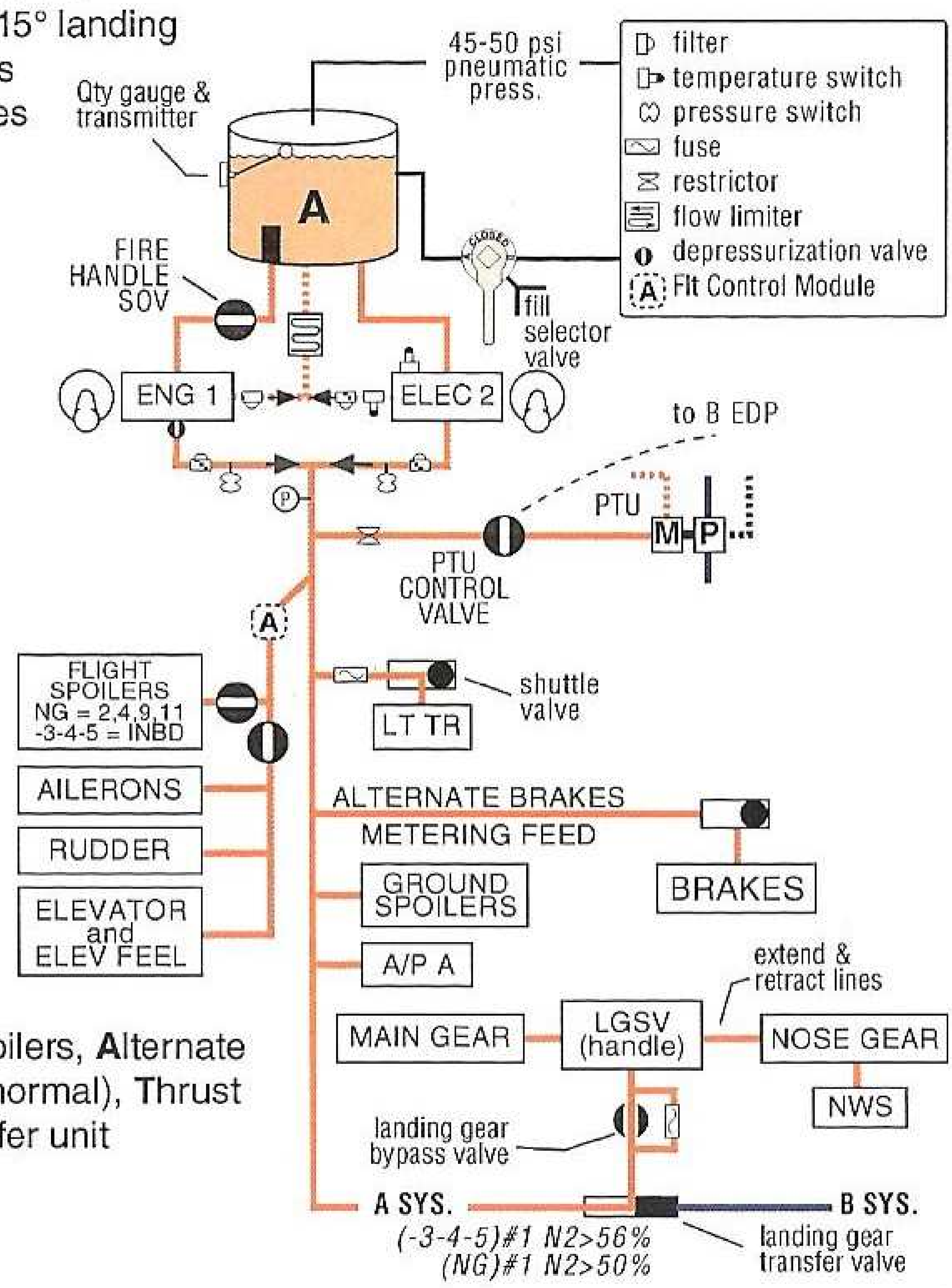
Hydraulic System Notes

1. General:
   - two main systems, A (#1 engine) and B (#2 engine)
   - and two auxiliary systems, standby hydraulic system and the power transfer unit (PTU)
   - normal pressure is 3000 psi
     - pressure sensor downstream of check valves indicates pressure of systems A and B
   - A and B have both engine driven pumps (EDP) and electric motor driven pumps (EMDP)
   - EDP, EMDP, and standby output volume and rated pressure (3-4-5/NG):
     - EDP flow rate approx. 22/36 gpm at 3000 psi
     - EMDP flow rate approx. 6/5.7 gpm at 2700
     - standby hyd pump flow rate approx. 3/3.7 gpm at 2700 psi
   - fire handle shuts off hyd fluid from reservoir to that EDP
     - if the engine continues to turn (windmill) the EDP may be damaged



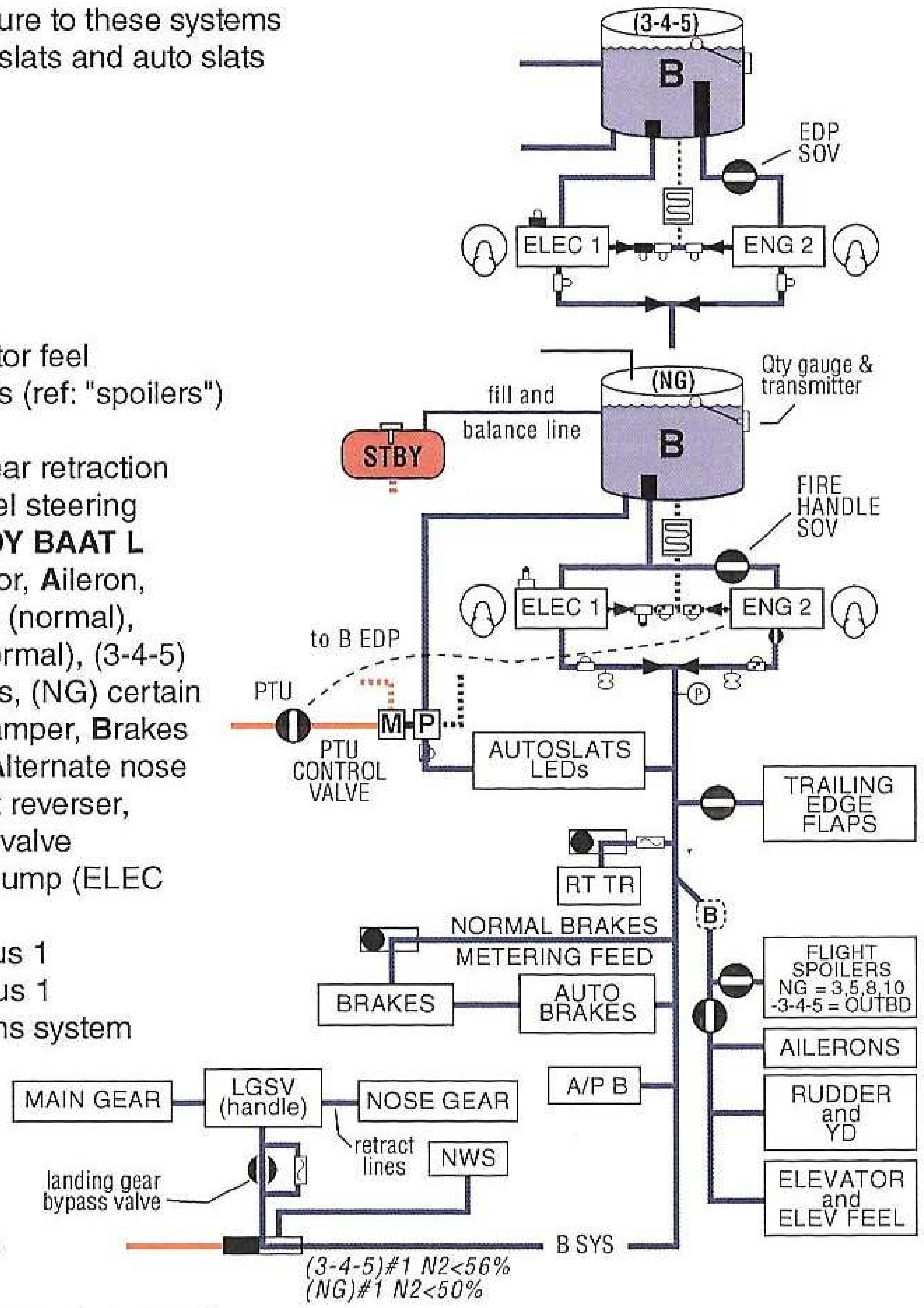
   - system A and B reservoirs are pressurized by air to insure positive flow to pumps and to prevent foaming
     - excess pressure from reservoirs vented through the APU fuel line shroud drain mast
   - the Standby reservoir is supplied by the B reservoir
   - B reservoir is serviced by first filling the Standby reservoir through the fill selector valve
   - major components are located in the main wheel well
   - when a clogged return filter causes a differential pressure across the filter element of 65 psi, the red differential pressure indicator will move up and you can see it on top of the filter element (bypasses at 100 psi)
   - common items that both A and B power are the "FEAR Group" Feel, Elev, Ail, Rud and Gear
   - standpipe in the A system reservoir prevents EDP from draining the A reservoir
   - standpipe(s) in the B system reservoir saves fluid for the PTU
     (NG) Engine pump fed through same standpipe as electric pump. Quantity gauge will indicate zero but fluid remains for PTU
   - if lose system B, plan on flaps 15° landing
   - variations in hyd. qty. indications occur when the system becomes pressurized after engine start, raising or lowering the gear or LEDs

2. System A supplies pressure to:
   - power transfer unit motor
   - left thrust reverser
   - alternate brakes
   - certain flight spoilers
   - autopilot A
   - rudder
   - ailerons
   - elevators and elevator feel
   - ground spoilers
   - landing gear extension and retraction
   - nose wheel steering
   - A System: **A REAL GIANT P**
     A/P A, Rudder, Elevator, Aileron, Landing gear, Ground spoilers, (3-4-5) Inboard flight spoilers, (NG) certain flight spoilers, Alternate brakes, Nose wheel steering (normal), Thrust reverser (normal), Power transfer unit



- electric motor driven pump (ELEC 2) powered by:
  - (3-4-5) generator bus 2
  - (NG) 115V AC xfr bus 2
  - this feature maintains system pressure with loss of either engine
- fuel heat exchanger in main tank #1
  - cools case drain fluid from both EDP and EMDP
- #1 fire switch closes a valve to cut off fluid to the engine driven pump
  - also deactivates engine driven pump LOW PRESSURE light
- components lost with loss of system A: **A GIANT**
  A/P A, **G**round spoilers, certain fl**i**ght spoilers, **A**lternate brakes, **N**ose wheel steering, **T**hrust reverser

3. System B supplies pressure to these systems
   - leading edge flaps, slats and auto slats
   - right thrust reverser
   - normal brakes
   - autobrakes
   - yaw damper
   - autopilot B
   - rudder
   - ailerons
   - elevators and elevator feel
   - certain flight spoilers (ref: "spoilers")
   - trailing edge flaps
   - alternate landing gear retraction
   - alternate nose wheel steering



- B System: **A REAL TOY BAAT L**
  A/P B, **R**udder, **E**levator, **A**ileron, **L**eading edge devices (normal), **T**railing edge flaps (normal), (3-4-5) **O**utboard flight spoilers, (NG) certain flight sp**O**ilers, **Y**aw damper, **B**rakes (normal), **A**uto slats, **A**lternate nose wheel steering, **T**hrust reverser, **L**anding gear transfer valve
- electric motor driven pump (ELEC 1) powered by:
  - (3-4-5) generator bus 1
  - (NG) 115V AC xfr bus 1
  - this feature maintains system pressure with loss of either engine
- fuel heat exchanger in tank #2
  - cools case drain fluid from both EDP and EMDP
- components lost with loss of system B
  TOY BAAT
  A/P B, **T**railing edge flaps, certain flight sp**O**ilers, **Y**aw damper, **B**rakes, **A**uto slats, **A**lternate nose wheel steering, **T**hrust reverser

Hydraulic System Notes

1. General:
   - two main systems, A (#1 engine) and B (#2 engine)
   - and two auxiliary systems, standby hydraulic system and the power transfer unit (PTU)
   - normal pressure is 3000 psi
     - pressure sensor downstream of check valves indicates pressure of systems A and B
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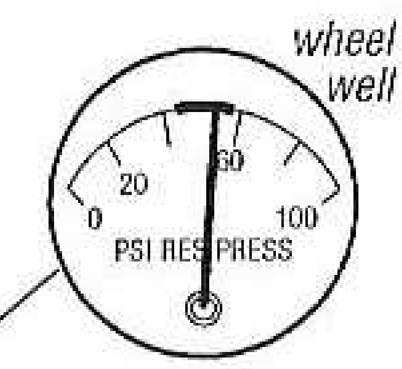

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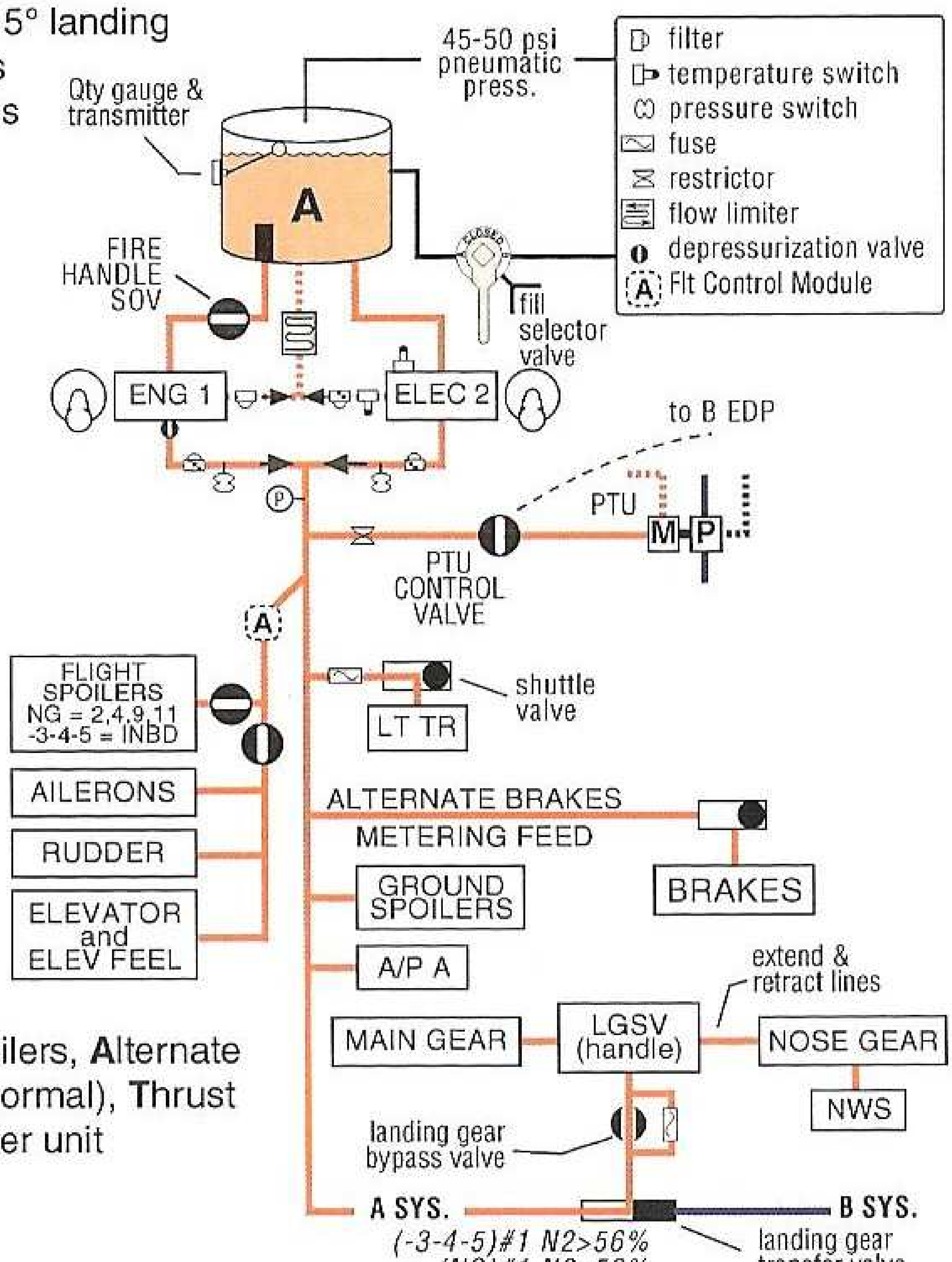
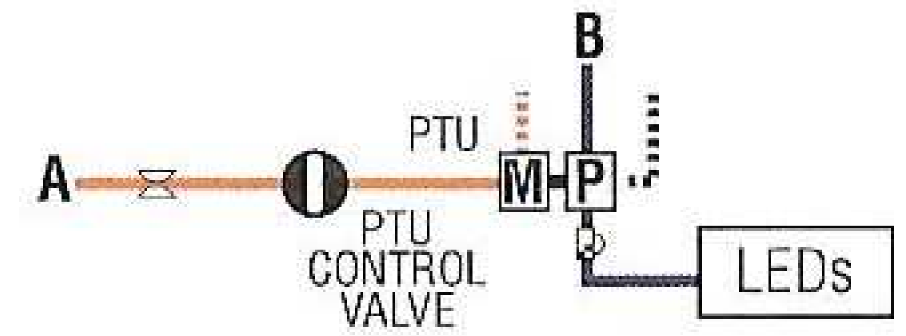
   - standpipe(s) in the B system reservoir saves fluid for the PTU
     (NG) Engine pump fed through same standpipe as electric pump. Quantity gauge will indicate zero but fluid remains for PTU
   - if lose system B, plan on flaps 15° landing
   - variations in hyd. qty. indications occur when the system becomes pressurized after engine start, raising or lowering the gear or LEDs
2. System A supplies pressure to:
   - power transfer unit motor
   - left thrust reverser
   - alternate brakes
   - certain flight spoilers
   - autopilot A
   - rudder
   - ailerons
   - elevators and elevator feel
   - ground spoilers
   - landing gear extension and retraction
   - nose wheel steering
   - A System: **A REAL GIANT P**
     A/P A, **R**udder, **E**levator, **A**ileron, **L**anding gear, **G**round spoilers, (3-4-5) **I**nboard flight spoilers, (NG) certain flight spoilers, **A**lternate brakes, **N**ose wheel steering (normal), **T**hrust reverser (normal), **P**ower transfer unit

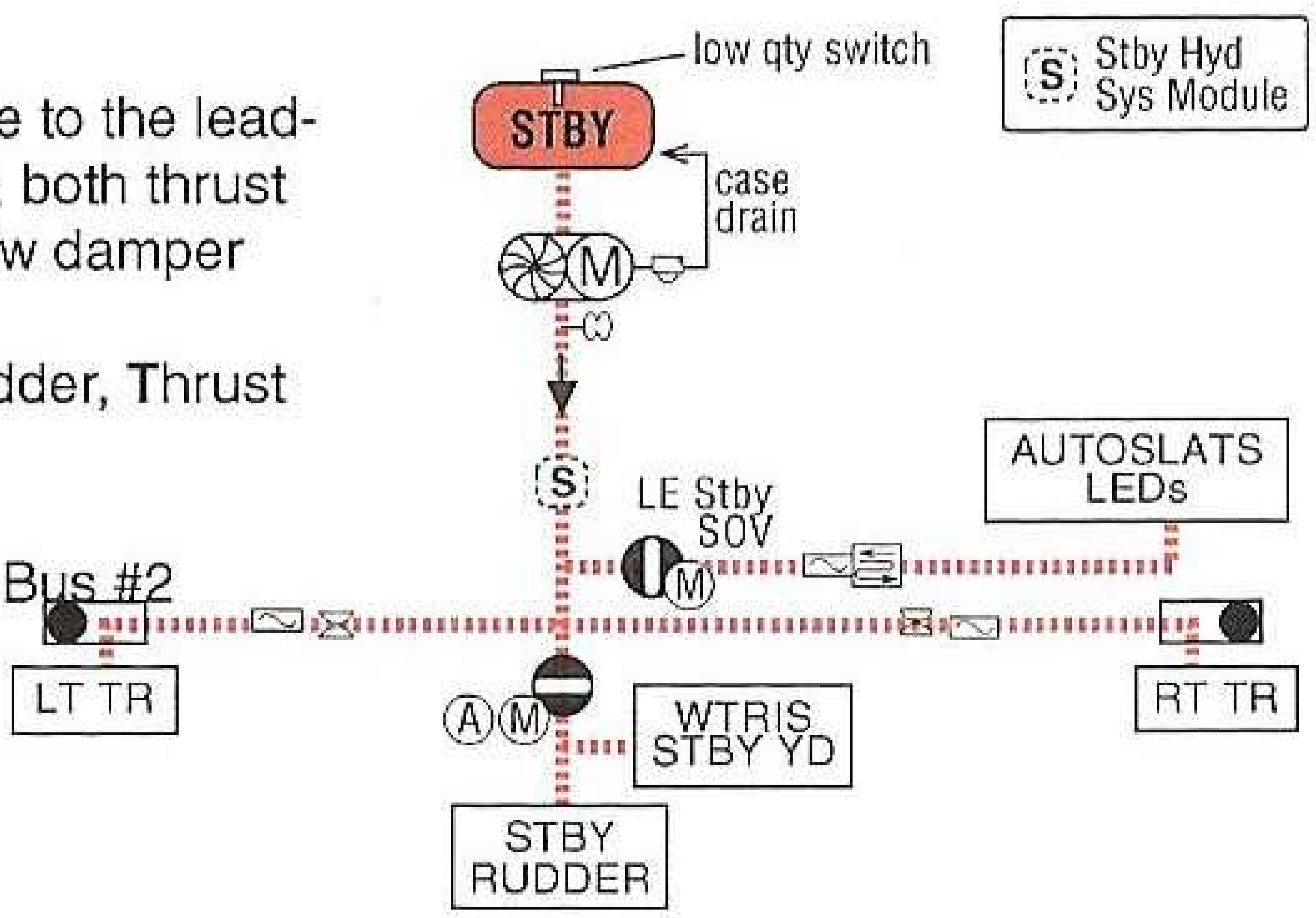


4. Power Transfer Unit (PTU)



- supplies alternate hydraulic pressure to the leading edge flaps and slats and autoslat system when hydraulic B system EDP pressure is below normal
- PTU control valve opens automatically when:
  - airplane is in the air
  - TE flap position is between up and 15
  - B system EDP pressure is low
    - the EDP pressure switch sends a signal to open the PTU control valve when B system EDP pump pressure decreases to less than 2350 psi
- when the Alternate Flaps Master switch is moved to ARM and the Alternate Flaps control switch is moved to DOWN, PTU control valve closes
- system A pressurizes the motor and system B supplies the fluid to the pump to run the LEDs to FULL EXT
  - there is no transfer of fluid between the two systems
  - the PTU takes fluid off the bottom of the B reservoir below the standpipes, therefore you should always have fluid unless there is a leak in the PTU system or the bottom of the B system reservoir

5. Standby Hydraulic System



- supplies alternate hydraulic pressure to the leading edge flaps and slats, the rudder, both thrust reversers, and (NG) the standby yaw damper
- gouge: "LSTS"
  Leading edge devices, **S**tandby Rudder, **T**hrust reversers, **S**tandby yaw damper
- (3-4-5) power is Gen Bus #1
  - will transfer automatically to Gen Bus #2
- (NG) power is XFR Bus #2
  (3-4-5) located on keel beam in wheel well
  (NG) located in right aft wing-to-body fairing
- cooled by case drain fluid and air
- activated three ways
  - either flight control system switch to STBY RUD
    - positioning either switch to STBY RUD will activate the standby pump and open the standby rudder SOV. The standby pump LOW PRESSURE light is armed. The associated LOW PRESSURE light extinguishes (except during auto operation) as the circuit switches to verify the standby ruddder valve position (open). This light would remain illuminated if the valve failed to open.
  - alternate flaps master switch to ARM
  - auto activated (power for rudder and thrust reverser) when
    - low pressure in A and/or B, and
    - flaps extended, and
    - airborne (takeoff) or wheel speed greater than 60 (landing)
      - auto operation does not deactivate the respective flight control LOW PRESSURE light
      - when airborne and flaps are retracted, STBY pump shuts off, STBY rudder shut off valve closes
      - wheel speed comes off anti skid generator, therefore if no antiskid, you may not have this auto system until airborne
- on aircraft with the new rudder mod, automatic operation of the standby hydraulic system will occur if the main rudder PCU force fight monitor (FFM) trips
- any time Standby pump is signaled to run, the Standby Hyd LOW PRESSURE light is armed

DOOR LIGHTS

illuminated means related door is not closed and locked

- 4 entry doors, 2 cargo doors, tire screen, EE doors
- AIRSTAIR indicates airstair pressure door is unlocked
  - light is inop if DC bus 1 not powered
- EQUIP door light; actually for two doors; EE door and door forward of nose gear
- TIRE SCREEN door light (amber) (3-4-5)
  - optional equipment
  - one of the tire screen locking pins is not properly seated/secure
  - if comes on, you may have damage with gear retraction

  (NG)
- circuits for the lights are in the PSEU
- (6-7-B) has 2 OVERWING exits
- (8-9-B2) has 4 OVERWING exits
- serves as indicators for the electrically operated flight locks
  - if the light illuminates, the overwing door is open or the flight lock did not lock, which would allow someone to open the door
  - flight locks prevent the operation of the emergency overwing DOORS in flight
  - flight locks are energized by the PSEU when 3 or more of the entry/service doors are closed, either engine is running, and air/ground logic is in air mode or both thrust levers are advanced more than 53°
    - this prevents operation of the door handle in low differential pressure and in unpressurized flight
  - if electric power is not available a tension spring unlocks the flight lock
  - when a flight lock is failed locked when it should be unlocked, or when a fault is detected, the PSEU light, the OVERHEAD annunciator, and the MASTER CAUTION lights illuminate; these indications are inhibited from takeoff until 30 seconds after the a/c is in the ground mode

-300, 400, 500 (with optional tire screen)

FWD ENTRY	TIRE SCREEN	FWD CARGO	FWD SERVICE
AFT ENTRY	EQUIP	AFT CARGO	AFT SERVICE

Left side of airplane | Right side of airplane

-300, 400, 500 (with optional airstair)

FWD ENTRY	AIRSTAIR	FWD CARGO	FWD SERVICE
AFT ENTRY	EQUIP	AFT CARGO	AFT SERVICE

Left side of airplane | Right side of airplane

6-7-B (with optional airstair)

AIRSTAIR	FWD ENTRY	FWD SERVICE	FWD CARGO
EQUIP	LEFT OVERWING	RIGHT OVERWING	AFT CARGO
	AFT ENTRY	AFT SERVICE	

Left side of airplane | Right side of airplane

8-9-B2 (with optional airstair)

	FWD ENTRY	FWD SERVICE	
AIRSTAIR	LEFT FWD OVERWING	RIGHT FWD OVERWING	FWD CARGO
EQUIP	LEFT AFT OVERWING	RIGHT AFT OVERWING	AFT CARGO
	AFT ENTRY	AFT SERVICE	

Left side of airplane | Right side of airplane

(MEL) Overwing Exit Flight Lock System - ATA 52

- may be inop provided each exit is verified to be capable of being unlatched and opened before each departure, and aircraft is not dispatched unless a person employed by the operator is designated to remain seated in the passenger seat nearest the affected exit(s) when the cabin differential pressure is less than 4 psi

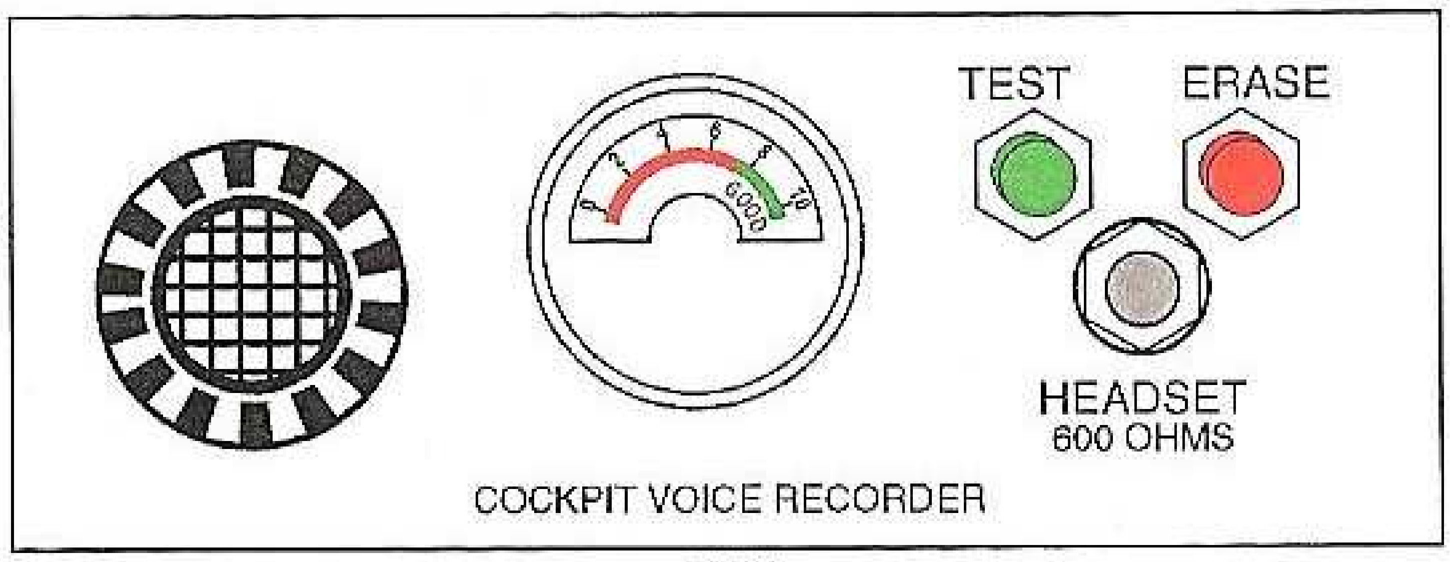
(QRH) Overwing Exit Cover

- installation of handle covers on the overwing exits must be verified prior to departure whenever passengers are carried

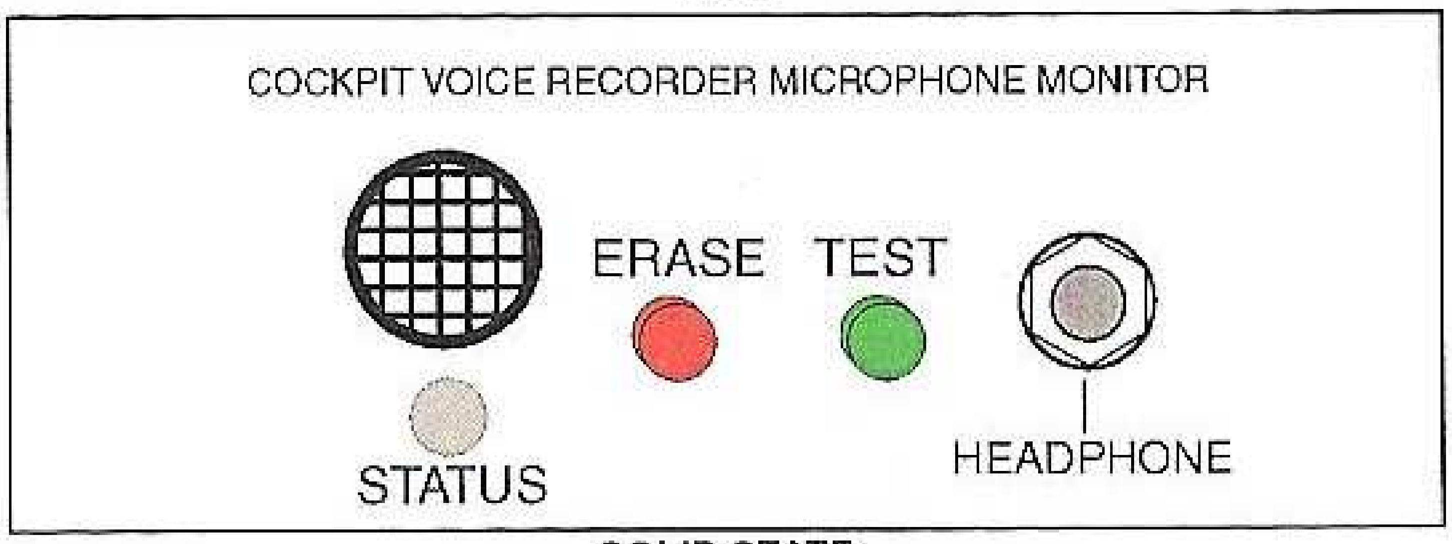
Door System Notes

- (3-4-5) overwing exits are a type III plug hatch
  - differential pressure holds the door against the door stops
  - a door must move inboard and down to clear the door stops to open
  - the latch handle and a pressure vent panel are connected to a common torque tube
  - when the cabin is pressurized, the vent panel resists opening the door latch handle
  - cabin pressure must vent before you can move the door latch handle to open

COCKPIT VOICE RECORDER (CVR)



TAPE



SOLID STATE

AREA MICROPHONE

- picks up cockpit area conversations, anytime 115V AC is on aircraft
  - (3-4-5) transfer Bus 1
  - (NG) transfer Bus 2

MONITOR INDICATOR

- pointer deflection confirms recording or erasure on all four channels (approximately 1 sec delay)
- during test the pointer rises into the green band

Voice Recorder TEST switch

- press - after slight delay, observe the monitor indicator rise into the green band and dip momentarily while remaining in the green band as it switches between channels
  - an audio tone may be heard through a headset plugged into the headset jack
  - processors monitor test data for faults
  - when a processor finds a fault, it stops the signal to the meter and stops the tone

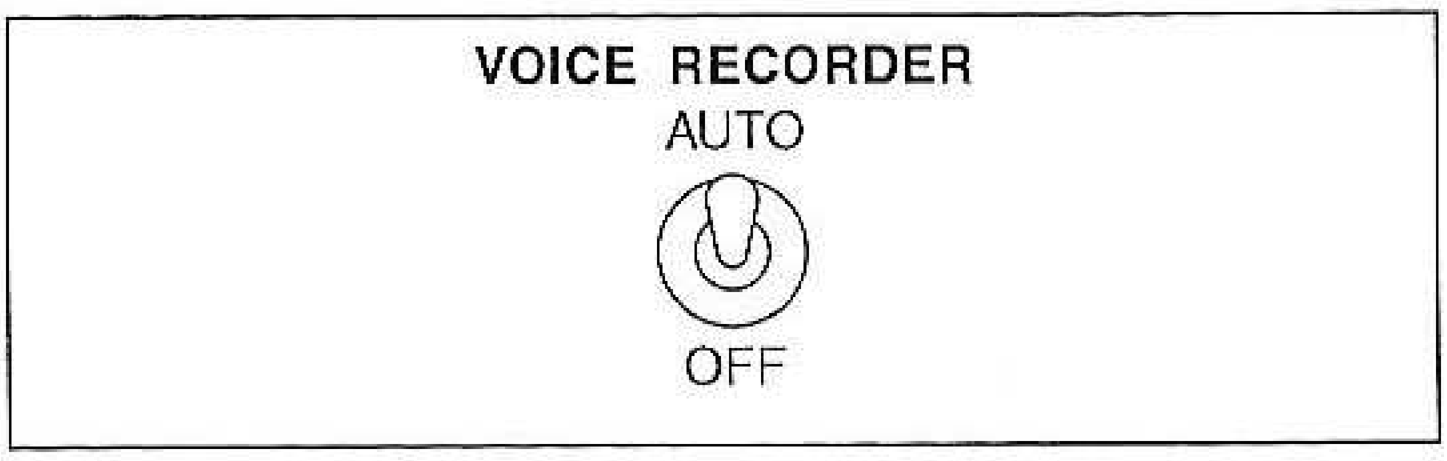
ERASE switch

- operative only when the airplane is on the ground and the parking brake is set
- press and hold for 2 secs - all four channels are simultaneously erased

HEADSET JACK

- headset may be plugged into the jack to monitor tone transmissions during test, or to monitor playback of voice audio

VOICE RECORDER switch (option)



AUTO powers the voice recorder from first engine start until 5 minutes after last engine shutdown

ON powers the voice recorder until first engine start, then trips the switch to AUTO

AREA MICROPHONE

- activated when engine is started or the Voice Recorder switch is placed to ON

STATUS light (green)

- momentary illuminates green when no faults are detected during recorder TEST

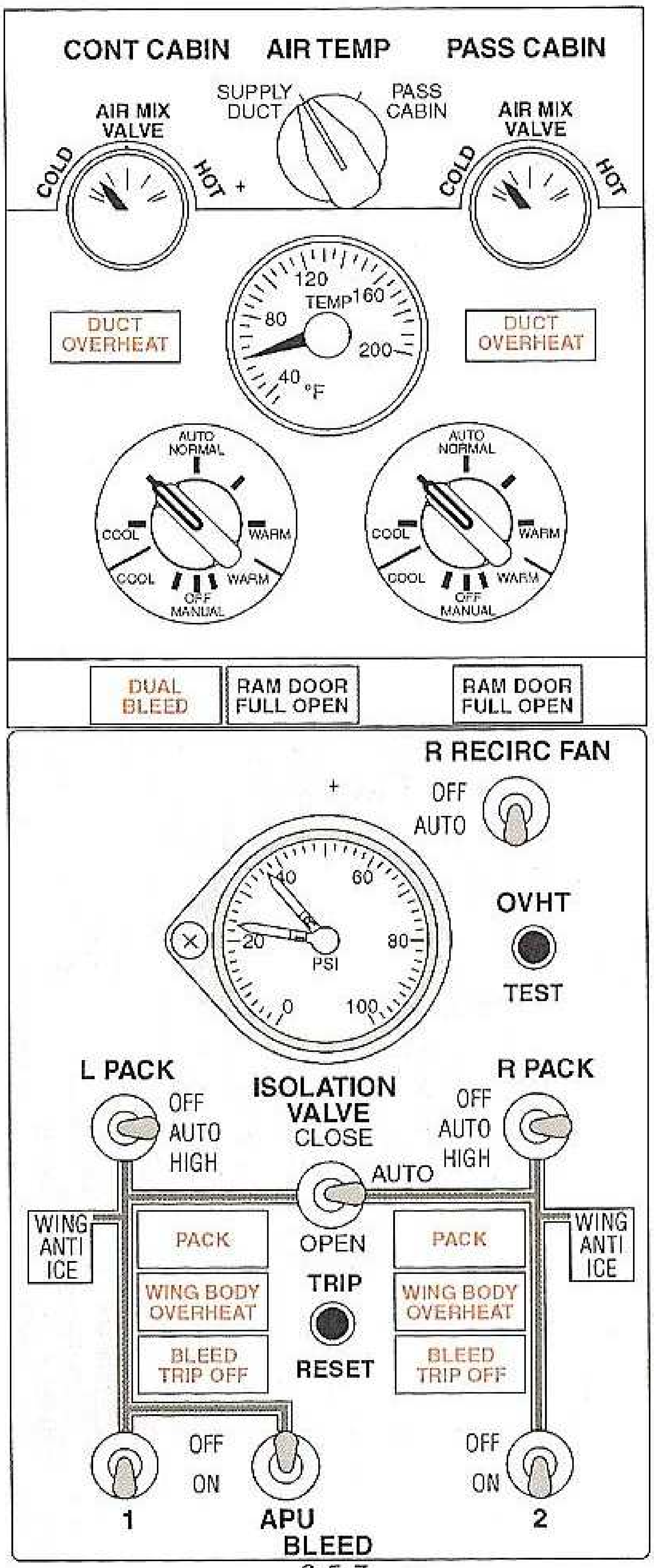
Voice Recorder TEST switch

- push: after a slight delay and no faults are detected
  - status light illuminates momentarily
  - a tone may be heard through a headset plugged into the headset jack

Cockpit Voice Recorder Notes

- tape based voice recorder
  - records and preserves a continuing record of the latest 30 minutes of flight crew communications and conversation.
  - four inputs for simultaneous recording of all communications in the cockpit on 4 track tape. Channel 1 receives audio from the first observer's audio selector panel, channel 2 receives audio from the first officer's audio selector panel and channel 3 receives audio from the captain's audio selector panel. Channel 4 audio is taken from a microphone in the voice recorder control panel
  - an erase head in the recorder automatically erases previously recorded information prior to recording. A 30-minute length of closed loop magnetic tape provides a record of the previous 30 minutes of conversation. An internal monitoring circuit ensures proper operation of the recording mechanism and circuits. Audible and visible indications derived from the monitoring circuits are presented at a meter and a jack on the control panel when the test switch on the control panel is operated. The entire tape may be erased after the airplane has landed and the parking brake has been set.
  - when the ERASE pushbutton is pushed for approximately 7 seconds, the recorder will erase the entire tape data
- solid state based voice recorder
  - records 4 separate channels simultaneously and stores the data in solid state memory for up to 120 minutes
  - Channels 1, 2, and 3 receive their audio from the audio management unit: channnel 1 receives first observer audio, channel 2 receives first officer audio, and channel 3 receives the captain audio. Channel 4 receives audio from a remote microphone in the overhead control panel
  - bulk erasure requires the ERASE switch be pushed a minimum of 1/2 second when the airplane is on the ground with the parking brake set. When the ERASE switch is released after being pushed, the header data is removed so the data can not be downloaded and a modulated sound is heard in the headset for 3 seconds
  - a successful erase function is indicated by the presence of a modulated sound for 3 seconds at the headphone jack.
- recordings automatically erased (although technology can resurrect erased recordings many layers deep)
- orange box is located in the aft right side of the aft cargo compartment
- underwater locator beacon on front of voice recorder

AIR CONDITIONING / PNEUMATICS



3-5-7

AIR TEMP SOURCE SELECTOR
(3-5-6-7)

SUPPLY DUCT
- selects main distribution supply duct sensor for temp
- if topping circuit is working properly, 60°C/140°F should be max you'd see here

PASS CABIN
- selects passenger cabin sensor for temp; measured at row #4

TEMPERATURE SELECTORS
(3-5-6-7) (L and R)
- flight deck (left) and passenger cabin (right)

AUTO
- temperature controlled automatically (max temp 60°C/140°F)
- for passenger cabin, by temp sensor in cabin ceiling, controller in electronic equipment bay

MANUAL
- moves mix valves manually (max 190°F)
- no topping circuit

TEMPERATURE INDICATOR
- indicates temperature at location selected with the AIR TEMP source selector
- °C or °F (carrier option)

AIR MIX VALVE INDICATORS
(3-5-6-7)
- indicates position of air mix valves
- left for cockpit, right for passenger cabin
- controlled automatically with temperature selector in AUTO, controlled manually with temperature selector in MANUAL
- air mix valves drive full cold anytime pack valve closes
  - pack off, bleed trip, duct overheat, or pack trip off

DUCT OVERHEAT light (amber) (3-5-6-7)
- temp in left or right duct is excessive (88°C/190°F)
- air mix valves drive full cold (does not close pack valve)

(QRH) Duct Overheat
- select a cooler temperature and press the TRIP RESET button. If duct temp increases rapidly or the mix valve indicator moves toward full hot, select MANUAL

DUAL BLEED light (amber)
- illuminated indicates
  - APU bleed valve is open and engine 1 bleed switch is ON or
  - APU bleed valve is open and engine 2 bleed switch is ON and isolation valve is open
  - when eng 1 bleed switch is ON and APU bleed switch is OFF, the DUAL BLEED light will go out when the APU bleed valve closes
- indicates that an engine and the APU both supply pressure to the pneumatic manifold
- power must be no higher than idle in case the APU bleed check valve fails

RAM DOOR FULL OPEN light (blue)

- ram door in full open position
  - on ground, or airborne with flaps extended, or airborne with flaps up but air conditioning pack requires maximum cooling
  - at all other times, ram doors modulate to maintain required cooling for heat exchangers
- ram air door modulation is a function of air/ground sensor, flaps, and compressor discharge temperature (dirty primary heat exchanger filter or ram air sys blockage)

GASPER FAN (option)

OFF - gasper fan signaled off

ON - increases airflow to individual gasper outlets in PSU

AIR TEMP SOURCE SELECTOR (4-8-9)

SUPPLY DUCT

- shows temperature of CONT CAB, FWD, or AFT zone SUPPLY DUCT

PASS CAB - shows temperature of FWD or AFT zone PASS CAB

PACK - selects L or R PACK temperature

TEMPERATURE SELECTORS (4-8-9)

CONT CAB, FWD CAB and AFT CAB

AUTO

- automatic temp control for the associated zones to approximately 70°F
- rotate toward C (cool) or W (warm) to set the temp (65°F - 85°F / 18°C - 30°C)
- failure of a temp selector will cause default to a 75°F (24 °C)

OFF

- closes the associated trim air modulating valve
- any individual zone switched OFF
  - temp selector setting will be ignored by the temperature control system
- all three temp selectors positioned OFF
  - the left pack maintains a fixed temperature of 75°F (24°C)
  - the right pack maintains a fixed temperature of 65° F (18°C)

(MEL) Pack Temp Control System (4-8-9-B2) - ATA 21

- one of the pack control systems may be inop provided the other (primary or standby) pack temp control is checked to operate normally.
- press recall. The affected PACK light, the AIR COND annunciator light and the MASTER CAUTION light will illuminate
- press MASTER CAUTION. If the affected PACK light, the AIR COND annunciator light and the MASTER CAUTION light extinguish, the affected pack temp control sys will operate normal

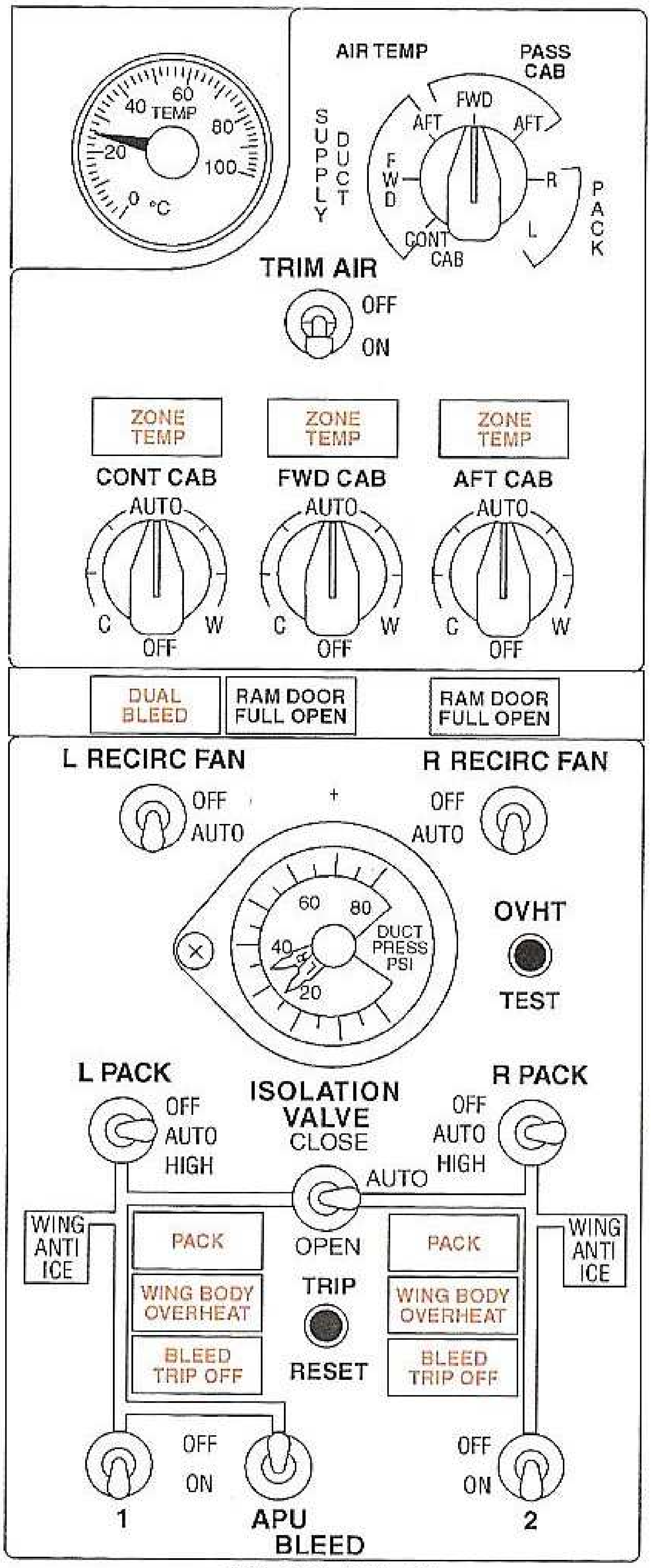
TRIM AIR switch (4-8-9)

ON

- trim air pressure regulating and shutoff valve signaled open
  - allows bleed air from upstream of the packs to be directed to the three trim air modulating valves
- enables the zone trim air channels in the pack/zone temperature controllers

OFF

- trim air pressure regulating and shutoff valve signaled closed
  - the three zone trim air systems are mechanically and electrically disabled
- left and / or right electronic controllers will control both packs independently
  - the left pack will provide air in response to the CONT CAB selector to establish the temp for the flight deck
  - the right pack will average the demands of the FWD and AFT zones



-400 -800 -900 -B2

ZONE TEMP lights (amber) (4-8-9)

- immediate illumination of the CONT CAB ZONE TEMP indicates a duct temp overheat or complete failure of the flight deck primary and standby control system (dual failure)
  - a failure of the primary or standby flight compartment temperature control or a malfunction in the system causes the CONT CAB ZONE TEMP light and AIR COND annunciator to come on only when the MASTER CAUTION system is recalled
- immediate illumination of the FWD CAB or AFT CAB ZONE TEMP indicates duct temp overheat
  - failure of the passenger zone temperature control causes the ZONE TEMP light to come on only when the MASTER CAUTION system is recalled
  - associated trim air mod. valve closes and cold air then flows through the duct to cool it
- select a cooler temp for the zone and press the trip reset button
  - if the air in the duct continues to overheat, a pack trip will occur
- FWD CAB or AFT CAB and AIR COND annunciator illuminate after a MASTER CAUTION recall if the associated zone temp control has failed
- if lights extinguish when MASTER CAUTION is reset, dispatch is permitted

RECIRC FAN switch(es)

AUTO

Right Recirc Fan (all)
- 1 pack HIGH or AUTO, fan is on
- both packs OFF or AUTO, fan is on
- either pack in HIGH, the fan shuts down

Left Recirc Fan (4-8-9)
- an additional recirc fan improves air circulation in the aft fuselage
- in flight...
  - both packs in AUTO, both fans are on
  - either pack in HIGH, the left recirc fan shuts down
  - both packs in HIGH, both fans shut down
- on the ground...
  - pack switches OFF, both recirc fans will run
  - both packs in AUTO, both recirc fans are on
  - either pack in HIGH, both recirc fans continue to run
  - both packs to HIGH, only the left recirc fan shuts down, the right continues to run

PNEUMATIC DUCT PRESSURE INDICATOR
- indicates pressure in the left and right pneumatic ducts

(L/OP) Air Cond. and Press, Start Pressure

(3-4-5) for engine start, min of 30 psi at sea level (minus 1/2 psig per 1000' above SL)
- min pressure for max cooling: 20-25 psi
- min pressure for 2 pack operation from 1 bleed source: 20-25 psi

AIR CONDITIONING PACK switch (L and R)

AUTO *normal airflow rates (3-5-6-7) appx. 55 lbs/min* (4-8-9) *appx. 75 lbs/min*
- with both packs operating, each pack regulates to normal air flow (normal scenario)
- with one pack operating, that pack regulates to high flow in-flight with flaps up
  - on the ground, or in the air with flaps extended, auto switch to high flow is inhibited with 1 pack operating for better single engine performance
- when operating one pack from the APU, such as during a bleeds-off takeoff, pack will auto switch to high airflow rate if both engine bleed switches are OFF
- in flight, if a pack shuts down from an overheat or a L or R pack switch is OFF, the operating pack switches to high flow mode

HIGH *high airflow rates (3-5-6-7) appx. 80 lbs/min* (4-8-9) *appx. 105 lbs/min*
- pack regulates to high airflow mode

APU *high airflow rates (3-5-6-7) appx. 100 lbs/min* (4-8-9) *appx. 130 lbs/min*
- regulates to APU high flow mode when the aircraft is on the ground, APU bleed is ON and either or both pack switches are in HIGH
- provides max airflow with APU as only source of bleed air

(L/OP) Air Cond. and Press, Bleeds and Packs
- with both engine bleeds ON, both packs must be set to AUTO or OFF for takeoff, approach, and landing

(MEL) Pack Inop - ATA 21
- one may be inop provided flight remains at or below FL250 (-900 check your MEL)
  - APU will supply more air than engine bleed when flaps are extended

ISOLATION VALVE switch

CLOSE / OPEN - isolation valve is closed or opened

AUTO - isolation valve is open if any corner switch (pack or bleed) is in OFF position
  - isolation valve is closed if all corner switches are ON, which is normal
- valve AC operated from transfer bus #1; fails in last position
- isolation valve is switch sensitive; not affected by position of APU bleed switch

PACK TRIP OFF lights (3-5-6-7) PACK lights (4-8) (L and R) (amber)
- indicates respective pack trip off
  - function of turbine inlet ovht, pack discharge ovht, or compressor discharge ovht
  - related pack valve closes (3-5-6-7) which drives the mix valve full cold
  - if ACM is working too hard to cool cabin, set to warmer temp
  - if duct gets too hot in warming cabin, set to cooler temp
  - can be caused by dirty heat exchangers
  - requires use of TRIP RESET after condition has been corrected

(4-8) adds these functions (does not have mix valves)
  - both primary and standby pack controls have failed for the associated pack
  - during MASTER CAUTION recall, if the PACK light illuminates, indicates failure of either primary or standby pack control - extinguishes when MASTER CAUTION is reset

WING BODY OVERHEAT light (L and R) (amber)
- LEFT: indicates overheat from a bleed air duct leak in the left engine pylon, left inboard wing leading edge, left air conditioning bay, keel beam or APU bleed air duct
- RIGHT: same items as above except no keel beam or APU bleed air (right engine strut, right inboard wing leading edge, right air conditioning bay)
- TRIP RESET switch will not reset this light
- no valves close automatically when this light comes on
- direct sunlight on a hot day for an extended period of time may cause a faulty indication; turn off all bleed sources to verify indication

FORWARD OVERHEAD PANEL

WING-BODY OVERHEAT TEST switch
- pressing does a check of the continuity of the sensing elements
  - if the sensing element has continuity both WING-BODY OVERHEAT lights illuminate
- there is no difference between a real alarm and a short circuit

BLEED TRIP OFF light (L and R) (amber)
- excessive engine bleed air temp (490°F) or pressure (220 psi)
- engine bleed valve closes
- related pack flow control & SOV closes, (3-5-6-7) which drives the mix valve full cold
- light remains illuminated until TRIP RESET switch is pushed
- after this light comes on, you will see zero pressure on that side of the system
- if trip during takeoff, especially a bleeds-off takeoff, it's probably excessive pressure
- overpressure bleed trip (instant reset when power is reduced)
  - failure of the high stage valve or high stage regulator
- overtemperature bleed trip (delayed reset due to cool-down time)
  - failure of precooler, precooler valve, or related thermostat(s)

(QRH) Bleed Trip

WING ANTI-ICE SWITCH ....OFF
- wing anti-ice use at high altitude may cause bleed trip

TRIP RESET BUTTON ....PRESS

If the BLEED TRIP OFF light remains illuminated

PACK (AFFECTED SIDE) ....OFF
- this opens the isolation valve while preventing two pack operation on a single bleed source and ensures the remaining pack switches to high flow

(QRH) Dual Bleed Trip
- operating the wing anti-ice at altitudes above those normally associated with icing conditions may cause a two-engine bleed trip
  - normally wing anti-ice is not required at high altitudes because any moisture will be frozen and ice particles will not adhere to the wing
- initial reset of a dual bleed trip may be unsuccessful
- turn the wing anti-ice switch off before resetting the trip

TRIP RESET switch
- press if the fault condition has been corrected (does not reset the WING-BODY OVERHEAT)
  (3-5-6-7) resets: DUCT OVERHEAT, PACK TRIP OFF, and BLEED TRIP OFF
  (4-8) resets ZONE TEMP, PACK, and BLEED TRIP OFF
- lights remain illuminated until reset

ENGINE BLEED AIR switch (L and R)

OFF - closes the pressure regulator and SOV

ON - opens the PRSOV if the engine is operating
- DC powered but requires air pressure to open; closes at engine shutdown

(MEL) Engine Bleed Valve - ATA 36
- except for ER ops, may be inop provided valve is secured closed before engine start and airplane is not operated in known or forecast icing conditions

(MEL) High Stage Valve - ATA 36
- one may be inop locked closed provided a minimum of 60% N1 is maintained on the associated engine during flight in icing conditions

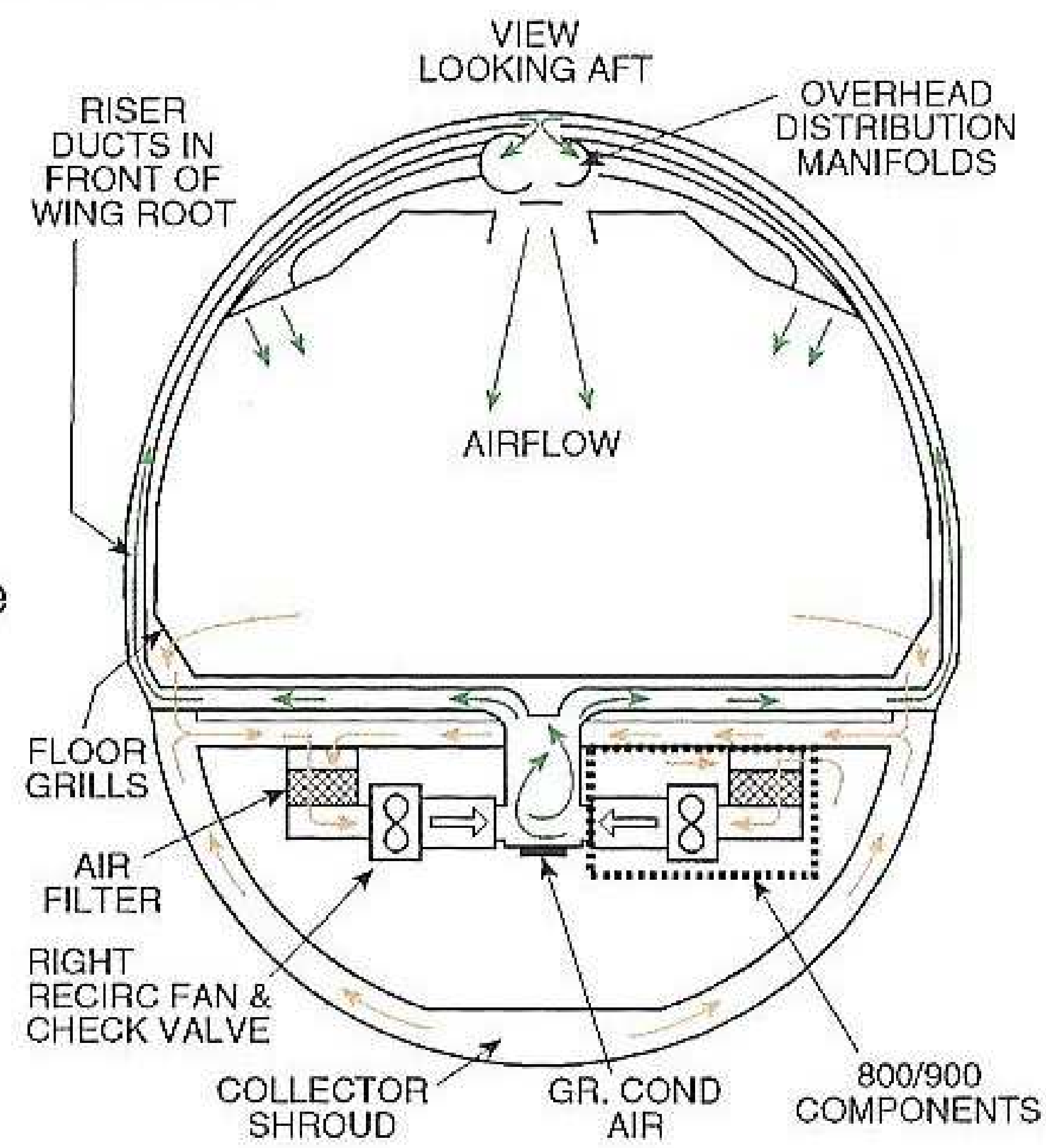
APU BLEED AIR switch

OFF - closes the APU bleed air valve
- turning APU start switch OFF also closes APU bleed valve DUAL BLEED light goes out

ON - opens the bleed air valve
- DC power (control) and APU load compressor air required to open and stay open

Air Conditioning System Notes

1. packs
   - engines, APU, or ground cart are sources for left and right packs
   - (3-5-6-7) distribution system has 2 independent temp control zones, cockpit and cabin
   - left pack supplies 20% to cockpit / 80% to mix manifold, right pack 100% to manifold
     - the amount of hot air that the flight deck gets in comparison to the manifold is less
     - sensors are placed on that smaller duct; it will overheat sooner than the right pack
   - smoke in cockpit air conditioning would most likely come from the left pack
   - flow control and SOV is DC controlled but requires air to open (spring loaded to close)
     - modulates to decrease flow rate as altitude increases
2. recirc fan(s)



   - reduces bleed demand by the packs by increasing the air flow to the cabin
     - 3 phase AC; moves approx. 830 cubic ft of air per minute
     - recirculates conditioned air from around the forward cargo compartment into the distribution manifold where the air mixes with the air supplied by the packs
     - after APU, fan(s) is a candidate for smoke

   (3-5-6-7) one recirc fan (4-8-9) two recirc fans (left draws air from distribution bay)
   - max ventilation in flight
     - left and right pack switches to HIGH, recirc fans OFF, landing altitude 10,000 ft
3. air cycle machine (ACM)
   - decreases air temperature by expansion through a turbine
   - the flow control shutoff valve controls the flow of bleed air into the pack where it first enters the primary heat exchanger
   - as the bleed air goes through the heat exchanger, ram air removes heat
   - this cooled bleed air next enters the ACM compressor inlet
   - the compressed air then goes to a secondary heat exchanger and back to the ACM
   - the air leaves the ACM, goes to the mix muff, then goes into the water separator
   - the water separator collects and removes moisture from the air before it goes into the distribution system
4. turbo fans (3-4-5)
   - located in each ram air exit duct upstream of exit louvers and augments ram air flow
   - operates on ground or during slow-flight with flaps not fully retracted
   - electrically activated when pack is on; pneumatically operated using bleed air

   (NG) when the a/c is on the ground, the ACM pulls air through the heat exchangers and up through the plenum to the impeller fan and out the ram air exhaust
   - deflector door extended by air/ground safety switch helps prevent ice and rock ingestion
5. pre-conditioned air (ground)
   - when ground-preconditioned air is utilized as the source for cool air, the pack switches and recirc fan(s) should be off
     - with the recirc fan off, air will not be circulated through the EE bay
6. pack temp control (4-8-9)
   - two electronic pack controllers command the pack temp control valve
   - each pack (left and right) has a primary and a standby pack controller
   - when the pack switches are in AUTO or HIGH, the left and right primary pack controllers control the position of the left and right pack temp control valves
   - pack temperature control valves are positioned such that the temperature demand of the zone requiring the most cooling is satisfied
   - if a primary pack control fails, the affected pack is controlled by the standby pack control in the opposite controller

- primary or standby pack control failure causes MASTER CAUTION and AIR COND annunciator lights to illuminate during recall. If pressing the MASTER CAUTION extinguishes the lights, the other pack control is operating
  - left pack control failure: left PACK light and two zone temp lights (CONT CAB and AFT CAB) on recall
  - right pack control failure: right PACK light and two zone temp lights (CONT CAB and FWD CAB) on recall
  - if both the primary and standby pack controls fail for the same pack, the PACK, MASTER CAUTION, and AIR COND annunciator lights illuminate. The pack will continue to operate without control unless excessive temperatures causes the pack to trip off
  - if all zone controls and primary pack controls fail, the standby pack control commands the packs to produce temps which will satisfy the average temp demand of the two cabin zones. The CONT CAB zone temp selector has no affect on stby pack control

PACK CONTROLLER FUNCTIONS

LEFT ELECTRONIC CONTROLLER	RIGHT ELECTRONIC CONTROLLER
Left Primary PACK Control	Right Primary PACK Control
Right Stby PACK Control	Left Stby PACK Control
Back-up CONT CAB Zone Temp Control	Primary CONT CAB Zone Temp Control
AFT CAB Zone Temp Control	FWD CAB Zone Temp Control
Left Ram Air Control	Right Ram Air Control

7. trim air
   - pressure regulating and modulating / shutoff butterfly-type valve
     - spring-loaded to the closed position
       - electrically controlled and pneumatically actuated
       - maintenance can manually close the valve
     - supplies trim air to the three zone trim air modulating valves
   - pack or zone temperature controllers control the trim air modulating valves to inject hot trim air into the ducts of the other zones
     - this increases the temperature of the air supply to the 3 zones
   - any failure of the trim air sys will cause the packs to revert to independent operation
     - if the CONT CAB trim air is lost, the left pack will be controlled by the CONT CAB temperature selector and the right pack will be controlled to provide air at a temperature to satisfy the demand of the passenger cabin zone requiring the coolest air
     - if the trim air for either or both passenger cabin zones is lost, or the trim air switch is turned OFF, the left pack will be controlled by the CONT CAB temp selector and the right pack will supply air at an averaged temp for the FWD CAB and AFT CAB temp selectors
8. zone temp control
   - distribution system has 3 independent temp control zones, CONT CAB (flight deck), FWD CAB, and AFT CAB
     - CONT CAB is in the left air conditioning compartment
     - FWD CAB and AFT CAB are in the right air conditioning compartment
   - selector range is approximately 65°F(18°C) to 85°F(30°C)
   - the packs produce an air temperature which will satisfy the zone which requires the most cooling. Hot trim air is then added to the other two zones to increase the air temp to maintain the zone temp selected on the control panel
   - when the primary and standby CONT CAB zone controls fail, the zone temperature control system is off
     - the left pack/zone controller controls the left pack to satisfy the CONT CAB zone duct demand. The right pack/zone controller controls the right pack to satisfy the coolest temperature requirements for the passenger compartments
   - the passenger zones (FWD CAB, and AFT CAB) do not have backup control. If a FWD or AFT CAB zone temp control fails the associated trim air modulating valve will close. The temp selectors are operable but the temp output will be an average of the FWD CAB and AFT CAB selectors while the left pack will output air at the CONT CAB selected temp
   - if any individual zone temp selector is switched off, the signal from that switch will be ignored by the electronic controller

- if all three selectors are switched off, the left pack will maintain 75°F (24°C) and the right pack will maintain 65°F (18°C) as measured at the pack temperature sensor
- during single pack ops with the trim air selected on, the operating pack will supply air at a temperature to satisfy the zone that requires the most cooling. Trim air will be added to the two remaining zones to supply the selected temperature requested.
- during single pack ops with the trim air selected off, the pack attempts to supply air at a temperature to satisfy the average temp demands of all three zones

7. gasper air system
   - provides a supplementary source of air flow to each PSU
   - air flows from the main distribution manifold, through the gasper fan, up the gasper air distributioin risers (next to the main air conditioning risers) to the gasper air distribution ducts to the PSUs
     - does not take air from the cold side of the ACM as the -200 does
   - 115 vac motor operated fan is located in the gasper air distribution manifold
     - the fan may be run continuously without damage

Pneumatics System Notes

1. supplies pressurized air to the following systems and components:
   - engine starters, air conditioning and pressurization, engine and wing anti-ice, hydraulic reservoirs and potable water system, and airflow for aspirated TAT probe (option)
2. bleed air source is 5th stage engine bleed (lower pressure) when power is high and 9th stage (higher pressure) when the power is at reduced level
   - 5th stage air is not sufficient for pneumatic system demand at low engine speeds so 9th stage assists, such as idle, or for high demand (crossbleed start)
   - when retarding the throttle, the engine bleed air system goes from 5th to 9th stage bleed
     - the duct pressure may decrease to approximately 20 psi based on how quickly the high stage valve opens and regulates the bleed air
   - 9th stage high pressure valve is spring loaded closed
     - opens at idle, and closes at 35 psi
     - 9th stage is much hotter than 5th stage and therefore, requires more cooling
     - while the bleed system precooler will cool the air adequately at all altitudes when operating on 5th stage air, its capability is reduced when operating with 9th stage air
3. engine bleed valve
   - needs DC control and pneumatic force to open, spring force to close
   - acts as
     - a pressure regulator and shut off valve (PRSOV) using 5th and 9th stage bleed air
       - limits pressure to 45 psi at cruise and takeoff
     - a temperature regulator
       - over temp (490°F, 254°C) closes bleed air valve - indicates failure of precooler
       - BLEED TRIP OFF, AIR COND and MASTER CAUTION lights illuminate
     - closed during engine start by signal from start valve

DUCT PRESS CHART

CLASSIC

N1(%)	DUCT PRESS
Sea Level	
Idle (<21)	Min 18 psi
27–50	32 ±6 psi
50–56	32–42
56–100	42 ±8 psi
FL370	
Idle (<38)	Min 10 psi
53–84	32 ±6 psi
84–96	32–48
96–100	42 ±8 psi

NG

N1(%)	DUCT PRESS
Sea Level	
Idle (<21)	Min 18 psi
26–47	32 ±6 psi
47–52	32–42
52–100	42 ±8 psi
FL370	
Idle (<38)	Min 18 psi
52–78	32 ±6 psi
78–85	32–42
85–100	42 ±8 psi
FL410	
Idle (<42)	Min 18 psi
58–84	32 ±6 psi
84–93	32–42
93–100	42 ±8 psi

If duct pressure is less than charted, the high pressure valve is not opening

If duct pressure split <20 psi, no action req'd

If duct pressure split >20 psi, log book entry req'd

This discrepncy can be deferred by maintenance as long s neither indicator is indicating <20 psi or greater than >60 psi and the supplied air is sufficeint to maintain cabin pressurization

  - if, during the walkaround, you hear air coming out of the cowl, with APU bleed air supplying air to the pack(s), you have failed PRSOV seals on that side

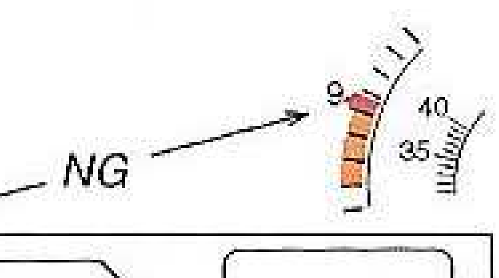
4. APU bleed switch / valve
   - 28 V DC - battery bus
   - valve is spring loaded closed (DC control and pneumatic pressure required to open)
   - when greater than 95% rpm, able to open bleed valve into the left duct
   - APU bleed switch must be off for crossbleed start
   - (3-4-5) must be on to pressurize water system for galley and sinks w/o engine bleed air
   - ground pneumatics connects into right duct
     - do not supply more than 60 psi of pressure to the pneumatic system
5. isolation valve
   - separates the manifold into left and right sides
   - AC operated and stays where it is with power failure
     - has a manual override lever for power-off operation
   - in AUTO, which is normal, with both engine bleeds ON and both packs in AUTO or HIGH, the isolation valve is closed (each engine supplies one pack)
     - this prevents a single pneumatic duct failure from loss of pressure to all of the manifold
   - in AUTO and either a pack or a bleed off, the isolation valve opens
     - when the isolation valve is in AUTO, if any of the "4 corner switches" (eng bleed or pack) are placed to OFF, the isolation valve will open
   - isolation valve looks at pack and bleed switches, not the valves; it's *switch sensitive*
   - *APU bleed switch has no effect on isolation valve position*

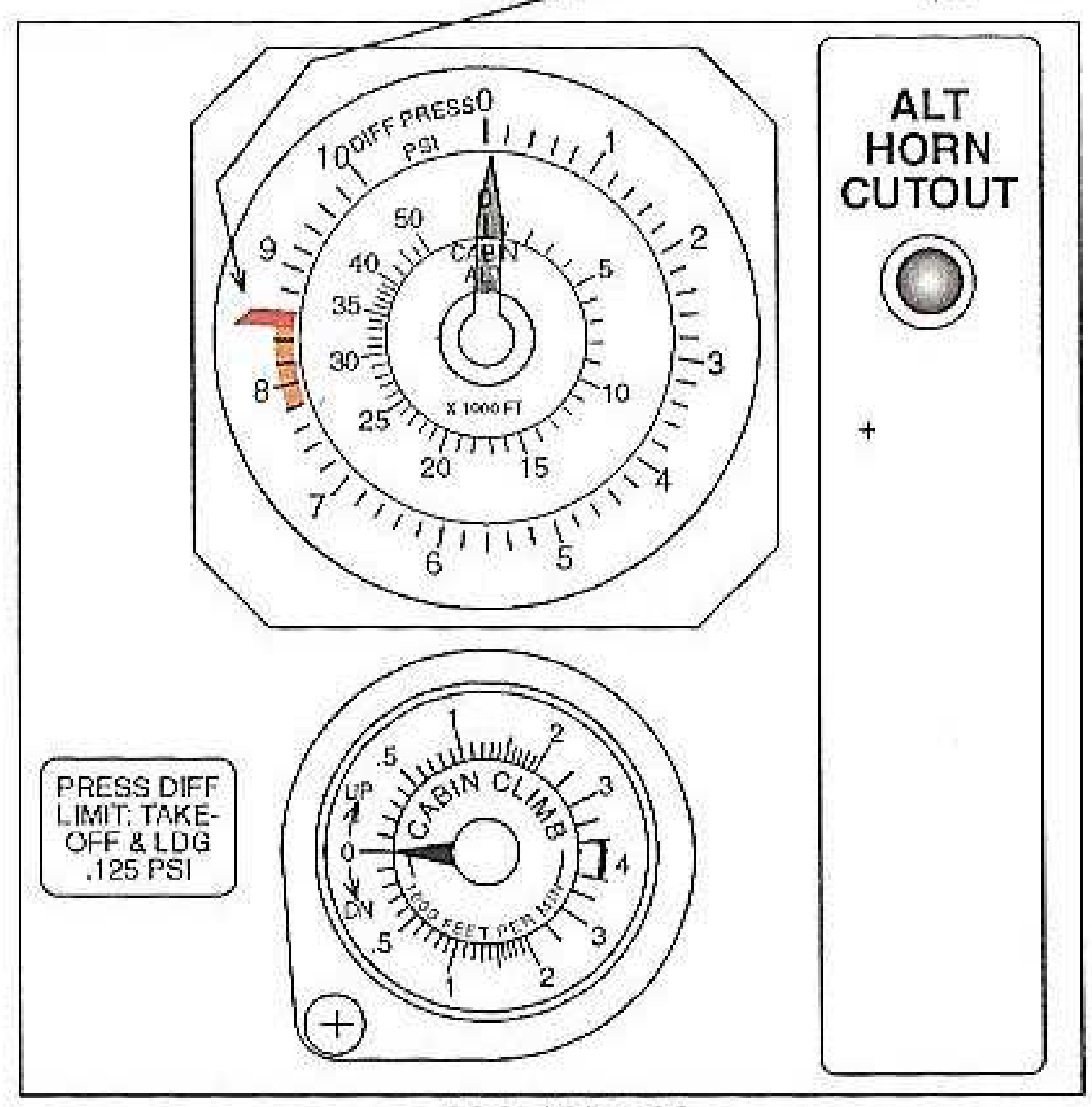
   (3-4-5)
     - for cooling, use only one pack from APU
     - for heating may use both packs since you don't use the ACM as much for heating

   (NG)
     - APU can supply enough air for both packs on the ground for cooling or heating
6. pneumatic pressure indicator requires AC power
   - at idle, normal duct pressure should be 26 to 38 psi
7. dual bleed provides chance of back-pressuring the APU
   - lights MASTER CAUTION and AIR COND annunciator
   - DUAL BLEED light is normal during engine start (but don't exceed idle power!)
8. bleeds-off takeoff (both bleeds OFF)
   - "counter clockwise C" for takeoff setup (both packs in AUTO, isol valve CLOSE, APU ON)
   - "clockwise C" for after takeoff cleanup, ("ON {pause}, OFF {pause}, ON, isol valve AUTO)
   - don't reconfigure after takeoff until after 2nd segment climb
9. smoke in cockpit or cabin
   - smoke or fumes flow into the cabin through the air distribution system is usually caused by contamination of the air by oil, glycol, fuel, or hydraulic fluid
     - in flight this can be caused by leakage of these fluids in one of the engines on the ground, the APU is a likely source of smoke or odors
10. ozone converter
    - keeps ozone concentrations to a satisfactory limit when the airplane is at high altitudes
    - is a catalytic device in the left and the right air conditioning compartments that removes ozone concentrations. Air goes through the converter before it goes into the pack
    - a chemical reaction in the converter changes ozone molecules to oxygen molecules
    - the ozone converter must be replaced after a period of in-use service

PRESSURIZATION

CABIN ALTIMETER / DIFFERENTIAL PRESSURE INDICATOR





-300-400-500

- inner scale: indicates cabin altitude in feet
- outer scale: indicates differential pressure between cabin and ambient in psi
- (NG) connected to alternate static system

(L/OP) Press, Max Differential Relief
- Max differential pressure limit (3-4-5) 8.65 psi (NG) 9.1 psi
- Max cabin diff. for Takeoff/Landing .125 psi

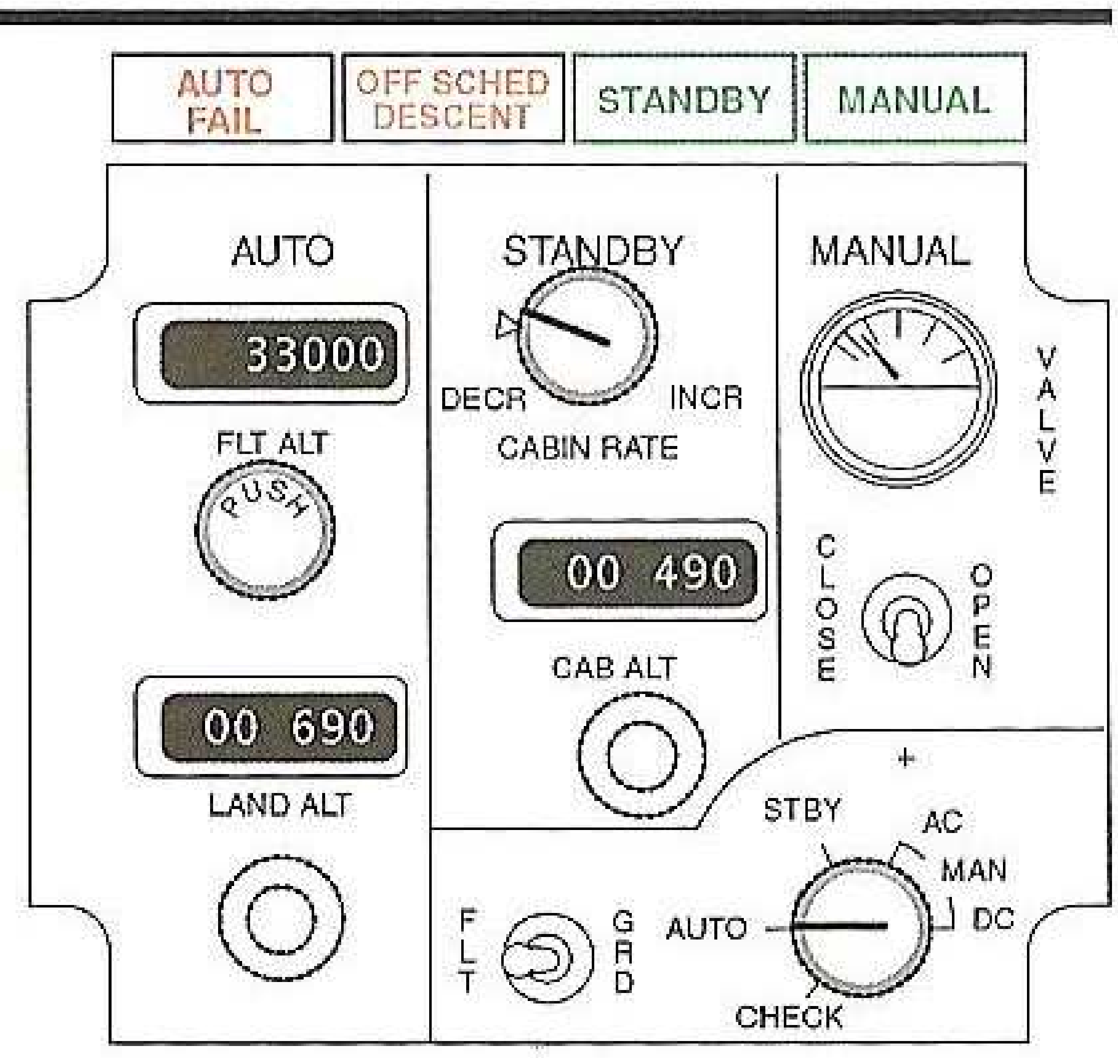
(L/OP) Press, Operating Differential Press
- operating differential psi:
  7.8 ±.1 psi above FL280 through FL 370
  7.45 ±.1 psi at or below FL280
  (NG) 8.35 ±.1 psi above FL370

CABIN RATE INDICATOR
- indicates rate of climb or descent in fpm, normally on descent the auto mode uses a maximum of 350 fpm; on climb, its maximum is 500 fpm
- detects pressure changes from a port on the back of the indicator

ALT HORN CUTOUT switch
- silences cabin altitude warning horn (horn sounds when cabin altitude reaches 10,000')

Two types of pressure controllers: Electronic and Digital
- (3-4-5) aircraft use the Electronic pressure controller
- (EFIS-option) and (NG) aircraft uses the Digital pressure controller
- both are described below

ELECTRONIC PRESS. CONTROLLER



AUTO FAIL light (amber)
- transfer to STBY occurrs automatically
- 3 causes:
  - loss of AUTO AC power for more than 15 sec.
    - if less than 12 sec. returns to AUTO
  - cabin alt 13,875 ft,
  - excessive cabin rate of pressure change
    - 1890 fpm or about 1.0 psi per minute
  - MASTER CAUTION and AIR COND illuminate

OFF SCHED DESCENT light (amber)
- airplane is descending prior to reaching cruise altitude (FLT ALT) with mode selector in AUTO
- controller programs the cabin to land at the takeoff field elevation
- If the FLT ALT is reselected or the FLT ALT reset is depressed during climb, the automatic cabin abort capability to the original takeoff field elevation will be lost

(QRH) Off Schedule Descent

FLT ALT AND LAND ALT .... RESET

STANDBY light (green
- pressurization system operating in standby mode

MANUAL light (green)
- pressurization system operating in manual mode

FLIGHT ALTITUDE INDICATOR
- shows selected cruise flight altitude
  - set before takeoff (00,000 to 40,000)

FLIGHT ALTITUDE SELECTOR
- push and rotate to set planned cruise altitude
- sets to nearest 100 ft
- if pushed during climbout, cancels "return-to-field" feature of OFF SCHED DESCENT

LAND ALTITUDE INDICATOR
- indicates altitude of intended landing field
  - set before takeoff (-990 to 13,990)

LAND ALTITUDE SELECTOR
- rotate to select planned landing field elevation
  - large diameter control sets nearest 1000'
  - small control sets nearest 10'

CABIN RATE SELECTOR
(standby rate selector)
DECR - cabin altitude rate of change equals 50 fpm
INCR - cabin altitude rate of change equals 2000 fpm
- index mark - cabin altitude rate of change equals 300 fpm

CABIN ALTITUDE INDICATOR
- indicates selected cabin altitude (-990 to 13,990)

CABIN ALTITUDE SELECTOR
- rotate to select desired cabin altitude
- large diameter control sets nearest 1000', small control sets nearest 10'
- for standby use: cruise, use placard chart; for TO and LDG, use landing field elevation minus 200'
- if you climb higher than this altitude, then the cabin will climb at 500 fpm, up to 7.9 psid. above 7.9, the cabin will climb with the aircraft

OUTFLOW VALVE POSITION IND
- indicates position of aft outflow valve; operates in all modes

OUTFLOW VALVE switch (spring loaded to center)
OPEN - opens main cabin outflow valve electrically, when using manual mode
CLOSE - closes main cabin outflow valve electrically, when using manual mode
- full travel: 7 sec in manual AC, 14 sec in manual DC

FLIGHT / GROUND switch
GND
- on the ground, drives outflow valve open at controlled rate, depressurizing aircraft
- inhibited after takeoff (functions same as FLT position)
- at touchdown, cabin altitude is held to 200 ft below selected destination until GND position is selected

FLT
- on the ground, pressurizes airplane to .1 psi
  - approximately 200 ft below airport elevation
- after takeoff, cabin pressure automatically controlled in climb and descent as function of airplane altitude
- in cruise, cabin pressure held constant
- this switch is effective with AUTO, STBY, and when the aircraft is on the ground

PRESSURIZATION MODE SELECTOR

CHECK - tests rate limit fault detector of the auto transfer

AUTO - airplane pressurization system controlled automatically
- altitude sensed from static ports and baro corrections from Capt altimeter
- AC motor is used

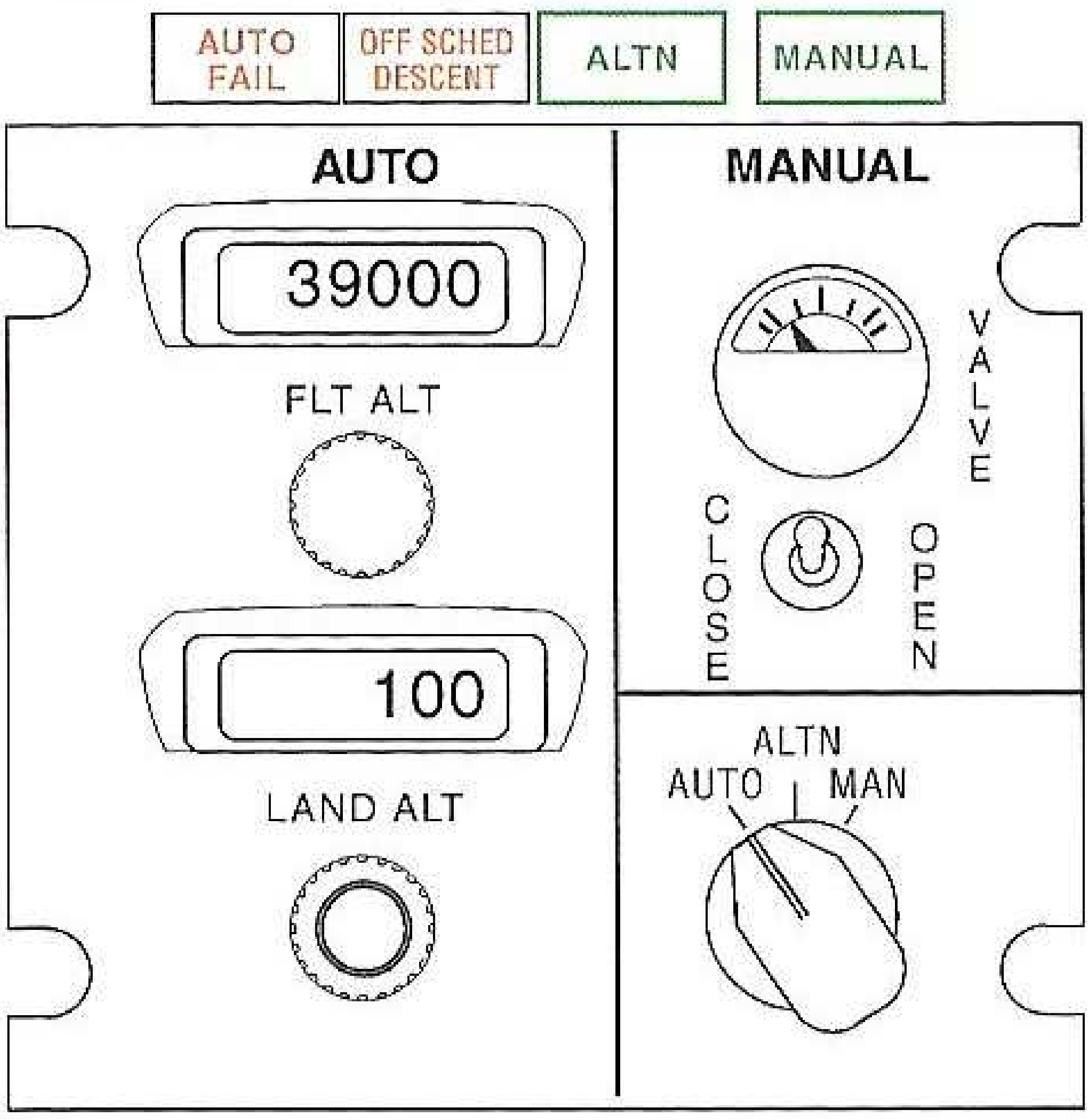
STANDBY - altitude sensed from ADC and barometric corrections from FO's altimeter
- on the ground, outlfow valve remains closed until pack is turned on; then modulates to maintain CAB ALT minus 200 ft
- requires cabin altitude rate of change and CAB ALT selections
- DC motor is used; maximum pressure differential is 7.8 psi

MANUAL - airplane pressurization controlled manually by outflow valve switch
- all auto and standby circuits are bypassed

AC - outflow valve operates from AC power which is a faster rate
- used by AUTO mode (full travel in 7 seconds)

DC - outflow valve operates from DC power; slower rate (half speed)
- used by STBY mode (full travel in 14 seconds)
- use for emergency evacuation

DIGITAL PRESSURIZATION CONTROLLER



AUTO FAIL light (amber)
- MASTER CAUTION and AIR COND annunciator lights come on
- causes:
  - loss of DC power,
  - pressure controller fault / failure,
  - outflow valve control fault
  - controller not responding properly
    - excessive diff press (>8.75 psi)
    - excessive rate of cabin pressure change (± 2,000 sea level ft/min)
    - high cabin altiitude (above 15,800 ft)
- transfer to ALTN occurrs automatically
  - moving mode selector to ALTN extinguishes the AUTO FAIL light; ALTN light remains illuninated
  - MASTER CAUTION and AIR COND annunciator also illuminate
- indicates a single controller failure when ALTN (green) light is also illuminated
- indicates both controllers have failed when AUTO FAIL (amber) illuminates alone
  - FLT ALT and LAND ALT will display 5 dashes
  - if you had a dual controller failure, you must physically go to MANUAL mode

OFF SCHED DESCENT light (amber)
- aircraft has started descent at least 1,000 ft prior to reaching cruise altitude (FLT ALT)
- MASTER CAUTION and AIR COND annunciator lights come on
- takeoff altitude is retained in memory and auto controller schedules descent for return to departure airport minus 300 ft
- off schedule descent feature is cancelled when the airplane gets to the FLT ALT

ALTN light (green)
- indicates pressurization system operating in alternate mode
  - selected automatically or manually
- if the mode selector is in AUTO, illumination of both the ALTN and AUTO FAIL lights indicate a single controller failure and automatic transfer to the ALTN mode

MANUAL light (green)
- pressurization system operating in manual mode, selected with mode switch

FLIGHT ALTITUDE INDICATOR
- shows selected cruise flight altitude
- set before takeoff (-1,000 to 42,000 in 500 ft increments)

FLIGHT ALTITUDE SELECTOR
- rotate to set planned cruise flight altitude

LAND ALTITUDE INDICATOR
- indicates altitude of intended landing field
- set before takeoff (-1000 to 14,000 in 50 ft increments)

LAND ALTITUDE SELECTOR
- rotate to select planned landing field elevation

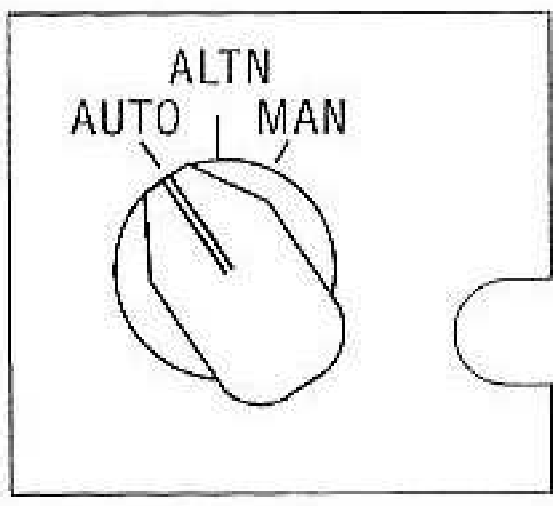
OUTFLOW VALVE POSITION IND
- indicates position of aft outflow valve; operates in all modes

> AUTO FAIL light illuminated
>
> ELECTRONIC SYSTEM
>
> The AUTO FAIL light illuminated indicates the automatic mode has failed. Illumination of the STANDBY light indicates the pressurization system has automatically changed to the standby mode.
>
> Pressurization Mode.................................... STBY
>
> Verify the AUTO FAIL light extinguishes.
>
> Set the cabin altitude with reference to the cabin/flight altitude placard. Before descent set landing field elevation minus 200 feet. Continue operation in STBY mode.
>
> DIGITAL SYSTEM
>
> The AUTO FAIL and ALTN lights illuminated indicates a single automatic controller has failed and an automatic transfer to the alternate automatic controller. Illumination of only the AUTO FAIL light indicates failure of both automatic pressurization controllers.
>
> Pressurization Mode.................................... ALTN
>
> Verify the AUTO FAIL light extinguishes.
>
> The ALTN light remains illuminated indicating selection of the alternate automatic pressurization controller. Continue operation in ALTN mode.

OUTFLOW VALVE switch
- spring loaded to center

OPEN - in manual mode, opens main cabin outflow valve electrically
- full range takes 20 seconds

CLOSE - in manual mode, closes main cabin outflow valve electrically



DIGITAL PRESS MODE SELECTOR

AUTO - airplane pressurization system controlled automatically using both ADIRUs
- the active controller changes with every flight or with an autofail event

ALTN - is the second of two digital cabin pressure controllers, so AUTO mode has dual redundancy
- the green ALTN light illuminates if ALTN is selected
- if AUTO FAIL is illuminated, it goes out when ALTN is selected
- controllers located in EE compartment and are interchangeable

MAN
- overrides and bypasses the two cabin pressure controllers
- has its own valve motor system for triple redundant architecture
- outflow valve full range takes approximately 20 seconds

CABIN / FLT ALTITUDE PLACARD
- used to determine setting for CAB ALT
- Example: in the event automatic mode is inop, and a flight is planned to FL220 using the Standby mode, set 1900 ft in the Cabin Altitude window after takeoff

CAB	-.3	.3	.8	1.4	1.9	2.4	2.9	3.4	3.9	4.4	5.0	5.0	5.1	5.6	6.0	6.4	6.8	7.2	7.6	8.0
FLT	18		20		22		24		26		28		30		32		34		36	

ALTITUDE X 1000 FEET - MAX PRESS SCHEDULE

(3-4-5)

CAB ALT	LAND ALT	2000	4000	6000	8000
FLT ALT	< FL160	FL220	FL260	FL320	FL410

(NG)

Pressurization System Notes

1. main outflow valve (aft)
   - regulated to exhaust only that additional quantity of air required to maintain the desired pressure in the cabin (galley and toilet vents are unregulated)
     (Analog Controller) one AC motor and one 28v DC motor
     - AUTO and MAN AC modes use AC motor; STBY and MAN DC modes use DC motor

     (Digital Controller) three different 28v DC motors (1 each for AUTO, ALTN, and MANUAL)
     - all use same actuator mechanism
   - signaled closed if
     (Electronic Controller) if cabin altitude exceeds 14,625 ft in STBY mode
     (Digital Controller) if cabin altitude exceeds14,500 ft AUTO and ALTN modes
     - this function does not affect manual mode of operation of outflow valve
2. flow control valve (3-4-5)
   - 4 " hole behind EE access door - warm air from EE bay is discharged overboard
   - spring loaded open during ground operation, unpressurized flight, and pressurized flight below a cabin differential pressure of approximately 2.5 psi
   - when the flow control valve closes, air is directed around the forward cargo compartment liner for in-flight heating
3. overboard exhaust valve (OEV) (NG)
   - is a pneumatically controlled pressure regulated air shutoff valve
   - 4 " hole behind EE access door on belly - air from EE bay is discharged overboard
   - 3 modes: *normal mode, high flow mode* and *smoke clearance flow mode*
     normal flow mode
     - when differential pressure is low, OEV is spring-loaded open
     - fully closed when the differential pressure is more than 1 psi; exhaust air is then discharged under the fwd cargo compartment floor for in-flight heating

     high flow mode
     OEV opens to allow for increased ventilation when all these conditions occur:
     - either pack is in HIGH,
     - (6-7) recirc fan is in AUTO (the recirc fan turns off automatically),
     - (8) right recirc fan is in AUTO (the left recirc fan turns off automatically),
     - main outflow valve has supplied "open enable" command

     smoke clearance flow mode (smoke control relay)
     28 vdc actuator overrides pneumatic control to open OEV to clear smoke from the EE compartment when all these conditions occur:
     - either pack is in HIGH,
     - (6-7) recirc fan is turned OFF,
     - (8) right recirc fan is turned OFF
4. forward outflow valve (3-4-5)
   - approximately 6' under first cabin window on left side of aircraft
   - discharge exit for air circulated around the forward cargo compartment
     - closes when the main outflow valve is within 0.5° of the full-closed position
     - closes when the recirc fan (right recirc fan on -400) is operating
     - opens when the main outflow valve opens approximately 4.5°
     - opens if the recirc fan is not operating
     - component of the cargo heating system and does not affect the pressurization control system
   - when aircraft has full passenger load, air can be "freshened" by placing right pack to HI
     - this turns the recirc fan off and opens the forward outflow valve, adding more fresh air to the pressure vessel
5. air/ground sensor (3-4-5)
   - if the aircraft did not sense the air mode, AUTO controller will maintain departure field elevation minus 200 ft until reaching 7.45 psid, then it would maintain 500 fpm climb. Above 7.9 psid, the cabin would climb with the aircraft

FORWARD OVERHEAD PANEL

6. Displays Control Panel annunciation (early production NG)
   - if the Captain's EFIS Control Panel fails, the barometric corrections to the AUTO and ALTN digital controllers are lost
     - a DISPLAYS CONTROLS PANEL annunciation is displayed on the Captain's PFD/EFIS
     - the pressurization system AUTOFAIL will illuminate
     - select DISPLAY switch to BOTH ON 2
7. pressurization relief valves
   - two safety relief valves prevent overpressurizing the airplane
     - located on each side of main outflow valve

     (3-4-5) limits differential pressure to 8.65 psi

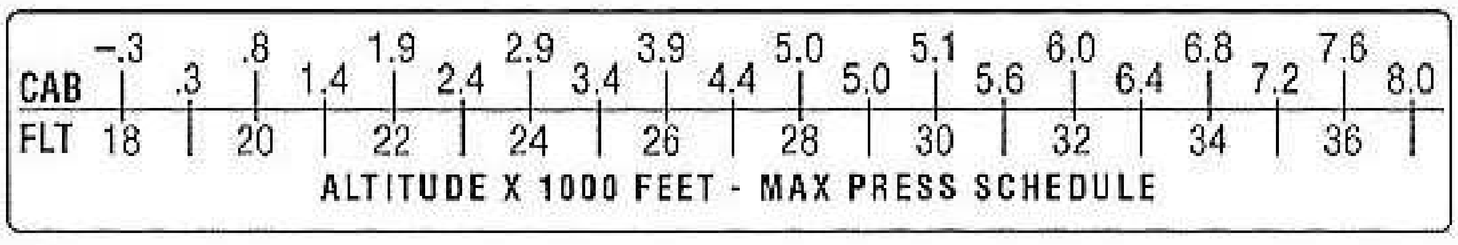
     (NG) limits differential pressure to 9.1 psi
   - vacuum relief valve prevents pressure inside the airplane becoming less than ambient
     - can be checked during walkaround by pushing door inward
   - pressure equalization valves are installed in both cargo compartments to provide a quick method of allowing cargo compartment pressure to vary, within limits, with cabin pressure
   - blowout panels in the forward bulkhead, aft bulkhead and ceiling of the forward cargo compartment and ceiling of the aft cargo compartment protect the respective structure from sudden differential in pressure between the cargo compartment interior and exterior
8. pressurization phases of flight
   - takeoff phase
     - pressurizes airplane to approximately 0.1 psid below field elevation when either of these conditions exist:
       - (Digital) both engine N1s > 60% or both engines N2s > 89%
       - (Electronic) FLT / GRD switch is in FLT position
   - climb phase
     - when the air/ground system indicates that the left and right landing gear are in the air, the climb phase starts
     - auto controller maintains a proportional pressure differential between airplane and cabin altitude
     - by increasing altitude at a rate proportional to cabin climb rate, cabin altitude change is held to the minimum rate required
     - climb rate is controlled to max of 600 fpm
   - cruise phase
     - activated when the airplane climbs to within 0.25 psi of the selected FLT ALT
     - during cruise the controller maintains the cabin altitude slightly below the selected LAND ALT at the schedule in the chart
     - deviations from flight altitude may cause the pressure differential to vary

SCHEDULE	PSI
SEA LEVEL to 18,500 ft	Landing Field Elevation
18, 500 ft to 28,000 ft	7.45 psid
28,000 ft to 37,000 ft	7.80 psid
37,000 ft and above	8.35 psid

   - descent phase
     - activated when the airplane descends 0.25 psi below selected FLT ALT
     - cabin begins a proportional descent to slightly below the selected LAND ALT
     - the maximum cabin pressurization rate of change for pressurization is 350 fpm
     - the system will pressurize the cabin to 0.15 psid below the LAND ALT so that rapid changes in altitude during approach result in minimum cabin pressure changes
   - landing phase
     - after landing, the outflow valve modulates to depressurize the airplane at a rate of 500
       - (NG) air/ground logic (from PSEU) indicates that both main gear are on the ground
     - both engine N1s < 50% and engine N2s < 84% (or both engines not running)
     - when the cabin pressure is the same as the local ambient pressure, the outflow valve opens

9. Standby and Manual Pressurization check (analog controller)
   - MODE SELECTOR ....STBY
     - verify standby light on
   - CABIN RATE ....FULL INCREASE
   - CABIN ALTITUDE ....SET 500 FT BELOW FIELD ELEVATION
   - FLT / GND SWITCH ....FLT
     - verify outflow valve goes to full close
   - CABIN ALTITUDE ....SET MINIMUM 500 FT ABOVE FIELD ELEVATION
     - verify outflow valve moves to full open
   - MODE SELECTOR ....MANUAL DC
     - verify MANUAL light on and AUTO FAIL, OFF SKED DESCENT, and STANDBY lights extinguished
     - toggle outflow valve switch towards close, verify valve movement
   - FLT / GRD SWITCH ....GRD
     - hold outflow valve switch towards close, verify steady valve movement
   - MODE SELECTOR .... AUTO
     - verify outflow valve moves full open
     - all lights off
     - return STANDBY CABIN RATE to index

10. STANDBY / ALTN Mode Operations
   - Before start
     PRESSURIZATION MODE SELECTOR..STBY
       STBY light illuminated
     CAB ALT SELECTOR ....SET
       SET TO TAKEOFF FIELD ELEVATION MINUS 200 FT
     FLT GRD SWITCH...GRD
       OUTFLOW VALVE WILL CLOSE
     CAB RATE SELECTOR .... INDEX
   - AFTER START
     AIR CONDITIONING PACK SWITCHES .... AUTO
       OUTFLOW VALVE MODULATES
     FLT GRD SWITCH ....FLT
       - this causes the outflow valve to move toward close, pressurizing the airplane to .1 psi (200 ft below field elevation).
       - With ALTN, the airplane will pressurize automatically after the engines have reached 60% N1 during takeoff
   - AFTER TAKEOFF
     CAB ALT SELECTOR .... SET AS REQ'D
       - EXAMPLE: FLIGHT PLANNED TO FL350, SET 7200 FT



     CAB RATE SELECTOR .... ADJUST
   - BEFORE DESCENT
     CAB ALT SELECTOR ....SET
       SET CAB ALT TO LANDING FIELD ELEVATION MINUS 200 FT
   - DESCENT
     CAB RATE SELECTOR .... ADJUST
   - AFTER LANDING
     FLT GRD SWITCH ....GRD

(QRH) Unpressurized Takeoff and Landing (3-4-5)

- may be a little noisier inside the airplane because the doors are not pressed against the door seals
- BEFORE TAKEOFF
  AIR CONDITIONING PACK SWITCHES .... BOTH AUTO
  ISOLATION VALVE SWITCH .... CLOSE
  ENGINE BLEED AIR SWITCHES .... OFF
  CAB ALT SELECTOR .... SET
    set 2,000 feet above field elevation
  CAB RATE SELECTOR .... INDEX
  PRESSURIZATION MODE SELECTOR .... STBY
  FLT GRD SWITCH .... FLT
- AFTER TAKEOFF, AT NOT LESS THAN 400 FT. AND PRIOR TO 2,000 FT ABOVE FIELD ELEVATION:
  NO 2 ENGINE BLEED SWITCH .... ON
  NO 1 ENGINE BLEED SWITCH .... ON
  ISOLATION VALVE SWITCH .... AUTO
  PRESSURIZATION MODE SELECTOR .... AUTO (AS REQUIRED)
  - in case of engine failure, do not switch bleeds prior to 1500' or obstruction clearance height
- LANDING
  WHEN BELOW 10,000 FT:
  CAB ALT SELECTOR .... SET
    set 1,500 ft above landing field elevation
  CAB RATE SELECTOR .... INDEX
  PRESSURIZATION MODE SELECTOR .... STBY
- WHEN STARTING APPROACH
  ENGINE BLEED SWITCHES .... OFF
    avoid high rates of descent for passenger comfort

Unpressurized Takeoff and Landing (NG)

- may be a little noisier inside the airplane because the doors are not pressed against the door seals
- Before takeoff
  AIR CONDITIONING PACK SWITCHES .... BOTH AUTO
  ISOLATION VALVE SWITCH .... CLOSE
  ENGINE BLEED AIR SWITCHES .... OFF
- After takeoff, at not less than 400 ft. and prior to 2,000 ft above field elevation:
  NO 2 ENGINE BLEED SWITCH .... ON
  - in case of engine failure, do not switch bleeds prior to 1500' or obstruction clearance height
- when cabin rate of climb indicator stabilizes
  NO 1 ENGINE BLEED SWITCH .... ON
  ISOLATION VALVE SWITCH .... AUTO
- Landing
  When below 10,000 ft and starting final approach turn
  ENGINE BLEED SWITCHES .... OFF
  - avoid high rates of descent for passenger comfort

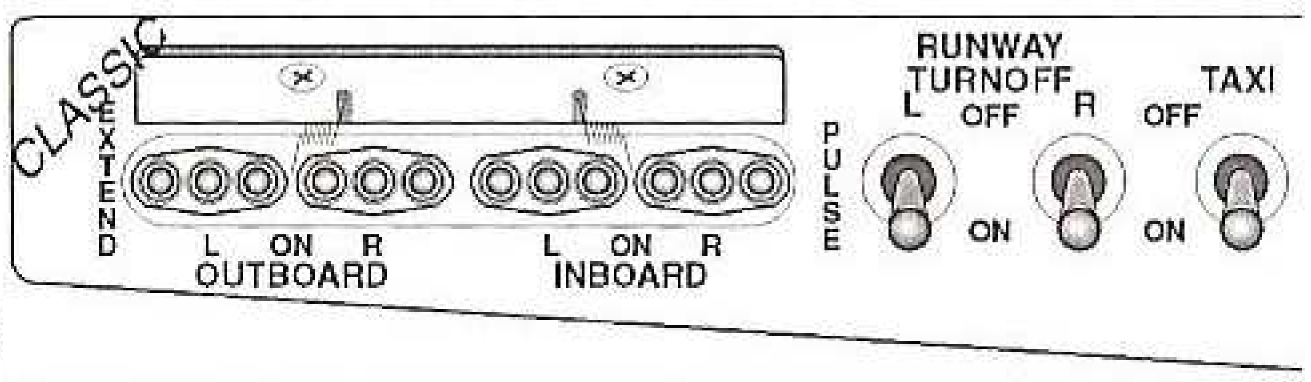
EXTERIOR LIGHTS

LANDING lights

RETRACTABLE landing lights
- (3-4-5) OUTBOARD mechanically stays parallel to earth regardless of flap setting

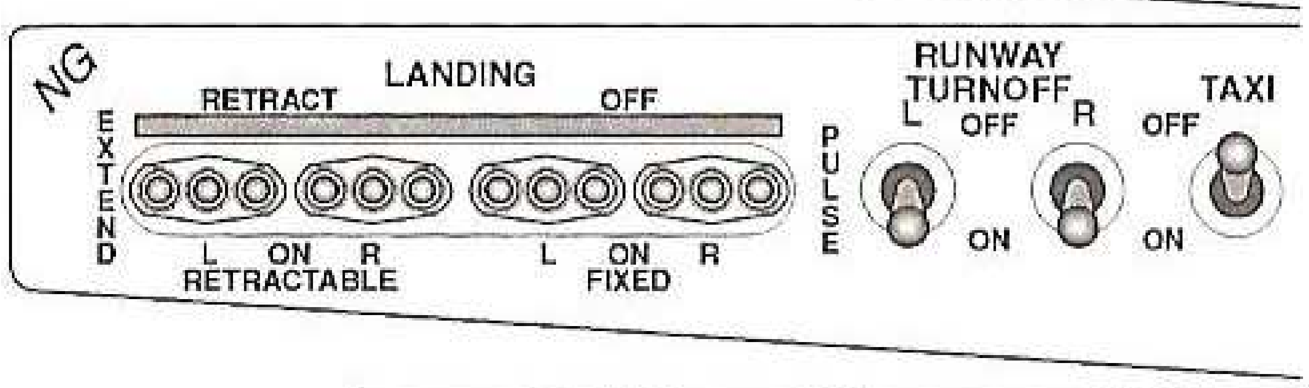
RETRACT - retracted and extinguished
EXTEND - extended and extinguished (no speed restrictions)
ON - extended and illuminated
(NG) retractable landing lights have been repositioned from the outboard flap track fairing to the belly, forward of each air conditioning bay.
- they extend and shine forward, parallel to water line of aircraft
- comes on when within 5° of full extension

FIXED landing lights
ON - illuminated fixed position down



RUNWAY TURNOFF lights

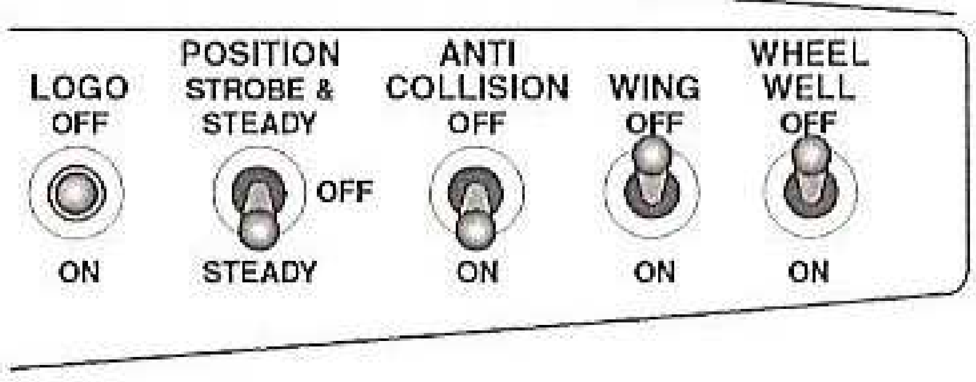
ON / OFF
- shines outward at approx. 30° angle



TAXI light

ON / OFF
- illuminates taxi light on nose gear

AUTO / OFF (option)
- turns off automatically at retraction



LOGO lights (option)

ON / OFF
- illuminates logo on vertical fin

(3-4-5) logo lights are on trailing edge of wing tips
(NG) logo lights are placed on top of each horizontal stabilizer
AUTO - illuminated automatically when slats are extended or the airplane is on the ground

STROBE lights

ON / OFF - 3 white strobes: each wing tip and the tail cone

POSITION lights ("navigation" lights)

ON BAT - illuminates the position lights from the battery bus if no other power is available
- Battery switch must be ON

ON - illuminates red-left, green-right wing-tip and the white trailing edge wing-tip lights (option)
STEADY - red and green wing-tip position lights and white trailing edge wing-tip lights
STROBE & STEADY - red and green wing-tip position lights, white trailing edge wing-tip lights, and wing-tip and tail strobe lights illuminated

ANTI COLLISION lights

ON / OFF - upper/lower red strobes; 1 per second says "engine start or run"

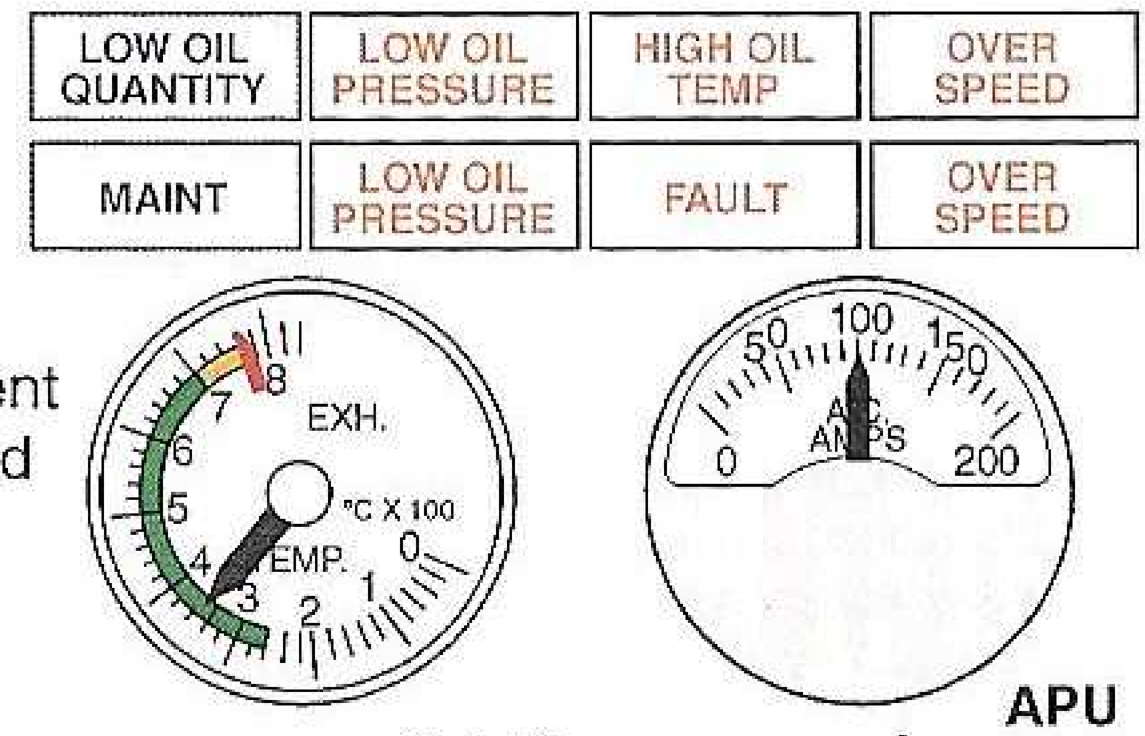
WING lights

ON / OFF
- two halogen lights illuminate wing leading edge to scan for ice, etc.

WHEEL WELL lights

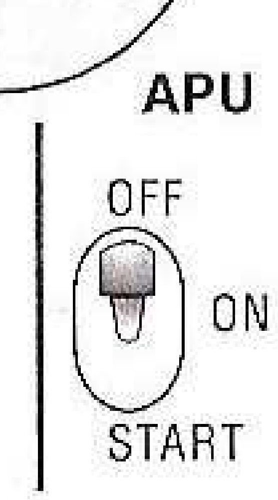
ON / OFF
- nose gear inspection (no-go item if equipped) and flood, left and right main gear
- external switches located in main wheel well and external power control panel
  - overrides cockpit switch - must be in NORMAL for cockpit switch to work

(MEL) Wheel Well lights (3-4-5)
- left and right main gear lights may be inop for day ops
- all gear inspection lights may be inop provided a landing gear indicating system other than the viewer system and independent of the center panel gear indicators is installed and operates normally



(3-4-5)

APU



LOW OIL QUANTITY light (blue)
- not armed when APU switch is OFF
- illuminated = insufficient oil for extended operation (can still use for short period)
- APU continues to run (the rest of the APU lights cause an auto shutdown)
- 1.5 qt turns on low light (the tank holds 6 quarts of oil)
  - can run APU with light on but not for a long time; but use caution, you may have an oil leak, which could mean it will run only a short time!

MAINT light (blue)
- replaces LOW OIL QUANTITY light; oil qty displayed on CDU APU MAINT page
- APU may be operated 30 - 50 hrs at normal oil consumption rate
- (3-5) low oil quantity, (NG) low oil quantity (3.8 qts) or shorted diode
- disarmed when APU switch is OFF

(NG) if light is on when APU switch is placed to OFF, light extinguishes after 5 min

LOW OIL PRESSURE light (amber)
- illuminated = oil press low, (auto shutdown occurs after the start cycle is complete)
- illuminates during start until oil pressure is normal
- disarmed when APU switch is OFF

(NG) if light is on when APU switch is placed to OFF, light extinguishes after 5 min

HIGH OIL TEMP light (amber)
- illuminated = oil temp excessive, auto shutdown occurs
- disarmed when APU switch is OFF
- (NG) aircraft this light is called FAULT

FAULT light (amber) (NG)
- replaces HIGH OIL TEMP light; on (3-5) means high oil temp
- APU ECU senses a fault and initiates an automatic shutdown
- also illuminates when overspeed protection is lost or when fuel valve fails to close after shutdown
  (NG)
- if light is illuminated when APU switch is placed OFF, light extinguishes after 5 min
- if start fails or the APU GEN OFF bus light fails to illuminate by the end of the start cycle, a system failure has occurred and the fault light illuminates
- disarmed when APU switch is OFF
- illuminates if shutdown for inlet door, fire, APU fuel valve, ECU, DC power loss, high oil temp, inlet overheat, load compressor reverse flow, loss of EGT, loss of speed, no acceleration, no APU rotation, no flame, oil filter, overtemp, sensor failure, underspeed
- combination of lesser faults will illuminate this light also

OVERSPEED light (amber)
- illuminates if actual overspeed (3-5) = 110%, (NG) = 106%
  - auto shutdown and light stays on even with switch OFF
  - maintenance must reset

- illuminated after shutdown if overspeed protection failed self test
  - do not restart, unless you have an emergency; i.e., you've lost both generators
  - this will cause MASTER CAUTION and APU annunciator to illuminate
- (3-4-5) illuminates if APU start is manually rejected prior to reaching 95% rpm
  - moving switch to OFF resets the light for another attempt
- goes out following a normal start

(NG) if light is on when APU switch is placed to OFF, light extinguishes after 5 min

(QRH) APU Overspeed

APU..OFF

- if the overspeed light illuminates due to RPM limit being exceeded or self test failure, maintenance action is required

APU EGT INDICATOR

- shows APU exhaust gas temp

(NG) remains powered for 5 minutes after shutdown

- no limitations on EGT gauge. System self-monitors exceedances

(L/OP) APU, Max EGT (3-4-5)

- Max EGT 760° (red line), Max Cont 710° (top of green band)

APU GENERATOR AC AMMETER

- shows APU generator current load

(NG) AC ammeter removed. APU generator amperage can be obtained by placing the AC meter selector on the electrical panel to APU GEN and reading AC amperage on the digital AC Ammeter

APU switch

ON - Normal position with the APU running

START

(3-4-5) - the starter is powered directly from the battery

(NG)

- with AC power available, the starter generator uses AC power to start the APU
- with no AC power available, the starter generator uses battery power to start
- (Momentary) - Positioning the APU Switch from OFF to START and releasing it to ON initiates an automatic start sequence

OFF

(3-4-5) initiates an APU shutdown. After shutdown, wait 20 secs for inlet door to close before turning BAT switch OFF

(NG) starts cool-down cycle. APU generator breaker trips and the APU bleed air valve closes. APU continues to run for 60 sec then shuts down. Wait 40 sec after the APU EGT goes below 300°C for the inlet door and fuel shutoff valve to close before turning BAT switch OFF. This is 1:40 after turning the APU switch off! Or, wait 2 minutes after the APU GEN OFF BUS light extinguishes before turning BAT switch OFF

(L/OpSpec) APU, Elec Operating Limits (3-4 / 5 / NG)

- max electrical load: gnd 150 A - air 125 A / gnd 160 A - air 140 A / gnd 260 A - air 188 A

(L/OpSpec) APU, Use of Pneumatics

- operate (warmup) for 1 minute before using as a bleed air source

(3-4-5) Operate 1 min with pneumatics off prior to shutdown

(L/OpSpec) APU, Aborted Starts

- wait 90 seconds prior to a second APU start attempt and allow 5 minute cooling period before a third. Do not attempt a fourth - call maintenance

(L/OpSpec) APU, Altitude Limits (3-4-5 / NG)

- 10,000 ft for: 1 pack and 1 generator bus / 1 pack and both transfer buses
- 17,000 ft for: 1 pack / 1 pack (APU bleed valve closes at approx. 20,000 ft)
- 35,000 ft for 1 generator bus / both transfer buses can be powered to 41,000 ft

(L/OpSpec) APU, Start & Oper. Param. (3-5)

- after shutdown, wait 20 seconds for inlet door to close before turning BAT switch to OFF

APU System Notes

1. air inlet aft of aft cargo door for combustion air and (3-5)cooling air
   (NG) cooling air enters the eductor air inlet above the APU exhaust outlet
2. APU fuel feed system
   - DC operated fuel pump (optional)
     - operates automatically during start and APU operation when the APU fuel control unit senses low pressure; it shuts off when AC fuel pump pressurizes the manifold
   - without AC power or optional DC boost pump, APU suction feeds from #1 tank
   - any pump in #1 tank or left center tank pump supplies APU with crossfeed closed
   - with crossfeed open, #2 tank can be used to feed APU
   - with fuel in all tanks and all pumps on, center tank will feed APU
   - using left center pump prevents fuel imbalance if running APU for extended period
     - shroud collects fuel leaks from APU fuel feed line and sends overboard to drain mast
3. APU burn rate
   - (3-4-5) normal = approximately 250 pph
   - (NG) normal gen load - 225 pph; 2 AC pack - 226 pph (add 15% for 1 pack ops)
4. (NG) two AC pack operation vs one
   - cooler cabin temps
   - decreased APU fuel burn - during 1 pack ops the APU must supply higher bleed air pressures to assure proper control system ops. This higher pressure requires a greater Inlet Guide Vane (IGV) open position than that required for 2 pack ops. Since there is less airflow required to operate 1 pack than is needed, a significant amount of unused bleed air is exhausted through the surge control valve. Higher IGV open position and large quantity of unused air translates into higher APU fuel burn and higher turbine inlet temps during 1 pack ops
5. Battery switch must be ON to start APU
   - APU shuts down if battery switch turned OFF
     - if BAT switch is turned OFF before APU switch is turned OFF, subsequent start cycle is interrupted. APU switch must be turned OFF to complete shutdown cycle then to START

     (3-4-5) APU will run in flight with battery switch OFF
6. APU start sequence
     - APU fire handle must be pushed down and APU fire handle in wheel well up
     - (3-4-5) could use the 28v DC power receptacle to start if battery were dead
     - (NG) APU may be started with AC from #1 AC transfer bus or from battery
     - aircraft with dual battery, RCCB opens and APU is started from main battery
   - APU switch to START, then release to ON (starts timer)
     - battery charger is disconnected or (option) locked to TR mode during start
     - fuel SOV in left wing-aft spar opens (NG) has a fuel shutoff battery to ensure power
     - air inlet door opens - takes approximately 8 seconds
     - ignition energizes and starter engages - ammeter indicates almost 400 amp draw
       (NG) amp draw indication and BAT DISCHARGE light only when starting off battery
     - LOW OIL PRESSURE light comes on and goes out in approximately 30 seconds
     - oil pressure switch (3-5 = 4 psi / NG = 7%) opens fuel solenoid valve at FCU
     - speed switch cuts out ignition at 60%; starter cuts out at (3-5) 50% (NG) 70%
       - indicated by smaller DC load
     - at operational speed (95%) APU GEN OFF BUS light comes on indicating the APU can take a load (electric or pneumatic)
       - a one minute delay before putting a bleed load on is an operational procedure to lengthen the life of the APU
     - if in 90-120 seconds the APU RPM is not high enough to disengage the starter, the start will be aborted to prevent damage to the starter
       - LOW OIL PRESS light will illuminate when starter finally cuts out
       - if the APU GEN OFF BUS light does not come on within the time limit of the starter motor, there may be a hung start (put APU switch to OFF)

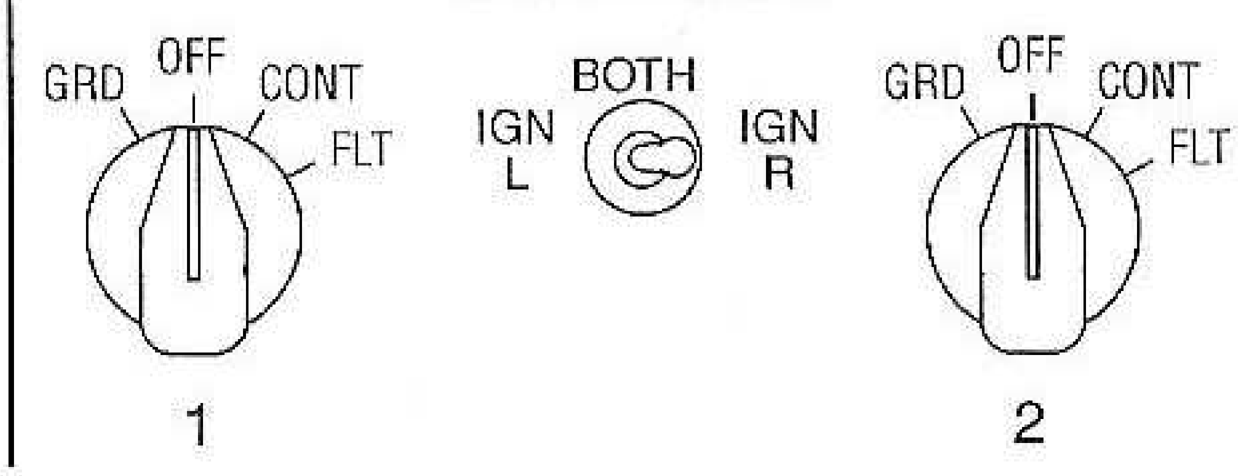
7. APU operation
   (3-4-5)
   - can operate one gen bus in flight, both gen buses on ground
   - can operate 1 pack on ground for cooling, 2 packs for heating

   (NG)
   - can operate both AC transfer buses on ground or in flight
   - can operate 2 packs on ground for heating or cooling

   (3-5) fuel flow and thus EGT are controlled to maintain rpm only, so generator frequency stays at 400 cps
   - the bleed valve will modulate closed so FCU can maintain 400 cps
   - bleed load is varied at the load control valve to prevent an EGT exceedance
   - (NG) RPM and bleed load both controlled by ECU computer
     - if you forget to put engine gens on line APU will continue to power both buses

   (NG) engine gens automatically come on line if APU quits or is shutdown in flight
8 APU normal shutdown
   - (3-4-5) normal shutdown simulates an overspeed condition closing fuel solenoid
   - (NG) Electronic Control Unit controls shutdown
     - moving the switch to OFF starts the 60 second cool-down timer, opens the generator control relay and the generator breaker and and closes the APU bleed valve
     - shutdown occurs automatically after 60 seconds
       - prevents coke in turbine bearing and fuel nozzels
       - ECU de-energizes the fuel solenoid valve which is spring loaded to close
     - wait 40 sec after EGT goes below 300°C for the inlet door and fuel SOV to close before moving battery switch to OFF
   - in emergency, immediate shutdown can be accomplished by pulling APU fire handle
9. APU protective shutdown
   - three different protective shutdown indications in the cockpit: FAULT light, OVERSPEED light, and LOW OIL PRESSURE light
   - APU auto shutdown
     - (3-4-5) APU fire warning, LOW OIL PRESSURE, HIGH OIL TEMP (FAULT), or OVERSPEED
     - (NG) LOW OIL PRESSURE, FAULT, or OVERSPEED light (remains on for 5 minutes after OFF)
     - LOW OIL PRESSURE = oil pressure less than 35 psi
     - OVERSPEED = an actual overspeed or a failure in the overspeed protection circuit
       - (3-4-5) an actual overspeed requires a reset in EE compartment
         - cannot try another start under these conditions
       - (NG) overspeed is reset by accessing the APU BITE through the CDU/MCDU
       - (NG) these conditions will cause a protective shutdown and an OVERSPEED light: fuel control unit solenoid failure, loss of overspeed protection, overspeed
     - FAULT light
       - (NG) these conditions will cause a protective shutdown and a FAULT light: fuel shutoff valve not in commanded position, loss of DC power, ECU failure, APU fire, inlet door not in command position, APU inlet overheat, loss of both EGT signals, no speed signal, no ignition, generator filter clogged, high oil temperature, overtemperature, reverse flow (load compressor), oil temperature or inlet air temperature sensor failure, underspeed
10. surge control valve (NG only)
   - sends excess pressurized air to the APU exhaust
     - this protects the load compressor from a surge
     - the ECU controls the surge control valve
11. APU bleed valve must be closed when:
   - ground air connected and isolation valve open
   - left engine bleed valve open
   - isolation valve and right engine bleed valve open

ENGINE START PANEL



ENGINE START switches

- solenoid held, spring loaded to OFF

GRD
  - opens the start valve
    - START VALVE OPEN light illuminates
  - ground starts - arms selected igniter(s) to provide ignition when the start lever is moved to IDLE
  - on airplanes delivered after Nov 1988, the start switch uses DC power from the battery bus to close the engine bleed air valve
  - starter cutout signal from (3-4-5) N2 tachometer at 46% (NG) DEU at 56%
  - Note: there are starting procedure differences when starting at a high altitude airport

  (NG)
  - inflight starts, arms both igniters to provide ignition when the start lever is moved to IDLE regardless of the position of the ignition select switch

OFF
  - start valve closed, ignition normally off
  - (NG) reference auto-relight/automatic ignition

AUTO (option - replaces OFF position)
  - works same as OFF except
    - provides automatic ignition to selected igniters when engine is running and flaps are not up below 18,000 ft or engine anti-ice is turned on

CONT
  - provides ignition to selected igniters, with the start lever in idle

  (NG) inflight, provides ignition to both igniters when N2 is < idle and start lever in IDLE

FLT
  - provides ignition through both igniters when the start lever in IDLE
  - the ignition select switch is bypassed when in this position (FLT)
  - use for air starts, severe turbulence, moderate to severe icing, moderate to heavy precipitation, hail, or sleet
  - (option 3-4-5) on airplanes that have the autothrottles connected to the FLT position, in-flight above 500 ft RA, anytime one or both engine start switch(es) are placed to FLT, the autothrottle, if armed, maintains a minimum engine speed of 45% N1. This increases engine tolerance to water ingestion

(QRH) Two Engine Flamout
- place start switches to FLIGHT and start levers to CUTOFF for at least 3 sec
- after EGT decrease, place start levers to IDLE

IGNITION SELECT switch

IGN L - selects the left igniter for use on both engines (respective transfer bus)
BOTH - selects both igniters for use on both engines
IGN R - selects the right igniter for use on both engines (Standby AC bus)

(L/OP) Powerplant, Ignition
- must be on (CONT) for takeoff, landing, engine anti-ice operation, operation in heavy rain

(QRH) Aborted Engine Starts
- no N1 rotation before start lever is raised to idle, no oil pressure indication by the time the engine is stabilized at idle, no increase in EGT within 10 sec on the ground or 30 sec in flight after start lever is raised to idle, no increase in, or a very slow increase in N1 or N2 after EGT indication, EGT rapidly approaching or exceeding the start limit

(L/OP) Powerplant, Starter Duty Cycle

(3-4-5)
  - first attempt: 2 minutes on, 20 seconds off
  - second and subsequent attempts: 2 minutes on, 3 minutes off

  (NG)
  - 2 minutes on, 10 seconds off for all start attempts

NORMAL START SEQUENCE

- fuel pumps on
  (3-4-5) duct 30 psi min (less .5 psi / 1000 ft ASL)
  (NG) demand system - will indicate approximately 10 - 15 psi before GRD is selected
- select L or R igniter (technique: right if at maintenance station)
- place start switch to GND
  - someone should start a clock and check START VALVE OPEN light illuminates
- check N2, oil pressure rising, and N1 (EGT will decrease a little as air flow increases)
  - must see N1 before moving start lever to idle
- at 25% N2 and [(3-4-5) N1 approx. 4%] [(NG) N1 approximately 2%], start lever to idle (otherwise at 20% and max motoring), start counting to ten (one-potato, two-potato)
  - ignition must occur within 10 sec. [(3-4-5) normally 1-2 sec] [(NG) normally 3-4 sec]
  - fuel flow starts around 400 pph, peaks at 1,000, and settles down to approx. 800 pph
- starter cutout at (3-4-5) 46% N2 (NG) 56% N2
- idle gouge is (3-4-5) "2,5,6,7" (NG) "2,4,6,6" for approximate indications
  - idle EGT may vary from (3-4-5) 450°C – 650°C (NG) 320°C – 520°C depending on OAT, bleed configuration, and engine conditions
- if abnormal start develops you've got the clock running for starter limitations
- (NG) APU EGT increase is less than the "classic" because air is from the load compressor and not from the engine compressor

BATTERY START

- N1, EGT and oil LOW PRESS light (NG) adds N2 and START VALVE OPEN light
- start #1 first, then crossbleed start #2 because air source is on right side of belly
- isolation valve must be open to start #1 (AC powered)
  - if isolation valve is closed, you'll have to start #2 first or manually open isol valve
- situation: APU is inop. You taxi to gate thinking GPU is good and shut #1 engine down with both packs and isol valve in AUTO, bleed switches ON. Next, the GPU fails. Now, you can't open the isol valve (it's closed from the position of the 4 corner switches) Technique: open the isol valve prior to shut down of #1 engine (last AC power source)

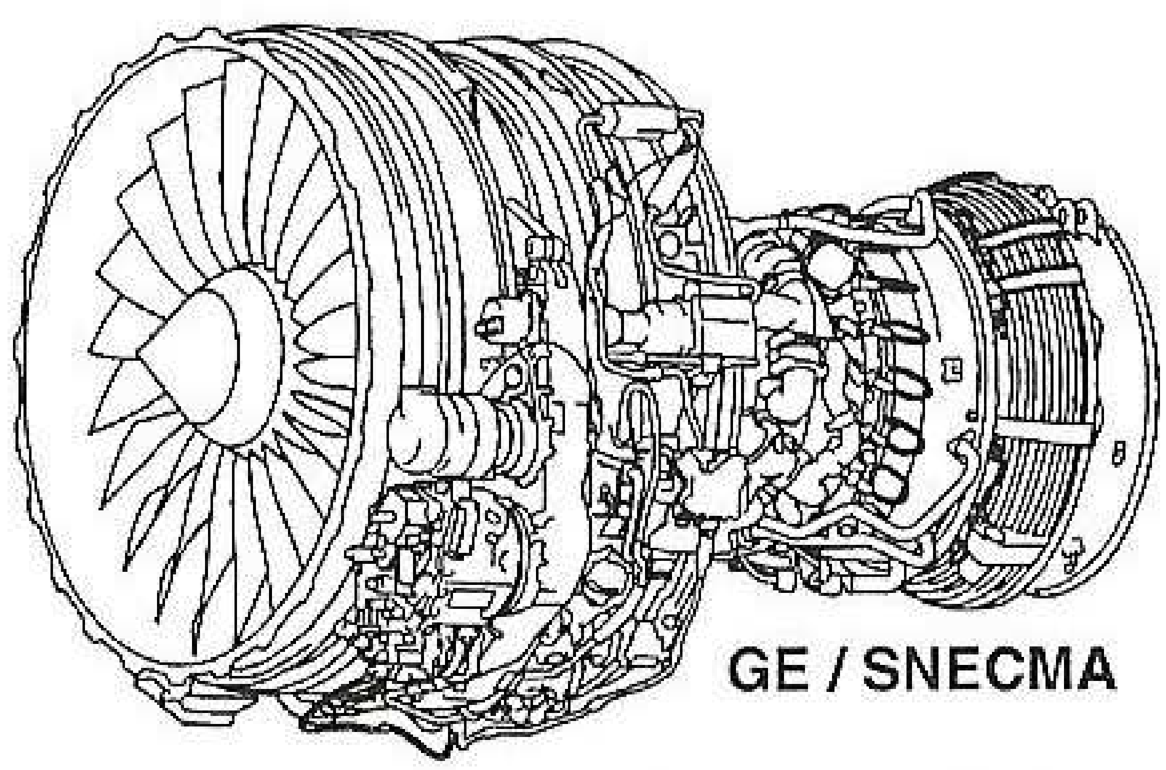
Engine System Notes

1. engines
   - GE/SNECMA CFM
     - common core heritage with the B-1B, F-18
     - about 80% of thrust is from the fan, 20% from the core
     - (3-4-5) bullet changed from pointed to rounded so as to better deflect precipitation and hail away from the core, and outward through the fan
   - (3-4-5) uses a Main Engine Control (MEC); (NG) uses a Hydro Mechanical Unit (HMU)
   - fuel heater operates continuously thru engine oil (and also cools the oil)
2. start protection (NG)
   - for engine start on the ground, start sequence automatically aborted if the EEC detects
     - hot start: (EGT is more than the limits for engine start)
       - the white box around the EGT readout flashes
       - if the EGT exceeds the start limit, the EGT display turns red
       - EGT digital display continues to flash until the engine start lever is moved to cutoff
     - wet start: no EGT rise within 15 sec after start lever is raised to IDLE
     - hung start: engine goes to idle during start but then decreases below 50% N2 and EGT goes above the start limit
3. auto-relight (NG)
   - EEC activates both igniters for engine flameout protection
     - flameout detected when start lever is in IDLE and an uncommanded rapid decrease in N2 occurs, or N2 is 50–57%, or in-flight, start switch off and N2 is below idle RPM
     - automatic ignition terminates when engine speed returns to normal or,
       - on the ground after start with start lever in idle and N2 below 50% with EGT >725°
       - after 30 sec and N2 between 50 - 57%

FORWARD OVERHEAD PANEL

• Engines	Weight lb	Thrust	Model	By-pass Ratio
CFM56-3B1		18,5 k - 20 k	-300/500	6.0
CFM56-3B2		22 k	-300/400	5.9
CFM56-3C1		18,5 k- 23,5 k	-300/400/500	6.0
CFM56-7B18	5,205	18,5 k	-600	5.5
CFM56-7B20	5,205	20.6 k	-600/700/IGW700	5.5
CFM56-7B22	5,205	22.7 k	-600/-700/IGW700	5.3
CFM56-7B24	5,205	24.2 k	-700/800/900/C40A/IGW700	5.3
CFM56-7B26	5,205	26.4 k	-800/900	5.1
CFM56-7B27	5,205	27.3 k	-800/900/	5.1

• Model	Basic GW	HGW Opt.
-300	124,500	138,500
-400	138,500	150,000
-500	115,500	133,500
-600	124,000	143,500
-700	133,000	154,500
-800	155,500	174,200
-900	164,000	174,200

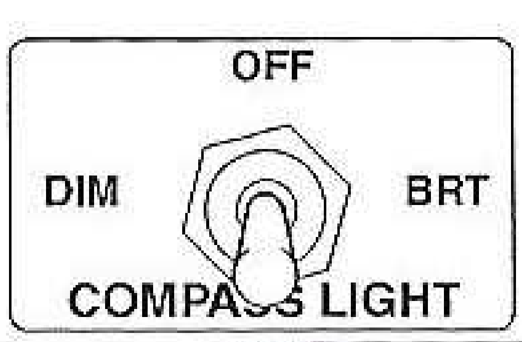


GE / SNECMA

- ignition
  - no time limit on continuous ignition
  - ENG 1 ignition systems receive 115v ac from ac transfer bus 1 and the ac standby bus
  - ENG 2 ignition systems receive 115v ac from ac transfer bus 2 and the ac standby bus
    - IGN L system powered by respective ac transfer bus
    - IGN R system powered by ac standby bus
      - used for inflight starts on standby (battery) power so this system is required for dispatch
  - each spark igniter has its own ignition lead which is cooled by fan air
  - (3-4-5 option) high energy ignition exciters change 115v ac to 15,000 - 20,000v dc
    - spark rate of 2 sparks per second at 2 joules per spark
  - (3-4-5 option) low energy ignition exciters change 115v ac to 14,000 - 18,000v dc
    - spark rate of 1 sparks per second at 1.2 joules per spark
  - (NG) ignition exciters change 115v ac to 15,000 - 20,000v dc
    - output of the ignition exciter is 14.5 to 16 joules (named after James Joule)

(MEL) Ignition System - ATA 74

- right ignition system, except for ER ops, may be inop provided ignition select switch is in BOTH and associated left ignitor is connected to the AC standby bus
  - the BOTH position eliminates confusion of which ignitor is inop and assures standby ignition is available at all times
  - normal operation of operable ignition system may be confirmed by selecting IGN R for start, then after start, select BOTH
- left ignition system, except for ER ops, can be inop provided ignition select switch is in BOTH and right ignition systems operate normally



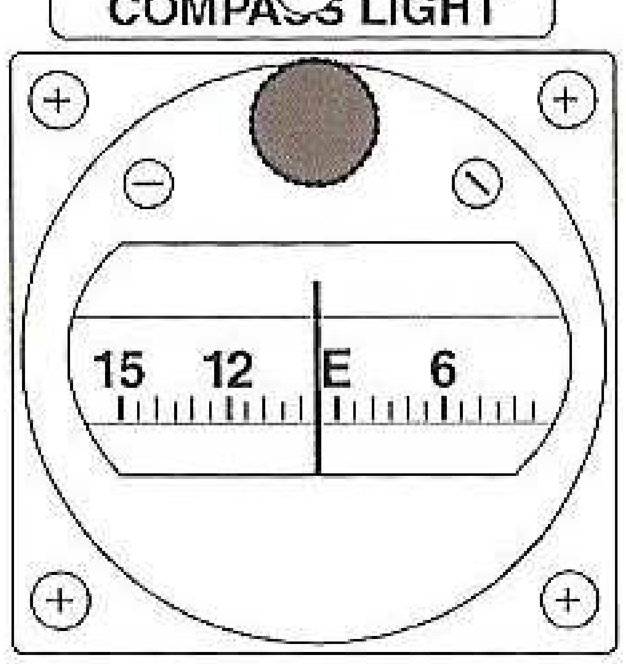
COMPASS light switch

(non EFIS 300) on the fold-down unit

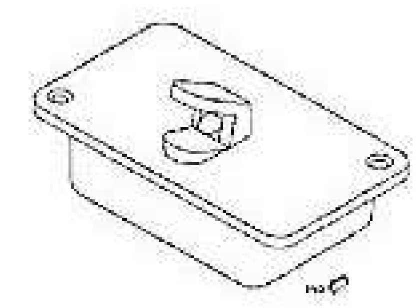
(EFIS / NG) located above compass and out of sight

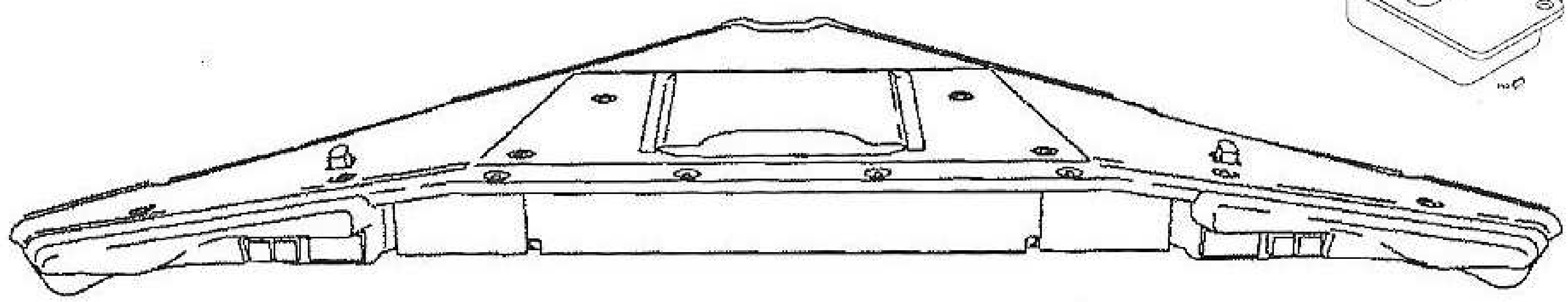
COMPASS

- backup magnetic heading reference
- two magnets in the horizontal plane and parallel to each other
- magnets align the compass with the magnetic flux lines of the earth
- correction card shows small errors that compensation screws cannot remove



GLARESHIELD PANEL (P7)





REMOTE LIGHT SENSOR

- two remote light sensors located on the forward part of the glareshield and face forward
- measure ambient light with photodiode sensor
- (3-4-5) the remote light sensor send the signal to the on-side EADI-EHSI pair
- (NG) the remote light sensors send the signal to the on-side outboard display units
  - the display units send these values to the DEU, which uses these inputs with other inputs to caclulate the brightness value for all LCDs
- field of view is 70° left and right, (3-4-5) 15° up and down; (NG) 40° up and 15° down
- operating power to each remote light sensor is provided by its associated EHSI

WARNING LIGHTS

FIRE WARN BELL CUTOUT	MASTER CAUTION PUSH TO RESET	FLT CONT	ELEC	ANTI-ICE	ENG	MASTER CAUTION PUSH TO RESET	FIRE WARN BELL CUTOUT
		IRS	APU	HYD	OVERHEAD		
		FUEL	OVHT/DET	DOORS	AIR COND		

FIRE WARN / BELL CUTOUT (red)

- illuminated = indicates fire warning or system test in engine, APU or main gear wheel well
- gives fire warning bell, and remote APU horn if on ground
- press to extinguish both master FIRE WARN lights, silence the bell and remote horn
- resets system for additional warnings
- pushing the BELL CUTOUT on Fire Panel (aft electronic panel) accomplishes the same thing

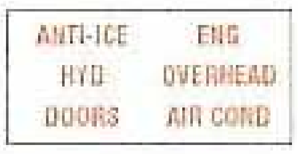
MASTER CAUTION (amber)

- illuminated = a system annunciator has come on
- press to reset MASTER CAUTION light and system annunciator light
  - if a fault condition remains, the MASTER CAUTION lights come on again
- resets system for additional MASTER CAUTION situations
- lights on forward panel do not light the MASTER CAUTION light, only "out of view" lights
- do not leave lights on when they are not necessary as excessive heat can distort the lenses

SYSTEM ANNUNCIATOR

- illuminated = an amber light relating to illuminated system annunciator has illuminated on forward overhead, aft overhead, or overheat/fire protection panel (except FAULT light)
  - position similar to light's location
- Captain and FO annunciators are different; show respective panel locations
- to extinguish, press either MASTER CAUTION
- push to RECALL
  - all system annunciator lights come on
  - when you release the "6-pack", the system annunciator lights that remain illuminated show which systems have faults

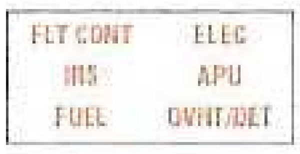
GLARE SHIELD PANEL



Annunciator Panel (3-4-5) "six pack"

Captain's Annunciator		First Officer's Annunciator	
FLT CONT LOW QUANTITY LOW PRESSURE FEEL DIFF PRESS SPEED TRIM FAIL MACH TRIM FAIL AUTO SLAT FAIL YAW DAMPER	**ELEC** LOW OIL PRESS HIGH OIL TEMP STBY PWR OFF TRANSFR BUS OFF BUS OFF	**ANTI ICE** WINDOW OVHT WINDOW HEAT OFF * PITOT HEAT COWL ANTI-ICE	**ENG** REVERSER PMC INOP LOW IDLE
IRS FAULT ON DC DC FAIL	**APU** LOW OIL PRESS FAULT / HI OIL TEMP OVERSPEED	**HYD** OVERHEAT LOW PRESSURE	**OVERHEAD** EQUIP COOLING EMER EXIT LIGHTS FLIGHT RECORDER PASS OXYGEN ELT*
FUEL LOW PRESS FILTER BYPASS	**OVHT / DET** ENGINE 1 OVHT ENGINE 2 OVHT APU DET INOP CARGO FIRE DET	**DOORS** FWD / AFT ENTRY EQUIP FWD / AFT CARGO FWD / AFT SERVICE TIRE SCREEN * AIRSTAIR *	**AIR COND** DUCT OVHT (3-5) DUAL BLEED PACK TRIP OFF (3-5) WING / BODY OVHT BLEED TRIP OFF PACK (4) ZONE TEMP (4) AUTO FAIL OFF SCHED DES

Annunciator Panel (NG) "six pack"

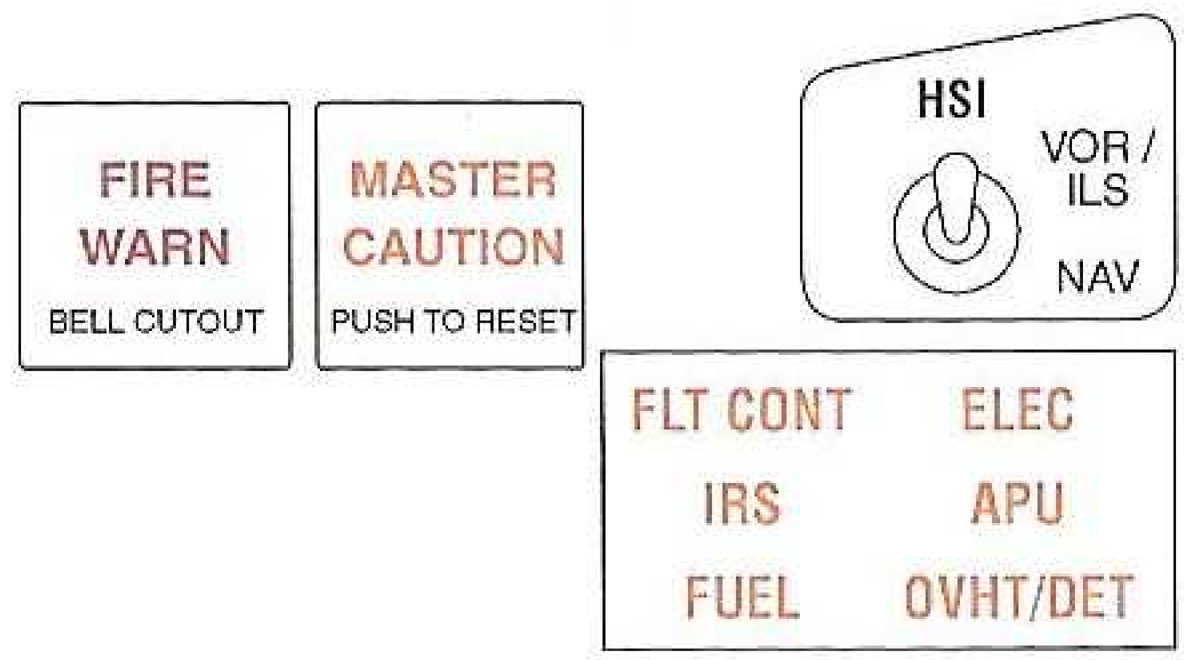


Captain's Annunciator		First Officer's Ann.	
FLT CONT STBY HYD LOW QUANTITY STBY HYD LOW PRESSURE FLT CONT LOW PRESSURE FEEL DIFF PRESS SPEED TRIM FAIL MACH TRIM FAIL AUTO SLAT FAIL YAW DAMPER STBY RUD ON (if installed)	**ELEC** STANDBY PWR OFF TRANSFR BUS OFF DRIVE SOURCE OFF TR UNIT BATT DISCHRG ELEC	**ANTI ICE** WINDOW OVHT PROBE HEAT COWL ANTI-ICE WINDOW HEAT OFF*	**ENG** EEC ALTN ENGINE CONTROL REVERSER
IRS FAULT ON DC DC FAIL GPS	**APU** LOW OIL PRESS FAULT OVERSPEED	**HYD** OVERHEAT LOW PRESSURE	**OVERHEAD** PSEU EQUIP COOLING OFF EMER EXIT LIGHTS ARMED FLIGHT RECORDER OFF PASS OXY ON ELT*
FUEL LOW PRESS FILTER BYPASS	**OVHT / DET** ENGINE 1 OVHT ENGINE 2 OVHT APU DET INOP	**DOORS** L/R OVERWING EXIT (6-7-8) L/R FWD OVERWING EXIT (8-9-B2) L/R AFT OVERWING EXIT (8-9-B2) FWD / AFT ENTRY FWD / AFT CARGO FWD / AFT SERVICE EQUIP AIRSTAIR*	**AIR COND** DUCT OVHT (6-7-B) DUAL BLEED PACK TRIP OFF (6-7-B) PACK (8-9-B2) WING / BODY OVHT BLEED TRIP OFF AUTO FAIL OFF SCHED DES ZONE TEMP (8-9-B2)

* option

(MEL) Annunciator Light - ATA 33
- one light may be inop for an operating system

HSI SWITCH (non-EFIS)



- this switch is not on the EFIS series airplanes; these functions are incorporated in the EFIS control panel (on the aft control stand)

VOR / ILS
- the HSI is in the VOR / ILS mode (conventional mode)
- the HSI course pointer shows the course set manually by the course selector on the MCP
- VHF navigation frequencies must be tuned manually
- Captain uses VHF Nav #1; FO uses VHF Nav #2 (with VHF Nav transfer in Normal)

NAV
- the HSI is in the NAV mode
- the HSI course pointer is automatically positioned by the FMC; you can monitor vertical and lateral deviations from the computed flight path
- the Waypoint Bearing Pointer will point to the active waypoint (the waypoint you are flying to), and also display the distance to that waypoint
- VHF navigation frequencies are selected automatically but may be manually selected if the Auto / Manual switch has been switched to the Manual mode

AUTOPILOT / FLIGHT GUIDANCE

FMS: Flight Management System (the FMC, A/T, A/P, F/D and IRS)
AFS: Autoflight System (AFDS and A/T)
AFDS: Autopilot Flight Director System (A/P and F/D)
FCC: Flight Control Computers (for A/P and F/D computers)
A/T: Autothrottle
F/D: Flight Director (command bars)
FMA: Flight Mode Annunciator (Capt and FO, show same information on actual status)
- on EFIS airplanes, incorporated with EADI

MCP: Mode Control Panel (lightshield panel; control for A/P, A/T, F/D)
FMC: Flight Management Computer (operated by CDU; inputs from many sources)
CDU: Control Display Unit (Capt and FO each have one, type in inputs to FMC)

(L/OP) Autopilot
- do not use the autopilot or autothrottle for approach if associated RA is inop

(L/OP) FMC

(3-4-5)
- the FMCS with single FMC meets the requirements for an area navigation system when operated with radio updating. When operated in this configuration, the FMC may be used for enroute, terminal and RNAV approaches.

(NG)
- the FMCS with dual FMC has been demonstrated to meet the applicable requirements for a multi-sensor area navigaton system when operated with radio or GPS updating. When operated in this configuration, the FMCS may be used for enroute, terminal area operations, and GPS/Overlay approaches (excluding ILS, LOC, LOC-BC, LDA, SDF, and MLS), assuming the ANP does not exceed the RNP as displayed on the FMC.

(MEL) FMC INOP - ATA 34
- FMC not required if you navigate by ground based navaids, and IRS display unit (ISDU) operates normally

(MEL) FMC Nav Database - ATA 34
- may be out of currency provided aero charts are used to crosscheck fixes prior to dispatch and approach nav radios are manually tuned and identified

MCP

- there are no line replaceable lamps or LEDs on the MCP
- 2 light sensors (one on each end of the MCP) adjust the 2 MA lights and the 10 mode switches

MCP MODE SELECTOR SWITCHES (for A/P and F/D)

- all mode selector switches are momentary contact switches; "push on, push off"
- see FMA lights on center panel for more information.
- Roll Modes - HDG SEL, LNAV, VOR-LOC
- Pitch Modes - VNAV, LVL CHG, ALT HLD and V/S (to use for a climb or descent, you must first select an altitude which is different from the present altitude)
- mode switch illuminates to indicate the mode can be deactivated by pressing mode switch a second time
- pressing a lighted mode switch deselects the mode and extinguishes the light
  - deselecting N1 or SPEED switch engages A/T in ARM mode
- switch lights do not indicate operating modes
  - you must look at the FMA to see what modes are engaged

COURSE SELECTOR KNOB

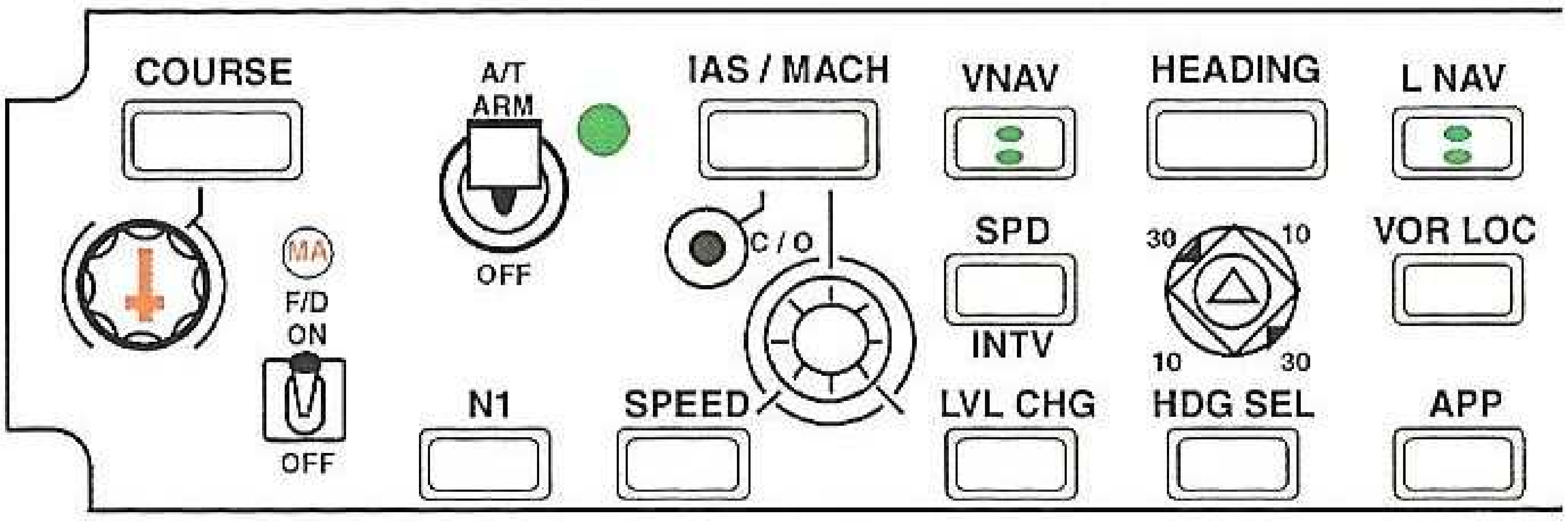
- Rotate: sets course in display for respective VHF NAV rec, AFDS and HSI course bar
- Capt: #1 VHF Nav rec, A FCC, and Capt HSI course pointer and deviation bar
- F/Os: #2 VHF Nav rec, B FCC, and F/O HSI course pointer and deviation bar

(QRH) MCP LOCKUP

- uncommanded autopilot disengagement in conjunction with MCP blanking or indicating flashing "8s" may indicate MCP lockup. With this condition, the autopilot will not re-engage and the MCP display will not be usable

CIRCUIT BREAKERS .... PULL, THEN RESET

  - pull and reset AFDS MCP DC 1 (P18-1 D5) and the AFDS MCP DC 2 (P6-2 C3) circuit breakers. This will reset the MCP display and allow re-engagement of the autopilot



FLIGHT DIRECTOR Switches
- left F/D switch activates command bars on Captain's ADI
- right F/D switch activates command bars on FO's ADI

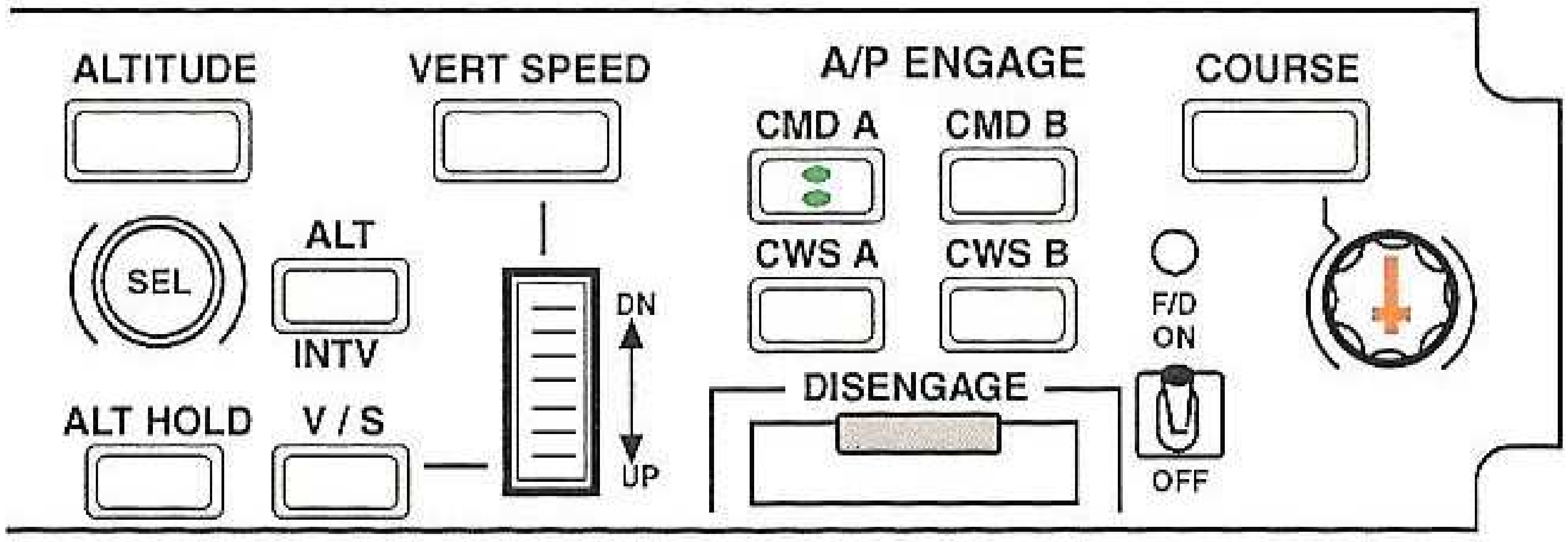
ON - displays FD in A/P status display if A/P is OFF or engaged in CWS
- in flight with A/P ON and F/Ds OFF, turning a F/D switch ON engages F/D in currently selected A/P modes
- enables command bar display on respective pilot's ADI
- command bars are displayed if command pitch and/or roll modes are engaged
- will work with or without A/P
- on ground, arms pitch and roll modes for engagement in TO/GA and wings-level when a TOGA switch is pushed

OFF - command bars retract from respective pilot's ADI

MASTER FLIGHT DIRECTOR INDICATOR lights (MA) (green)
- if a F/D switch is ON, the light indicates which FCC is controlling the F/D modes
- illuminated = respective FCC is controlling F/D modes (PF should be master)
  - if the onside FD is turned off the other FCC will become the MA by default
  - if the electrical source of one FCC fails, the other will become the MA
- extinguished = F/D modes are controlled from opposite FCC
- master FCC is determined by
  - with neither A/P engaged in CMD, the first F/D turned on is master, or
  - A/P in CMD, the FCC of the engaged A/P is the master (engaged A/P always wins)
- both lights illuminated = each FCC is controlling modes for respective F/D and indicates independent F/D operation
  - need APP mode engaged with LOC and GS captured, or GA mode engaged and below 400' RA, or TO mode engaged and below 400' RA
  - when independent operation terminates, the MA light extinguishes on the slaved side
- need to be aware of which is master for 2 reasons: if in VOR or LOC mode, the MA light will tell you which nav receiver the FCC is tracking; the left FCC uses the Capt altimeter and baroset, while the right FCC looks at the FO altimeter and baroset

FLIGHT DIRECTORS
- can use one at a time, or both together
- F/D commands operate in the same command modes as the A/P, except takeoff mode is a F/D mode only
- dual F/D guidance is available for single engine operation
- the F/D has no landing flare capability. The command bars retract at about 50' RA on an ILS approach
- normally the A FCC drives the Capt F/D and B FCC drives the FO F/D
- if both F/D switches are on, then the master FCC controls both pilot's F/D modes. Use caution if each pilot has different nav frequencies tuned, or different courses set (i.e., their F/D commands may not agree)
- if a generator is lost, the unaffected FCC controls both ADIs, and MA light on affected side goes out
- no command bars unless an MCP pitch and/or roll mode is selected

GLARE SHIELD PANEL



TAKEOFF MODE

- engaged for takeoff by turning both FD switches ON and pushing either TO/GA switch
  - N1 and TOGA annunciate and sets takeoff thrust prior to 80kt
- AFDS commands 10° nose down until 60 kts; 15° nose up after 60 kts; 84 kts autothrottles go to throttle hold - THR HOLD annunciates; 15° nose up after lift-off until a sufficient climb rate is acquired then pitch is commmanded to maintain MCP + 20 kts
- roll commands wings-level
- after passing 400' RA, you can then use other F/D modes
- after liftoff A/T remains in THR HOLD until 800 ft RA, then ARM
- selecting A/P in CMD after TO automatically engages LVL CHG and HDG SEL
  - if F/D roll mode (LNAV, HDG SEL, or VOR LOC) was selected prior to A/P engagement, then the A/P engages in the same mode
  - if LVL CHG engages, the airspeed displays V2 + 20k
- if engine fails before reaching V2, pitch bar commands V2
- if failure occurs after V2, but less than V2 + 20k, pitch bar commands existing speed
  - if failure occurs above V2 + 20k, pitch bar commands V2 + 20k
- TO/GA can also be engaged for takeoff with F/D switches off if a TO/GA switch is pushed after 80 kts below 2000 ft AGL and prior to 150 seconds after lift-off

GO AROUND MODE

- armed with RA below 2000 ft or RA above 2000 ft with flaps down or G/S captured
  - engages by pushing either TO/GA button
- initial pitch commands 15° up, then to hold maneuvering speed for each flap setting
- roll bar commands approach ground track that existed at GA engagement
- during a single-engine GA, the A/T commands full N1 Limit; pitch bar commands 13° up then maintains a target speed. If engine fails before GA engagement, then target speed is the MCP selected speed. If engine fails prior to 10 seconds after GA engagement, target speed is the selected approach speed existing at engagement. If engine fails after GA engagement + 10 secs and airspeed is within 5 kts of GA engagement speed, the airspeed that existed at GA engagement becomes the target speed or if airspeed when engine fails is greater than 5 kts above GA engagement speed, then current airspeed becomes the target speed. Target speed is never less than V2 for flap settings (except if windshear). Speeds are displayed on MCP and airspeed indicator.
- below 400' RA both F/D switches must be off to exit GA mode. Above 400' RA, other modes can be selected. If roll mode is changed first (HDG SEL or LNAV), the pitch mode remains in GA mode. If the pitch mode is changed first, the roll mode automatically changes to HDG SEL.

AUTOTHROTTLE ARM switch

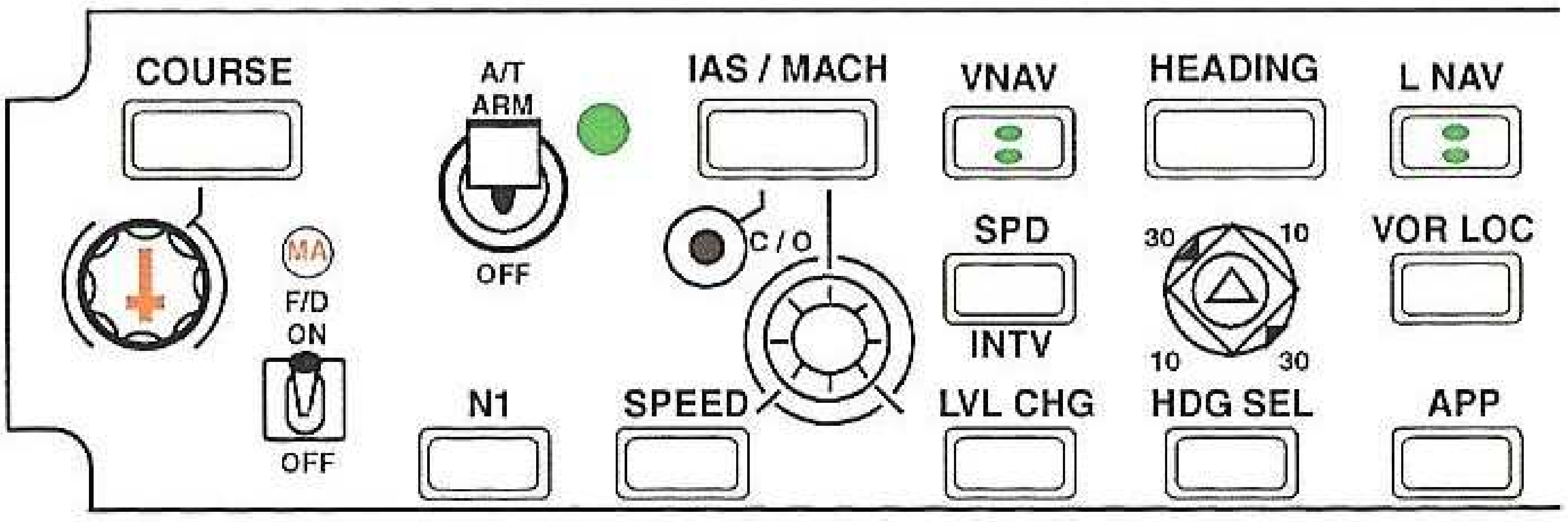
ARM - arms A/T for engagement, magnetically held at ARM
OFF - disengages A/T, prevents A/T engagement

AUTOTHROTTLE INDICATOR light (green)

- A/T ARM switch in ARM position

AUTOTHROTTLE LIMIT (A/T LIM) indication (white)

- above N1 gauges, indicates FMC is not providing the A/T system with N1 limit values
  - the A/T is using a degraded N1 thrust limit from the related EEC



AUTOTHROTTLES

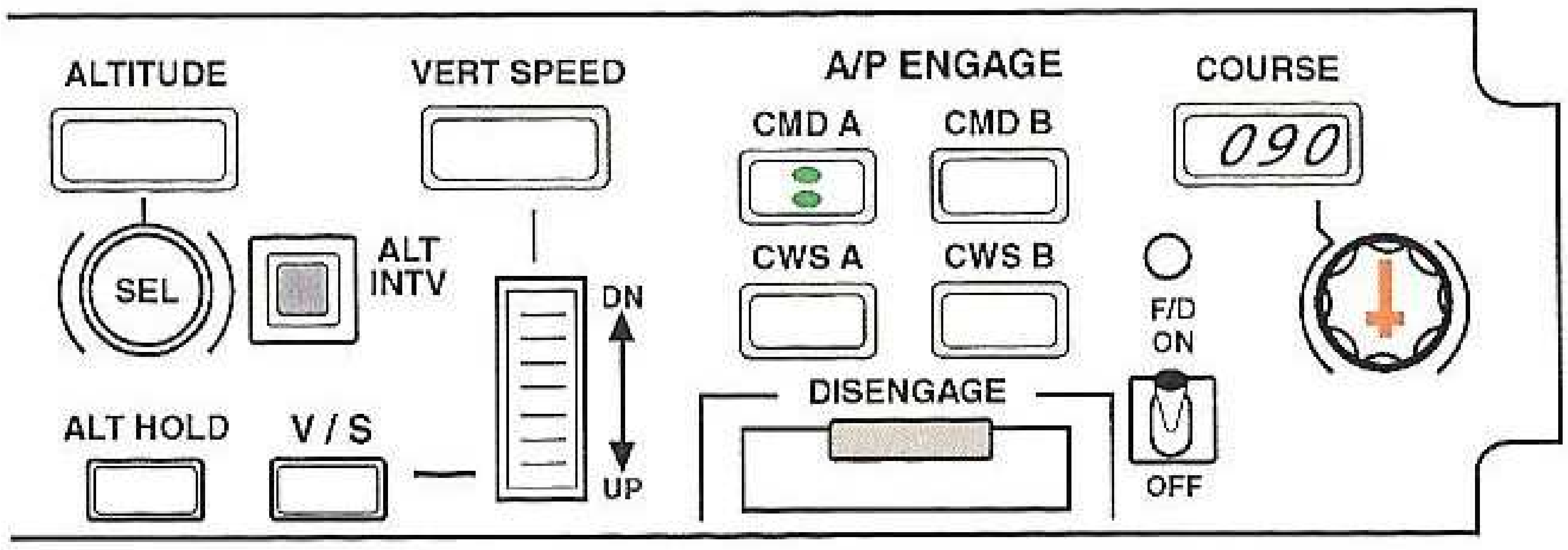
- full time operation, with or without A/P or F/D systems, from takeoff to landing
- 3 modes of operation: N1, SPEED, and VNAV (press respective switch to ON)
- will not disengage if throttles moved manually but A/T will reposition them unless in THR HOLD or ARM modes
- tries to equalize N1, with maximum of 8° throttle separation

(3-4-5)
  - may be operated with or without PMCs, however both PMCs should be ON or OFF

(NG)
  - may be operated with or without EECs, however both EECs should be ON or ALTN

- press TO/GA to activate A/T for takeoff or go-around
- press A/T DISENGAGE button to turn off
- A/T status is annunciated on the Flight Mode Annunciators (FMA)
- features *automatic gust compensation*, i.e., when used throughout approach and landing, it is not necessary to apply wind corrections
- provides flap and gear maximum speed protection
- provides minimum speed protection (maneuvering, etc.) except if A/T OFF and A/P or F/D engaged in Alt Hold, Alt Acq, or GS capture
- each throttle has its own servo motor and clutch
- A/T TAKEOFF MODE
  - press TO/GA button on ground (ref: TO/GA Takeoff)
- to terminate takeoff mode below 400 ft move both FD switches OFF
  - above 400 ft RA, other FD pitch and roll modes can be selected
- any of the following will cause autothrottle disengagement
  - moving A/T ARM switch to OFF, pressing either A/T disengage switch, an autothrottle system fault is detected, or 2 seconds have elapsed since landing touchdown
- the autothrottle also disengages if it is engaged in a Speed mode, RETARD for descent mode, or an N1 mode other than A/T GA mode AND;
  - thrust levers become separated more than 10°
  - significant thrust difference along with control wheel roll input of 10° or more at any point throughout the entire flight envelope
- A/T disengagement is followed by A/T arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.
- in the event the autothrottle detects an FMC failure by loss of transmission from the FMC for an FMC N1 limit which is greater than the A/T computer internally computed maximum N1 limit, the A/T utilizes an internally computed reversion limit and the A/T annunciates A/T limit. The A/Ttakeoff mode is locked out if this condition exists.
- in moderate to heavy rain, hail or sleet, turn engine start switches to CON, disengage autothrottles, and slowly adjust the thrust levers
- may "hunt" when encountering wind, temp and large pressure changes.

GLARE SHIELD PANEL



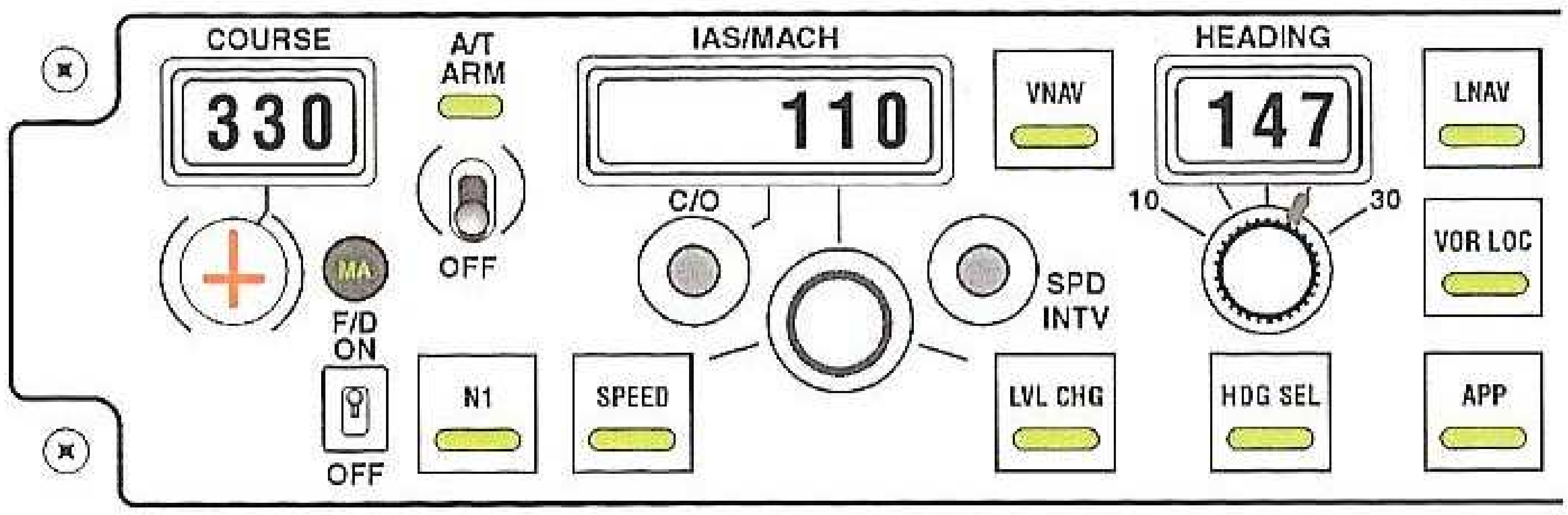
N1 SWITCH (only selects A/T mode)
- illuminates N1 switch light and annunciates N1 autothrottle mode
- A/T holds thrust at N1 limit (TO, GA, CLB, CRZ or CON) sent from FMC
- engaged manually by pushing N1 switch if N1 mode is compatible with existing AFDS modes
- engages automatically when engaging LVL CHG in climb (except during inhibit period for 2.5 min after lift-off), and when engaging VNAV in climb
- if an engine fails, its throttle advances 8° forward of other throttle
- when deselected, autothrottles engage in ARM mode

SPEED SWITCH (only selects A/T mode)
- illuminates SPEED switch light and annunciates MCP SPD autothrottle mode
- A/T holds speed shown on IAS/MACH display or a performance or limit speed
- engaged manually by pushing SPEED switch if speed mode is compatible with existing AFDS modes
- engaged automatically when ALT ACQ, ALT HOLD, or V/S engages, or G/S capture
- A/T does not set thrust above N1 limit, even if it cannot maintain speed
- A/T can exceed N1 value if manually set by N1 manual set knob
- if an engine fails, both throttles advance to maintain the target speed
- below 400', A/T will allow for rapid engine acceleration
- when deselected, autothrottles engage in ARM mode

IAS / MACH DISPLAY
- displays 100 kts when power is first applied
- displays selected speed when speed knob is controlling airspeed cursors
- sets V2 + 15 bug on the ground
- displayed speed range
  - 100 knots to VMO in increments of 1 knot, .60M to MMO increments of .01 Mach
- display is blank when VNAV mode engaged, or during a 2 engine F/D go-around or when A/T engaged in FMC SPD mode

SPEED CONDITION SYMBOLS
- overspeed or underspeed limiting symbol apears when commanded speed cannot be reached
- flashing 8 symbol means overspeed of VMO/MMO, landing gear, or flap limit
- flashing **A** ("alpha", for AOA) symbol means underspeed: below minimum speed (as sensed from angle of attack) or V/S mode *performance reversion* (airspeed becomes 5k less than MCP selected speed and there is no acceleration)

IAS/MACH SPEED SELECTOR
- rotating sets speed in IAS/MACH display and positions airspeed cursors
- selected speed is reference speed for AFDS and A/T
- not operative when IAS/MACH display is blank
- cannot enter speeds over VMO/MMO limits
- can enter speeds over flap placards, gear placards, and minimum speeds
- interruption of power drives MCP speed to 100
  - therefore, with power interruption, re-check MCP



CHANGE OVER switch
- pressing changes IAS/MACH display between IAS and MACH
- if using LVL CHG or V/S, automatic changeover occurs at approximately FL260 (IAS to equivalent Mach)

SPEED INTERVENTION (SPD INTV)
- used to make temporary changes to FMC target speed while remaining in VNAV
- SPD INTV can be used during climb, cruise or descent
- selecting when VNAV is engaged opens the IAS / MACH display on the MCP
  - FMC target speed is then displayed in IAS / MACH display
  - speed can be changed with the IAS / MACH speed selector on the MCP
  - selected speed will be displayed on airspeed indicator
  - selected speed will be displayed on the TGT SPD line of either the CLB, CRZ or DES page (depending on phase of flight) of the MCDU (i.e. 310 / MCP or .79 / MCP)
- in a VNAV PTH descent during idle thrust segment, FMA pitch mode will change from VNAV PTH to VNAV SPD
  - pitch mode on aircraft with geometric descent path will change to VNAV PTH after crossing the first altitude restriction
  - in non-idle segments of a VNAV descent, FMA pitch mode will change to VNAV PTH if not already in VNAV PTH
- pitch mode remains in VNAV PTH during approach after SPD INTV is exited
- in all other phases of flight, the current pitch mode remains unchanged
- deselecting SPD INTV button will cause IAS / MACH display to blank and speed will return to the FMC computed target speed

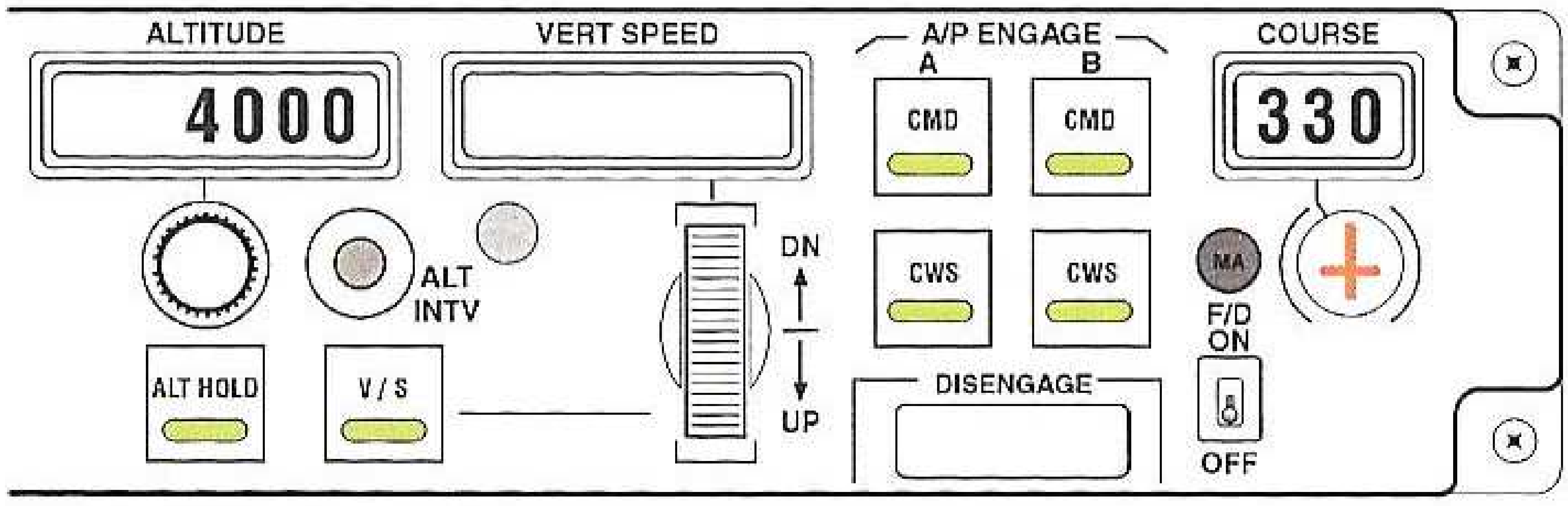
Caution must be taken when using SPD INTV during climb or descent to avoid speed violations. The use of speed intervention will supersede the default "250 / 10000" speed restriction on the CLB page and the "240 / 10000" speed restriction on the DES page

LEVEL CHANGE SWITCH / MODE
- LVL CHG switch light illuminates and pitch mode annunciates MCP SPD
- A/T holds limit thrust for climbs and idle thrust for descents
  - FMA A/T mode annunciates N1 for climb and RETARD followed by ARM for descent
- AFDS and A/T execute automatic climbs and descents to MCP selected altitude at selected airspeed
- AFDS holds selected airspeed
- if a speed mode is active when LVL CHG is engaged, this speed is retained as target
  - if a speed mode is not active, existing speed becomes target speed
- inhibited after glideslope capture

HEADING DISPLAY
- displays selected heading (also displayed on PFD Heading and Track Indicator)

BANK ANGLE SELECTOR
- sets maximum bank angle for AFDS operation in HDG SEL and VOR modes
- bank angles of 10, 15, 20, 25, and 30 can be selected

GLARE SHIELD PANEL



HEADING SELECTOR

- rotating sets heading in Heading Display and positions heading bugs on the PFD and ND

HEADING SELECT MODE

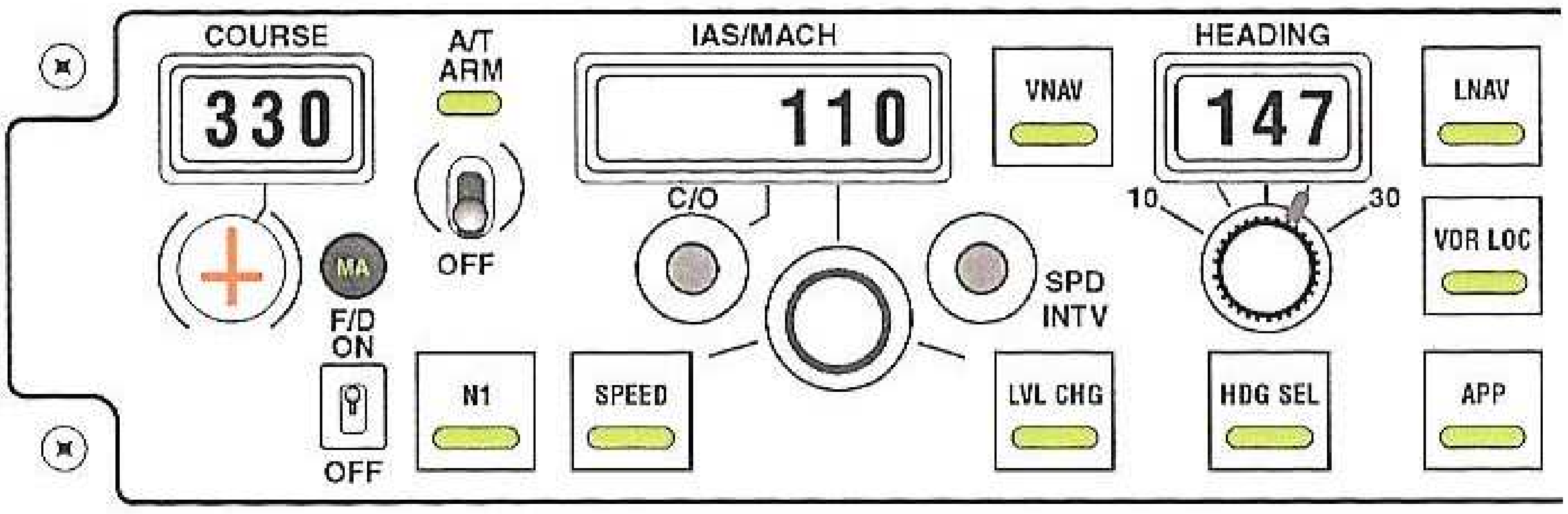
- AFDS turns to and maintains heading set in the heading display
- active with VOR LOC or APP selected (VOR/LOC armed) prior to selected radio course capture (automatically disengages upon capture of selected radio course)
- bank is established by the bank angle selector
- when the HDG SEL mode is initially engaged, the AP commands a turn in the shortest direction to the selected heading
- if the HDG SEL mode is currently engaged, the AP commands a turn in the direction the heading knob is rotated, and continues in that direction even if the heading select marker is rotated past 180°
  - example: positioned on runway 18 with a clearance to turn right to a heading of 030. Takeoff with HDG SEL in 180. At 400 ft, engage HDG SEL and turn it clockwise to 030
- disengages when LNAV is selected

VERTICAL NAVIGATION MODE (VNAV)

- AFDS and A/T follow thrust and speed commands from the FMC
- in VNAV climb, A/T holds FMC thrust limit and AFDS holds FMC target speed
- during VNAV SPD descent, A/T retards thrust to idle and AFDS holds FMC target
- during VNAV PATH descent, AFDS tracks FMC descent path. A/T starts with idle-ARM but can be commanded to FMC SPD if actual speed becomes too slow
- during a VNAV SPD climb or a VNAV PATH descent, automatic level off occurs at MCP selected altitude or at VNAV altitude constraint in the FMC, whichever is reached first
- in VNAV cruise, AFDS holds altitude and A/T holds FMC target speed
- VNAV mode is terminated by selecting another pitch mode, G/S capture, reaching end of LNAV route, transition of glideslope intercept waypoint with G/S armed (VNAV can be re-engaged) or XTK deviation exceeds twice the RNP during PTH descent for an active leg with a database vertical angle and LNAV not engaged.

LATERAL NAVIGATION MODE (LNAV)

- AFDS follows FMC roll commands to intercept and track the active FMC route
- selectable on ground with; (LNAV becomes active at 50 ft. AGL)
  - origin runway selected, and
  - active route entered, and
  - track of first leg within 5° of runway heading
- selectable in flight with;
  - active route entered, and
  - within 3 NM of active route, or
  - outside of 3NM, be on intercept course of 90° or less
- disengages automatically for the following
  - HDG SEL is engaged
  - VOR or LOC capture
  - reaching a route discontinuity
  - reaching end of active route
  - loss of capture criteria



VOR LOC SWITCH/MODE

- commands AFDS roll to intercept selected VOR course or inbound front LOC course
  - back course tracking is not available
- selected course can be intercepted while engaged in LNAV, HDG SEL, or CWS R if autopilot is engaged in CMD
- A A/P and Capt FD use information from Capt course selector and #1 VHF nav
- B A/P and FO FD use information from FO course selector and #2 VHF nav
- different course and/or frequencies for two VHF nav receivers can cause disagrement between the displays
- course capture point varies depending on course deviation, closure rate and intercept angle, but not later than 1/2 dot
- VOR or LOC mode depends on what is tuned in
  - if LOC tuned, VHF nav radios switch from tail antenna to front antenna when VOR/ LOC is annunciated
  - if antenna switching does not occur, LOC is inhibited
- disengages if nav radio detuned

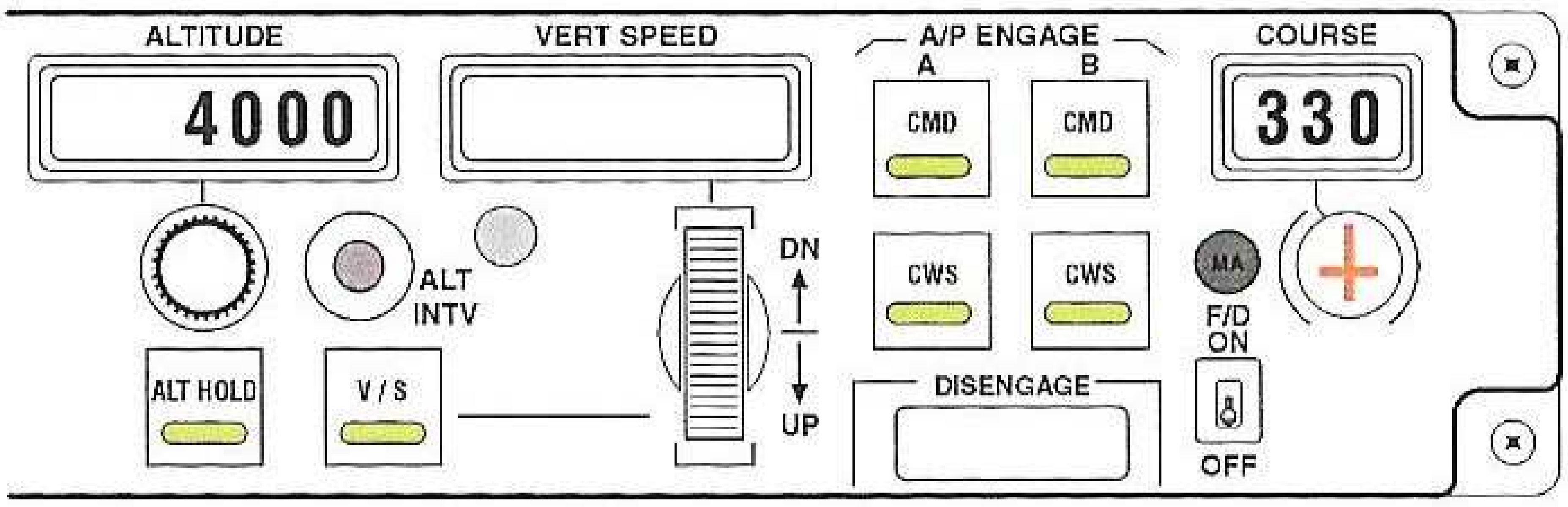
APPROACH MODE

- arms IAN mode to capture and track final approach course and glide path
- selectable after ILS frequency tuned
- use after "Cleared For Approach" but do not violate step down altitudes
  - glide slope beam does not guarantee crossing restrictions
- permits single or dual A/P operation
  - dual A/P operation requires that both VHF NAV receivers be tuned to the ILS frequency and the second A/P be engaged in CMD prior to 800 feet RA
- AFDS intercepts and captures LOC no later than 1/2 dot
- AFDS captures GS at 2/5 dot (above or below) then commands a descent rate and tracks the GS
  - LOC must be captured before GS will capture, GS capture is inhibited prior to LOC capture
- after LOC and GS capture, APP mode switch extinguishes, previous pitch mode disengages, and GA is displayed on TMA
- to exit APP mode (after localizer and glideslope capture):
  - press TO/GA, or disengage A/P(s) and turn both F/Ds off, or retune the VHF Nav receive
- turn both F/Ds on, to provide backup guidance and primary go around guidance
- FD bars retract at 50' RA
- at or above DH, the A/P should be disengaged and either a manual landing or a manual go-around executed
- for the VOR LOC and APPROACH modes, the A FCC, A A/P, and Captain's F/D use the selected course set by the Captain and nav data from the #1 VHF NAV rec. The B FCC, B A/P, and FO's F/D use the selected course set by the FO and nav data from the #2 VHF NAV rec

ALTITUDE DISPLAY

- displays selected altitudes from 0 to 50,000 ft in 100 ft increments
- displayed altitude is reference for altitude alerting and automatic level-offs

GLARE SHIELD PANEL



ALTITUDE SELECTOR

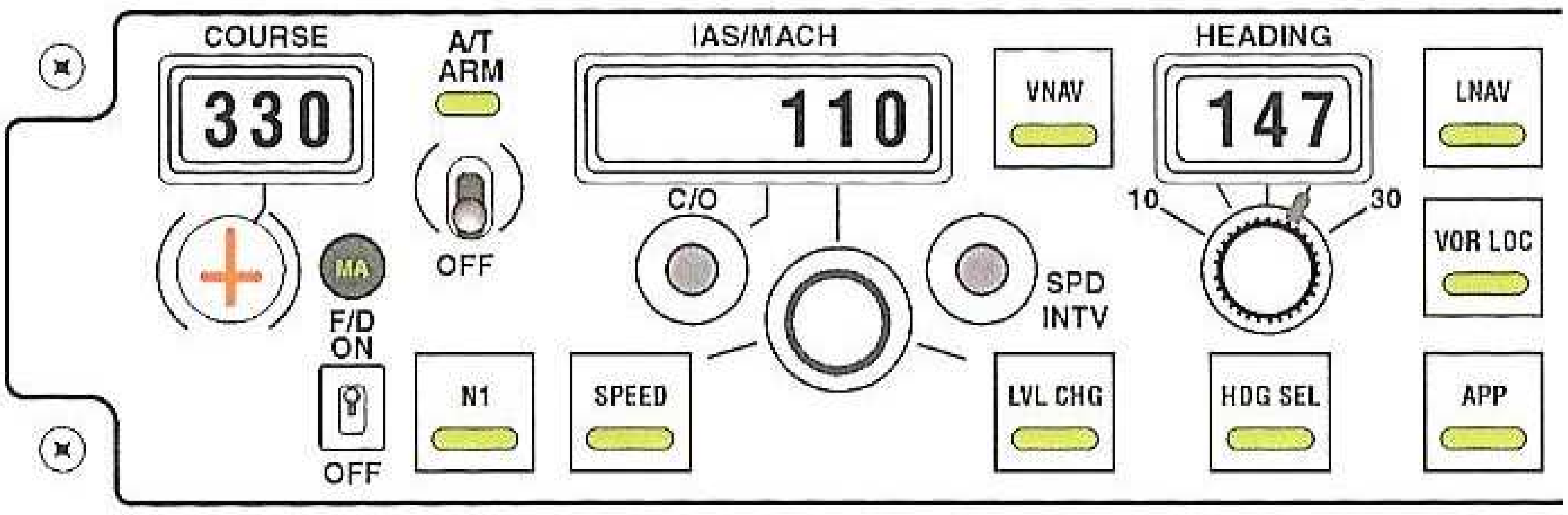
- selects reference altitude for altitude alerting and AP altitude acquisition
- rotating sets altitude in 100 ft. increments
- arms Vertical Speed mode if rotated while in ALT HOLD at selected altitude

ALTITUDE HOLD MODE (ALT HOLD)

- AFDS commands pitch to hold MCP selected altitude
- AFDS holds altitude at which switch is pressed
- mode selector switch extinguishes if altitude being held is within 100' of selected altitude
- ALT HOLD is annunciated at all times mode is active
- inhibited after GS captured

ALTITUDE INTERVENTION (ALT INTV) switch

- during climb or descent in VNAV, allows manual deletion of next FMC altitude constraints that are between the current altitude and MCP altitude. One altitude constraint will be deleted with each press of the switch
- during climb or cruise in VNAV, will change FMC cruise altitude to MCP selected altitude if MCP altitude is higher than current FMC cruise altitude (FMC cruise altitude cannot be decreased using ALT INTV switch)
- during cruise in VNAV, allows aircraft to initiate a cruise descent if MCP altitude is lower than FMC cruise altitude
- VNAV climb
  - lowest FMC altitude constraint below the MCP altitude is deleted
  - if currently at FMC altitude constraint with VNAV PTH annunciated on the FMA, allows airplane to continue to climb in VNAV as long as MCP altitude is above current altitude
  - if currently at MCP altitude with VNAV ALT annunciated on the FMA, raising the altitude on the MCP and selecting ALT INTV will allow the airplane to continue to climb in VNAV
  - if MCP altitude is set higher than current FMC altitude, FMC cruise altitude will be changed to selected MCP altitude
- VNAV cruise
  - if MCP altitude is set higher than current FMC cruise altitude, FMC cruise altitude will be changed to selected MCP altitude and a cruise climb will be initiated
  - if MCP altitude is set below the current FMC cruise altitude, an early descent is initiated (same as selecting DES NOW on descent page). Aircraft will fly a cruise descent (1000 FPM) until MCP altitude is reached or VNAV path is captured
- VNAV descent
  - highest FMC altitude constraint above MCP altitude is deleted
  - if currently at FMC altitude constraint with VNAV PTH annunciated on the FMA, allows airplane to continue to descend in VNAV as long as MCP altitude is below current altitude
  - if currently at MCP altitude with VNAV ALT annunciated on the FMA, lowering the altitude on the MCP and selecting ALT INTV will allow the airplane to continue to descend in VNAV



VERTICAL SPEED DISPLAY

- selected vertical speeds from -7900 to +6000 fpm
- blank when V/S mode not active
- present V/S when V/S mode is engaged with V/S mode switch
- 50 fpm increment if less than 1000 fpm, 100 fpm increment if 1000 fpm or greater

VERTICAL SPEED MODE

- is not selectable while ALT HOLD mode is active at selected altitude or after glide slope captured in APP mode
- V/S is automatically:
  - activated by pressing the V/S mode switch or when a new altitude is selected (> 100') while ALT ACQ is annunciated
  - armed if a new altitude (> 100') is selected while ALT HOLD mode is active at previously selected altitude. Moving V/S thumbwheel then activates V/S mode starting at zero fpm rate
- once activated, the vertical speed display shows vertical speed
- when V/S activated, the A/T (if armed), will engage in MCP SPEED mode, to maintain selected airspeed or mach
- Performance Limit Reversion:
  - if the airspeed becomes more than 5 kts below the MCP selected airspeed and is not increasing, the AFS reverts to LVL CHG and the underspeed symbol appears in the MCP IAS/Mach display
  - Performance Limit Reversion can occur with A/T off and A/P on
- Minimum Speed Reversion occurs when the selected speed is less than 1.3 Vs.
  - AFDS reverts to LVL CHG and commands a speed 5 kts greater than min speed
- minimum speed reversion is not available
  - when the A/T is OFF and the AFDS is in the ALT HOLD mode, or
  - after G/S capture, or
  - when in VNAV PTH and flying a level segment

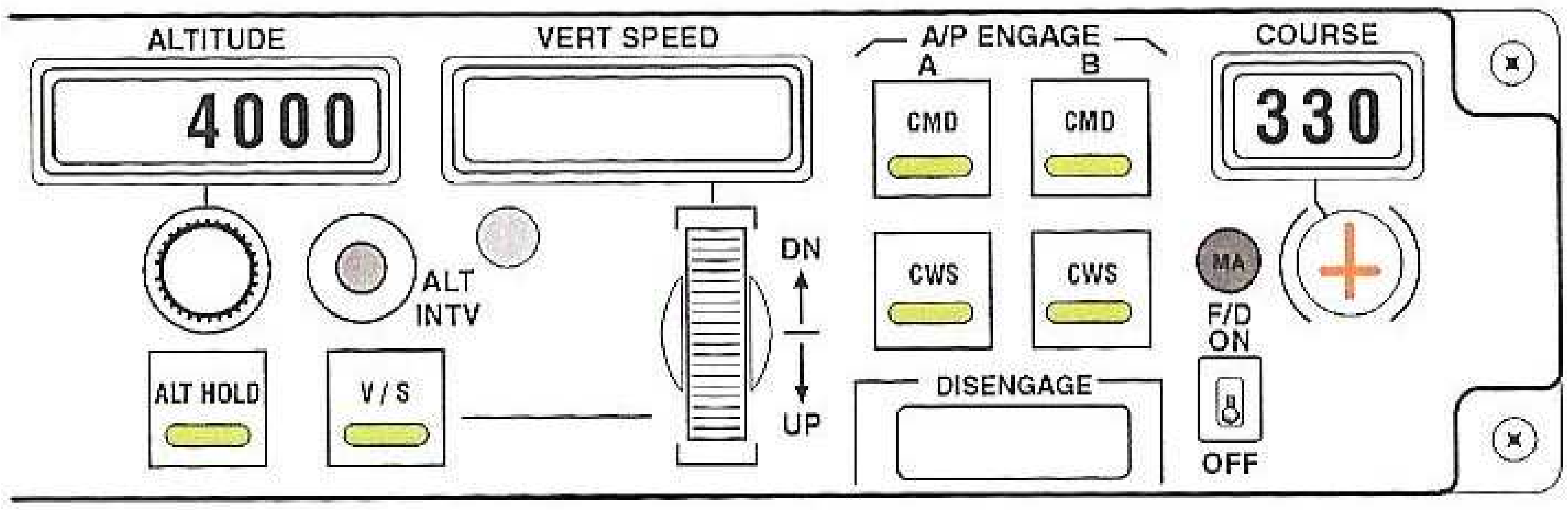
AUTOPILOT ENGAGE switches (A or B)

- A/P engagement prohibited unless
  - no force is being applied to control wheel, and
  - STAB TRIM AUTOPILOT CUTOUT switch is in NORMAL
- switches (buttons) selectable one at a time unless APP mode is engaged
  - selecting second switch will cause first to disengage when not in APP mode
  - in APP mode second A/P must be engaged prior to 800 feet RA

CMD

- enables all command modes for AFDS in addition to CWS (if none selected or by overriding greater than normal CWS control forces)
- if one or both FDs in command mode and the bars are not within 1/2 scale of center, then the A/P goes automatically CWS for pitch and / or roll and the F/D bars retract
- command modes can be armed or engaged with a switch in CMD and/or one or both F/D switches are ON

GLARE SHIELD PANEL



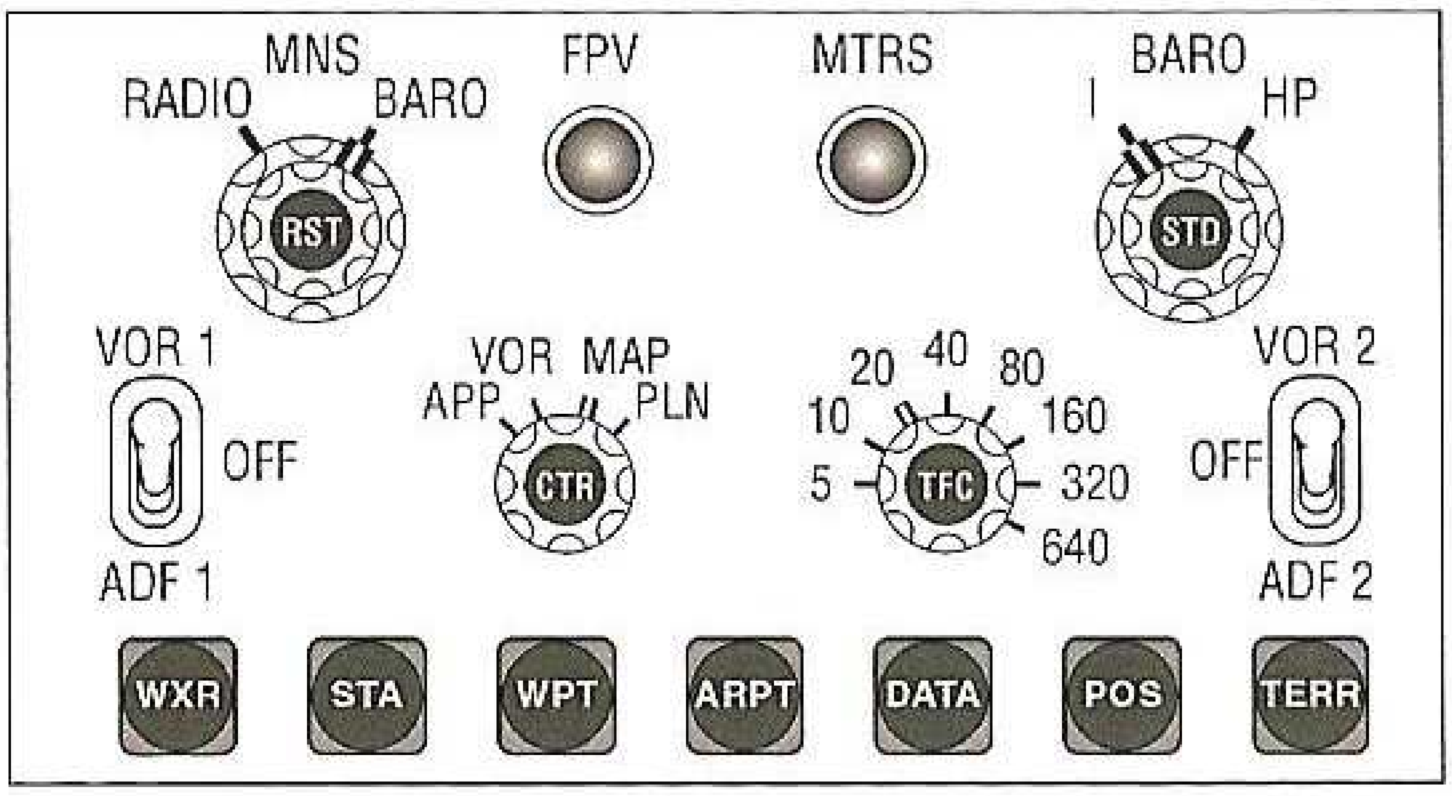
CWS

- CWS engages if pitch or roll mode not selected, if pitch or roll mode deselected, or if pitch or roll mode manually overridden with control column force
- displays CWS P and/or CWS R in A/P status display
- FDs, if ON, display guidance commands and FD annunciates in A/P status display
  - A/P does not follow commands while in CWS

  CAUTION: CWS does not capture altitude for level-off - monitor closely!
- A/P pitch and roll are controlled through control wheel and column pressures
- if control pressure is released, A/P holds existing attitude
- if aileron pressure is released with 6° or less of bank, A/P rolls wing level and holds existing heading
  - heading hold feature inhibited if below 1500' RA with gear down, or after LOC capture in APP mode, or after VOR capture with TAS 250 kts or less
- when approaching a selected radio course in CWS R with VOR/LOC or approach mode armed, VOR/LOC engages when course is intercepted
- if pitch is manually overridden while in ALT HOLD and control force released within 250 ft of selected altitude, A/P pitch mode engages in ALT ACQ and returns to selected altitude in ALT HOLD mode
- use CWS if in severe turbulence or if a/c is occilating in VNAV or LVL CHG climb

- for coupled single channel approaches with electronic glideslope, the autopilot shall not remain engaged below 50 ft AGL
- for non precision approaches disengage the autopilot before descending below 50' MDA
- max wind speeds for autoland: headwind 25 kts; crosswind 20 kts (15 kts Cat II/III approach); tailwind 10 kts
- autoland may only be used for flaps 30 and 40 with both engines operating
- in a dual autopilot mode, the 737 incorporates a fail-passive automatic flight control system. This system meets the applicable airworthiness and performance reliability requirements for auto coupled approaches and landings
- Autopilot will disengage for the following
  - pressing either A/P disengage switch
  - pressing either TO/GA switch with single A/P engaged in CMD or CWS above 2000 ft RA with flaps not up or G/S captured
  - pressing either TO/GA switch with single A/P engaged in CMD or CWS below 2000 ft
  - pressing either TO/GA switch after touchdown with both A/P's engaged in CMD
  - pressing an illuminated A/P engage switch
  - pushing the A/P engage bar down
  - activating either pilot's control wheel trim switch
  - moving the stab trim autopilot cutout switch to CUTOUT
  - either the left or right IRS system fail or fault light illuminated
  - moving an IRS or EFI switch
  - loss of electrical power or a sensor input which prevents proper operation of the engaged A/P and mode
  - loss of the respective hydraulic system pressure

EFIS CONTROL PANEL (NG)



MINS Selector (outer knob-2 position)
- RADIO selects radio altitude as the minimums reference
- BARO selects barometric altitude as the minimums reference

MINS Selector (middle)
- rotate to adjust the radio or baro minimums altitude

MINS Reset push button switch (RST)
- push: (option - Altitude Alert, ALT)
- blanks radio height ALT alert
- resets the radio altitude minimums alert display on the attitude indicator
- blanks the reference altitude marker on the altimeter if displayed; sets the reference altitude marker to zero if not previously displayed

FPV (option) (gone if ATT fails)
- push the Flight Path Vector button to display flight path vector ("birdie") on the ADI
- aircraft's velocity vector through the air as determined by ADIRU and barometric altitude inputs, independent of airspeed
- *lateral axis*
  - shows motion of the aircraft relative to the airplane heading
  - FPV moves left (wind from rt) or right (wind from lt) to indicate the relative position of the ground track to the present heading (drift angle). The amount of drift cannot be determined because there are no heading marks on the horizon line
  - in a crosswind landing, if you have the correct cross-control input, the *lateral axis display will be on centerline; you will have no side slip and the aircraft's vector at touchdown will be zero side-load*
- *vertical axis (prioritized by usefulness)*
  - shows Flight Path Angle (motion of the a/c) relative to the horizon line
  - in climbs or descents, radar tilt can be adjusted to an appropriate elevation based on the current FPA. Radar tilt, like the FPV, is referenced to the horizon. For example, adjusting the radar tilt to the same angle relative to the horizon as the FPV during climb results in the radar beam centered on the existing flight path.
  - to maintain level flight without the FD, place the FPV on the horizon line
    - but you should still know what attitudes produce level flight, climbs, descents
  - every degree below level flight equals approximately 100 ft descent per nm.
    - ex: 3 degree descent is 320 ft per nm
  - to maintain a 3° descent during a non-precision approach, place the FPV 3° below the horizon line. The FPV does not indicate airplane glide path relative to the runway, a ground based navaid such as the GS or VASI, or FMC VNAV path.
  - with loss of airspeed, adjust the pitch to establish desired flight path by placing FPV above, below, or on the horizon line
- Caution: vector instrument flight is different from attitude instrument flight

MTRS
- a window appears in the upper half of the altimeter that displays airplane altitude in meters (white)
- altitude display above the altimeter is the MCP altitude setting in meters (magenta)
- both meters displays are suffixed with an **M** in cyan
- not available in compact display

BAROmetric Selector (outer knob-2 position)

IN selects inches of mercury

HPA selects hectopascals as the barometric altitude reference

BAROmetric Selector (middle)
- rotate to adjust the barometric altitude setting on the altimeter

BAROmetric Standard (STD) switch (inner button)
- push to automatically select QNE (29.92 inches or 1013 HPA)
- push again to select previous altimeter setting (QNH)

VOR/ADF switch
- replaces "rabbit ears" on older RMDI
- VOR 1/2 displays the selected VOR bearing pointer
  - info in lower left and right corners of the ND (VOR 1, VOR 2, frequency or station ID and DME) are in green
  - narrow pointer for #1 and wide pointer for #2 are in green

OFF removes the VOR or ADF displays. EFIS - displays OFF in place of the bearing pointer source indicators on the RDMI. ND it blanks
- ADF 1/2 displays the selected ADF pointer
  - info in lower left and right corners of the ND (ADF 1, ADF 2, frequency or station ID) are in cyan
  - narrow pointer for #1 and wide pointer for #2 are in cyan

MODE SELECTOR

- selects the type of data symbols displayed on the ND

APP position
- the ND reference is airplane heading up
- with a LOC frequency selected:
  - displays ILS frequency data in heading-up display
  - displays the source of navigation data as ILS 1 or ILS 2
  - displays the navigation source frequency or (ND) identifier
  - weather radar and TCAS are not displayed in center APP mode
- with a VOR frequency tuned, EFIS MODE / NAV FREQ DISAGREE message appears

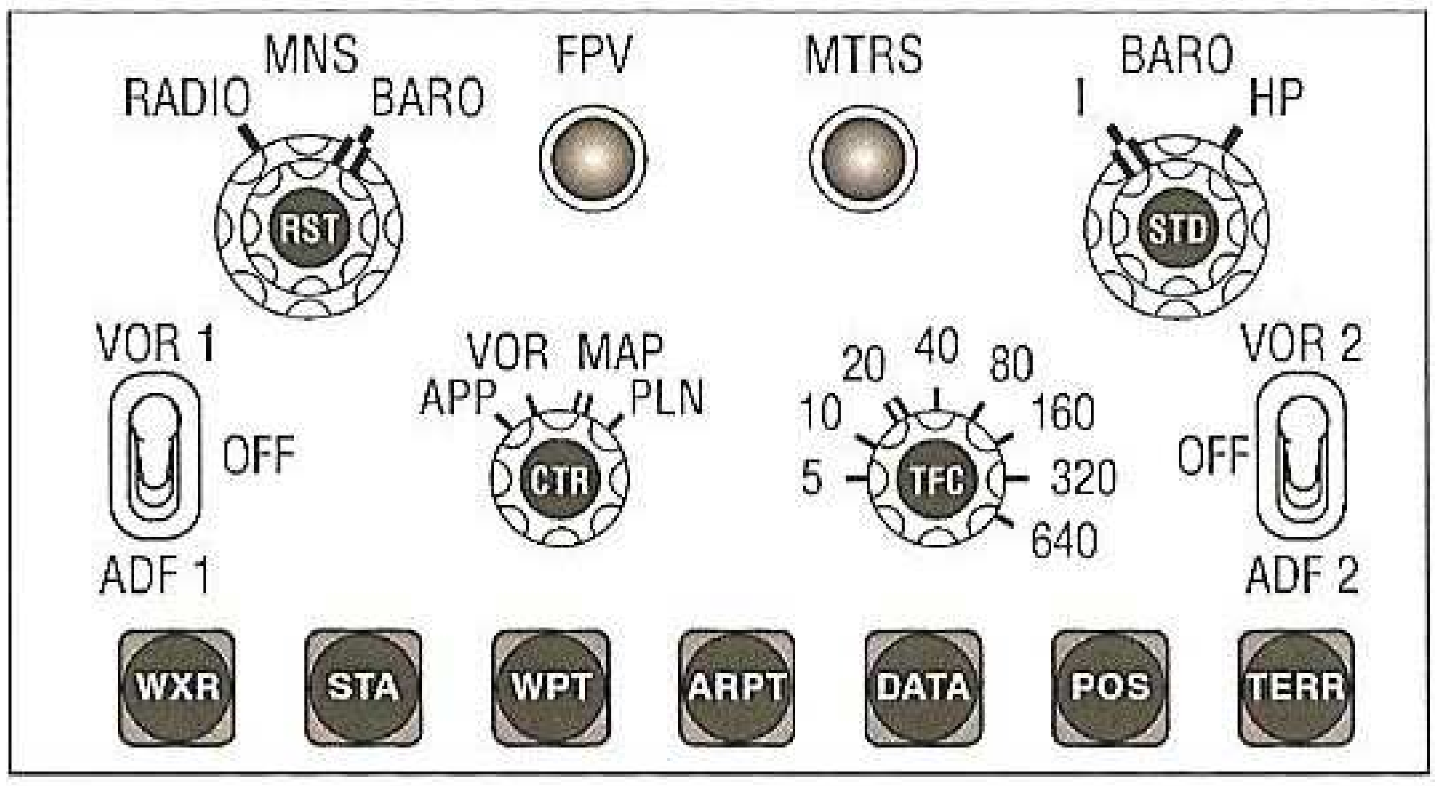
VOR position
- the ND reference is airplane heading up
- with a VOR frequency selected:
  - displays VOR navigation data in heading-up display
  - displays the source of nav data as VOR 1 or VOR 2
  - displays TO/FROM annunciation and the nav source frequency or (ND) identifier
  - weather radar and TCAS are not displayed in center APP mode
- with an ILS frequency tuned, EFIS MODE / NAV FREQ DISAGREE message displays

MAP position
- the ND reference is airplane track
- displays a fixed aircraft symbol superimposed on a moving map background. The basic map background data includes origin/destination airports, flight plan route, and display of navaids in use
- weather radar return data is displayed when the WXR switch is ON

PLAN position
- displays a static map which is oriented to true north
- the airplane symbol represents actual airplane position and orientation
- allows the pilot to review the planned route by using the on-side LEGS page CENTER STEP line select key
- weather radar display data and TCAS display are inhibited

CTR MAP switch
- displays the same data and symbols as the other positions, but the airplane symbol is placed in the center of the full compass rose (center) for APP, VOR and MAP modes
- VOR and APP modes shifts from EXP to FULL
- subsequent presses alternate between expanded and center displays

MAP switches



- when selected, add background data/symbols to EHSI / ND
- multiple options can be selected simultaneously
- EXCESS DATA message appears where there is too much symbology for the SG to handle. Flight plan wpts are drawn with priority
- ON when pressed

  WXR radar switch
  - displays weather radar return data on the EHSI / ND when the Mode Selector is in APP, VOR, MAP or MAP CTR positions (all but PLAN). Deselects TERR display if on.

  STA map switch
  - displays FMC database high altitude navigation aids on map scales 80, 160, 320, or 640 NM
  - displays all FMC database navigation aids if on map scales 10, 20, or 40 NM

  WPT map switch (Waypoints)
  - displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 NM or less

  ARPT map switch (Airports)
  - displays all airports which are stored in the FMC database and which are within viewable map area

  DATA map switch (Route Data)
  - displays altitude constraint (if applicable) and estimated time of arrival (ETA) for each active route waypoint

  POS map switch
  - displays VOR and/or ADF (EFIS if installed) raw data radial if the VOR or ADF receiver(s) is tuned to a usable station and valid data is being received

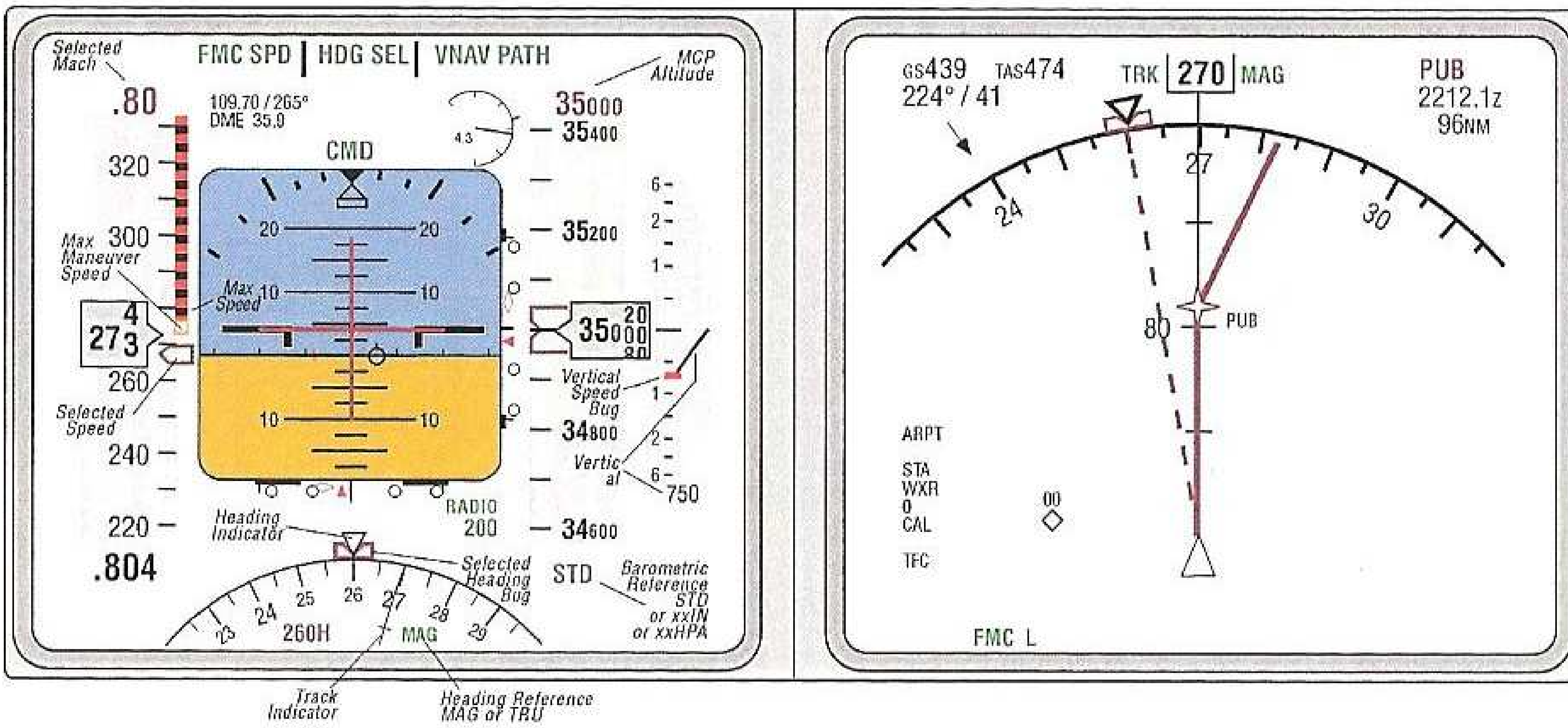
  (NG) PFD/ND display, ADIRU and GPS positions displayed using symbols

  TERR map switch
  - displays terrain data in expanded MAP, CTR MAP, expanded VOR, and expanded APP modes
  - arms terrain display in PLN, CTR VOR, and CTR APP modes
  - deselects weather radar display if on
  - terrain and weather radar cannot be displayed simultaneously on an individual display; however, the captain's and first officer's map displays are independent, so weather can be selected on one display while terrain is displayed on the other
- when ARPT, WPT, or STA is selected, the label will be displayed on the Map at the 7 o'clock position

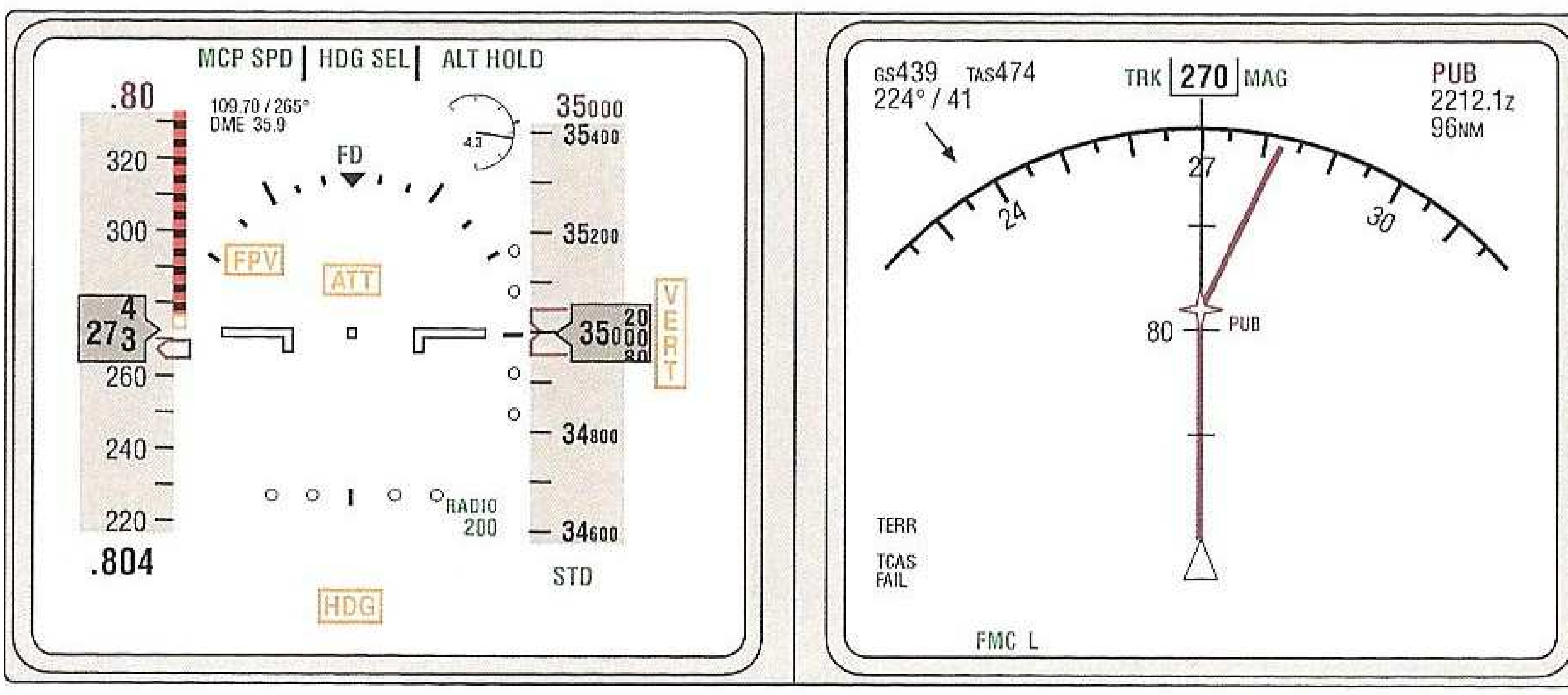
(QRH) (NG) Displays Control Panel

- reference Index for (QRH) Displays Control Panel
- DISPLAYS CONTROL PANEL message indicates failure of the related EFIS Control Panel

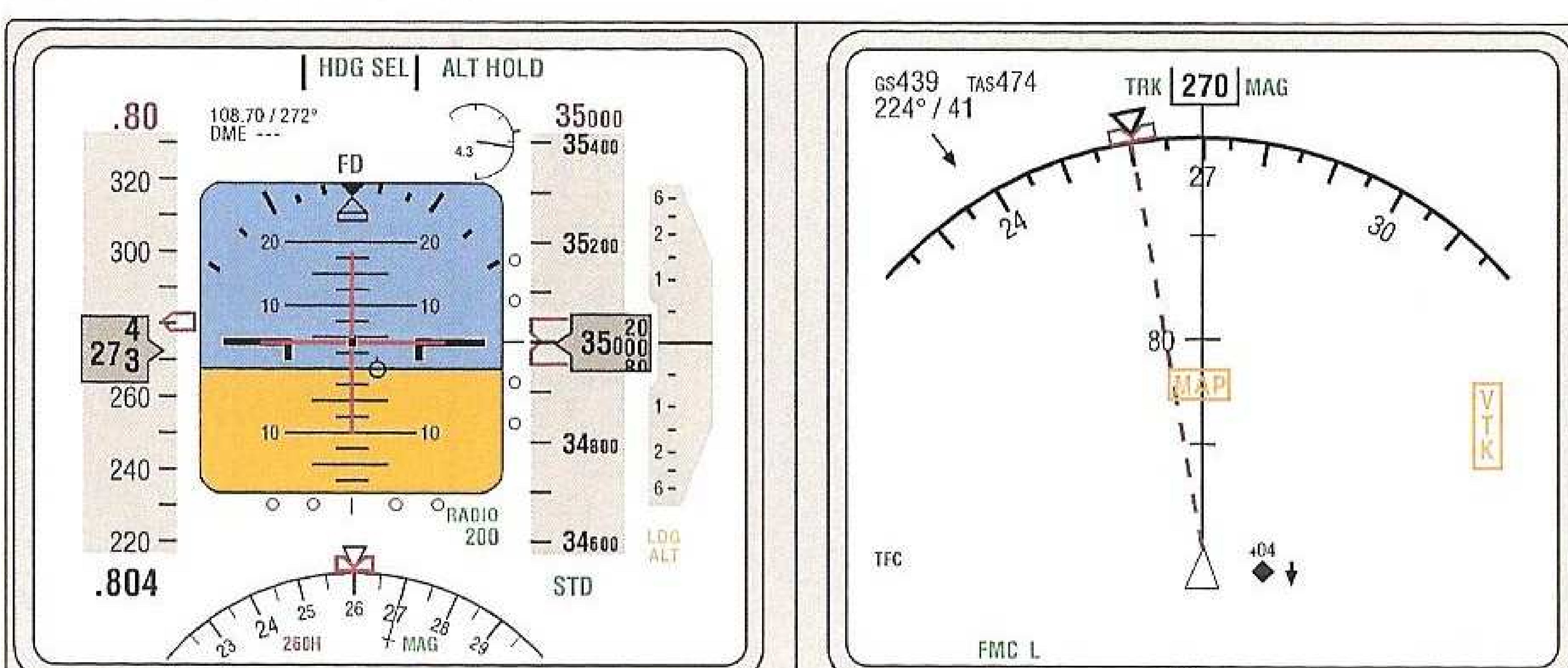
PFD/ND DISPLAY OPTION (NG)



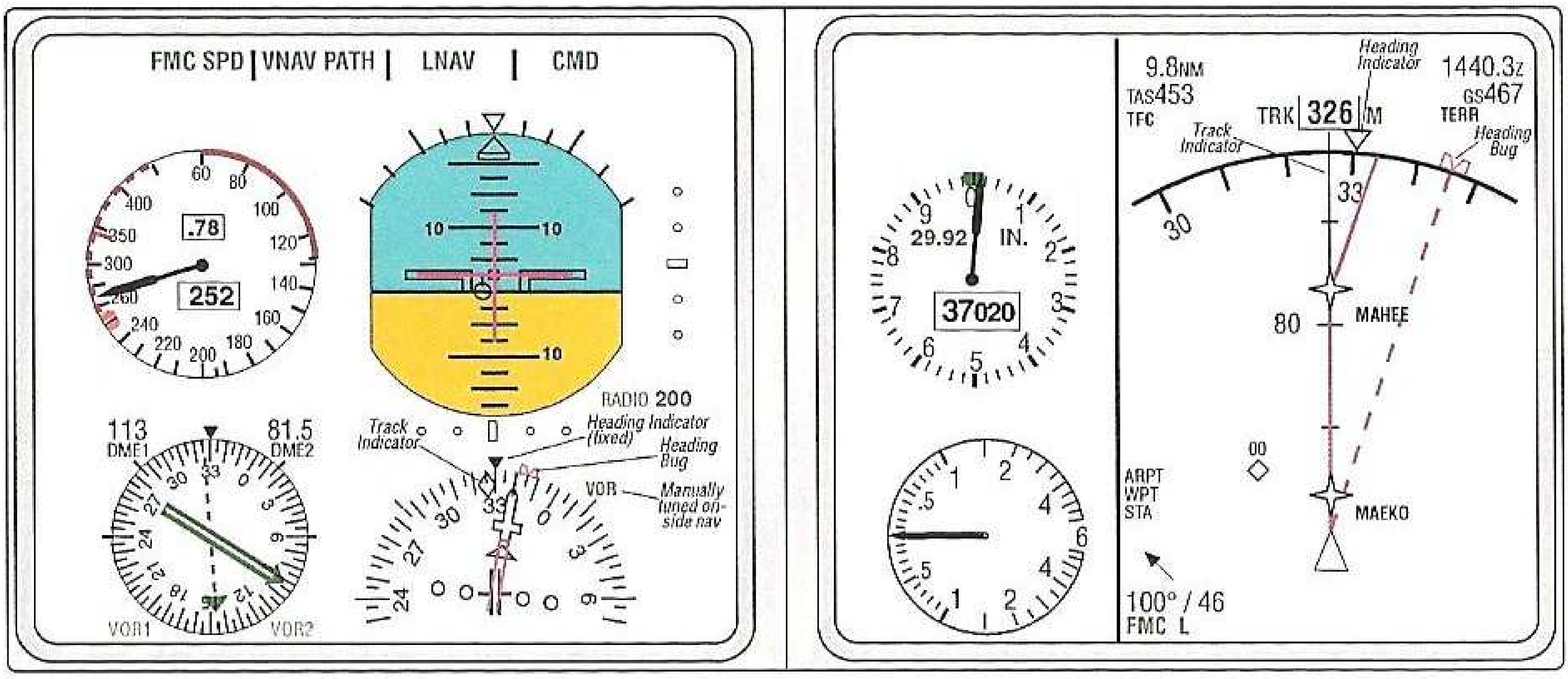
PFD/ND DISPLAY IRU INOP



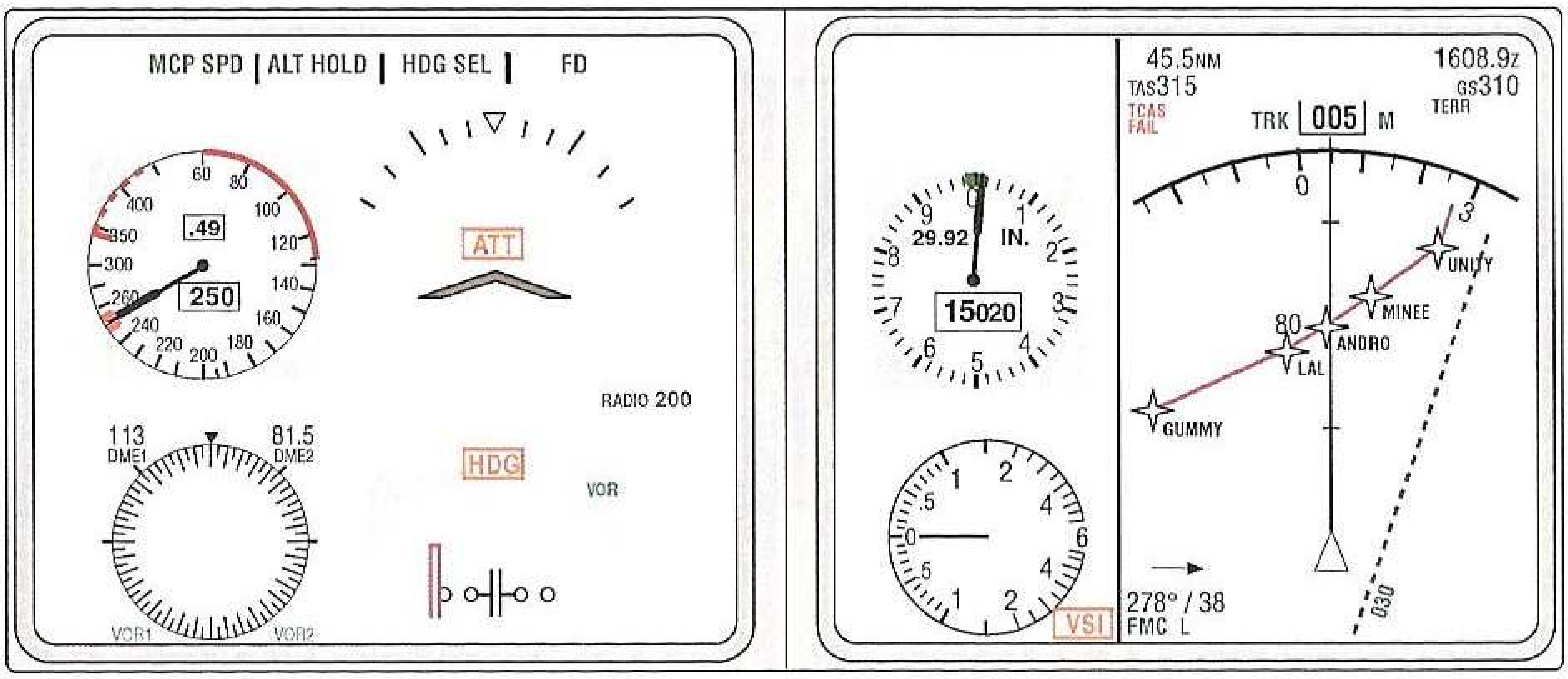
PFD/ND DISPLAY FMC INOP



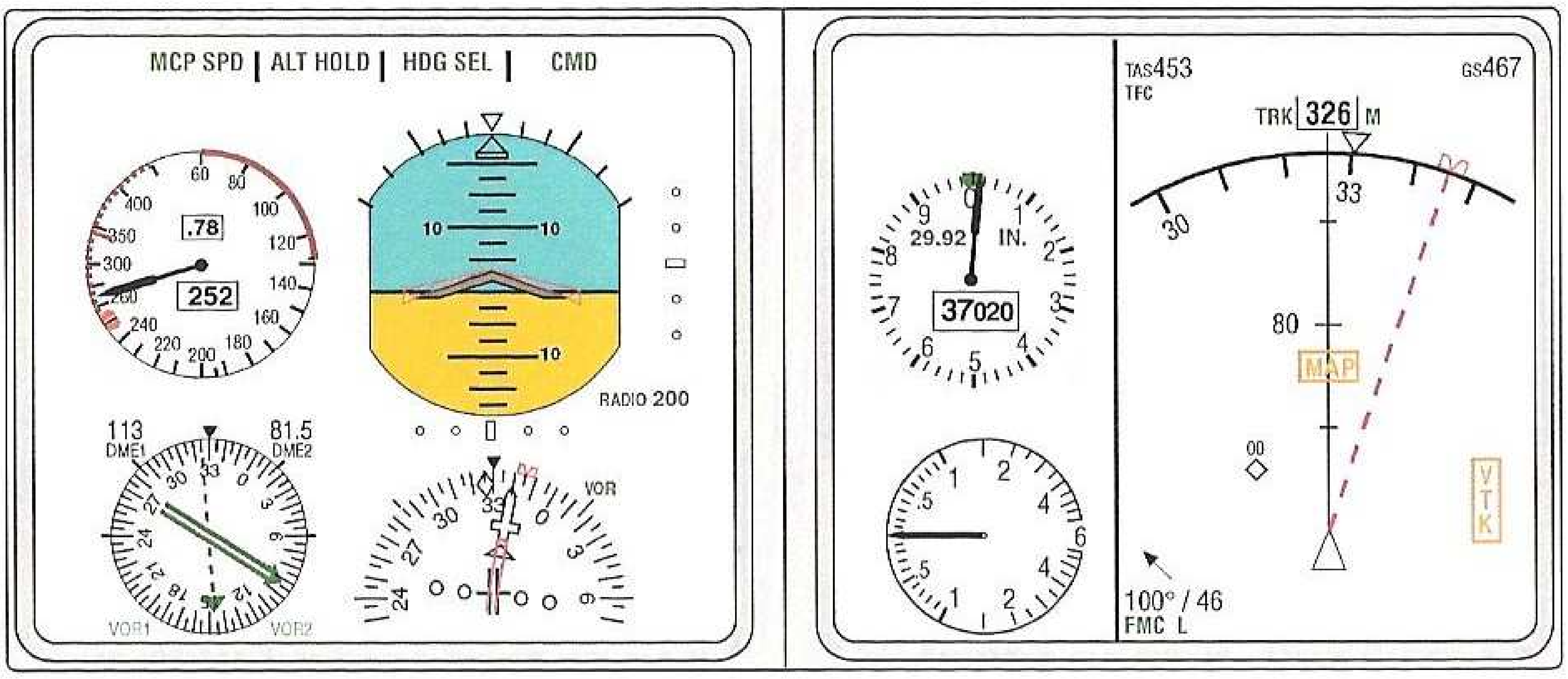
EFIS DISPLAY OPTION (NG)



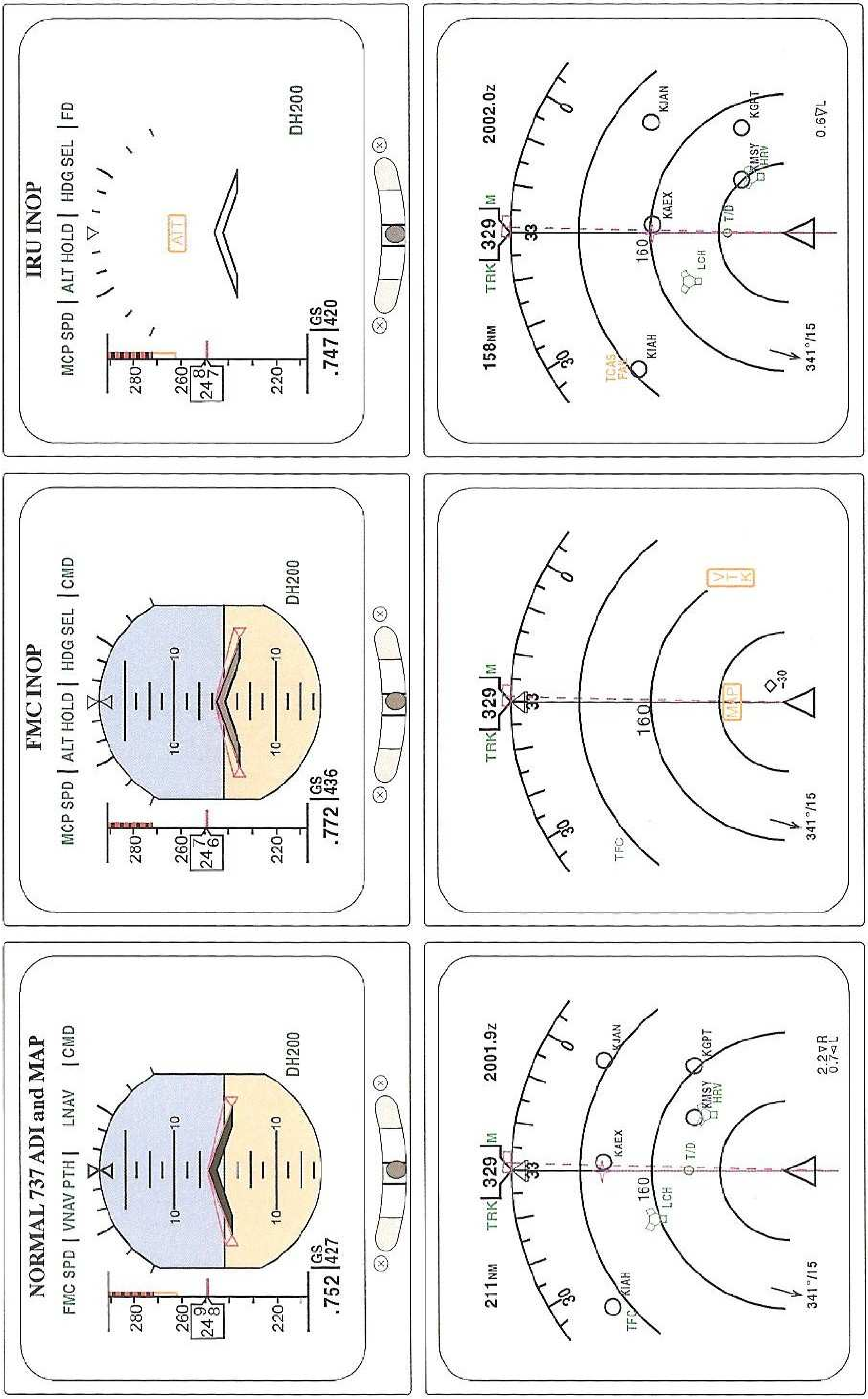
EFIS DISPLAY IRU INOP



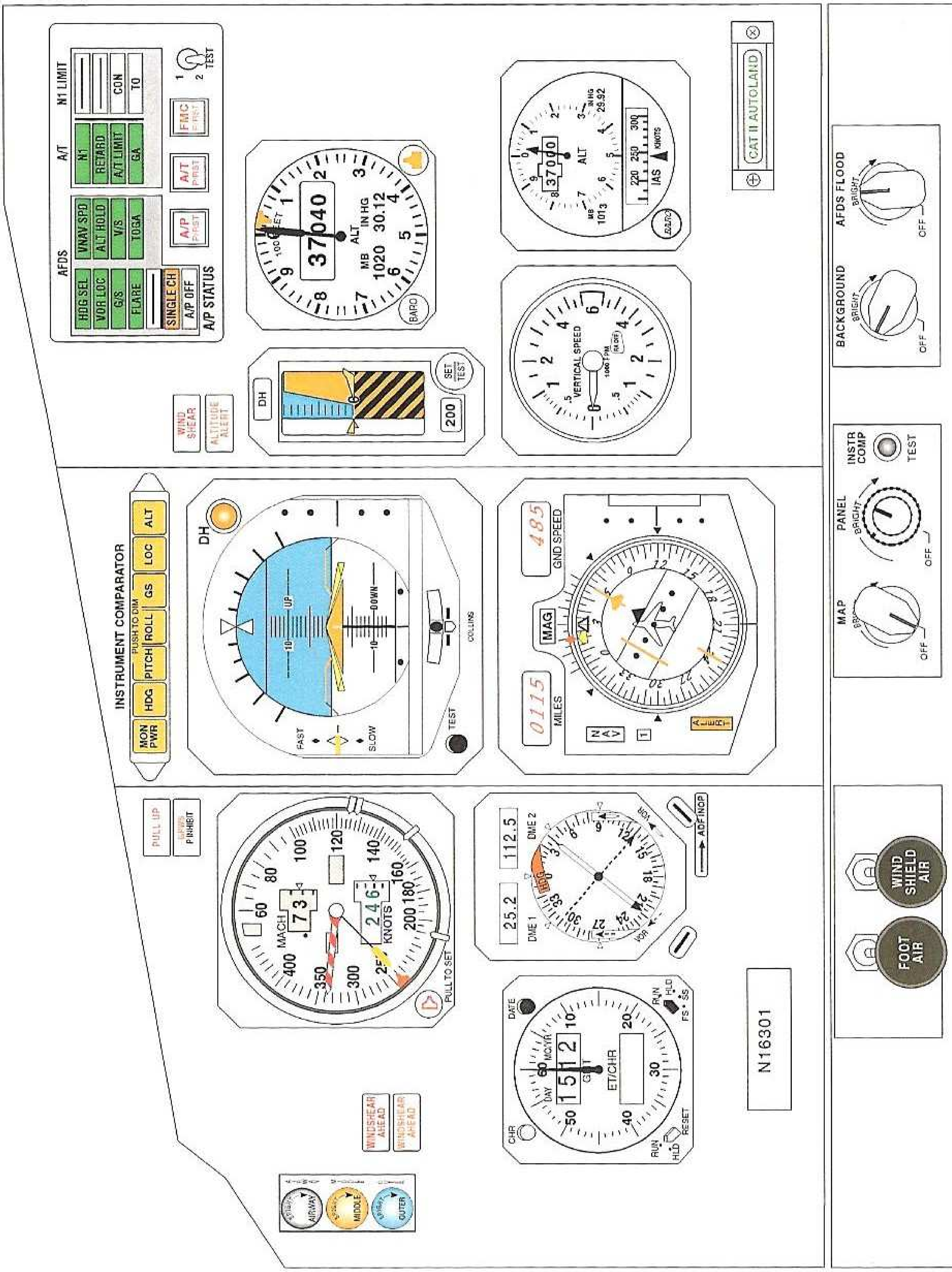
EFIS DISPLAY FMC INOP



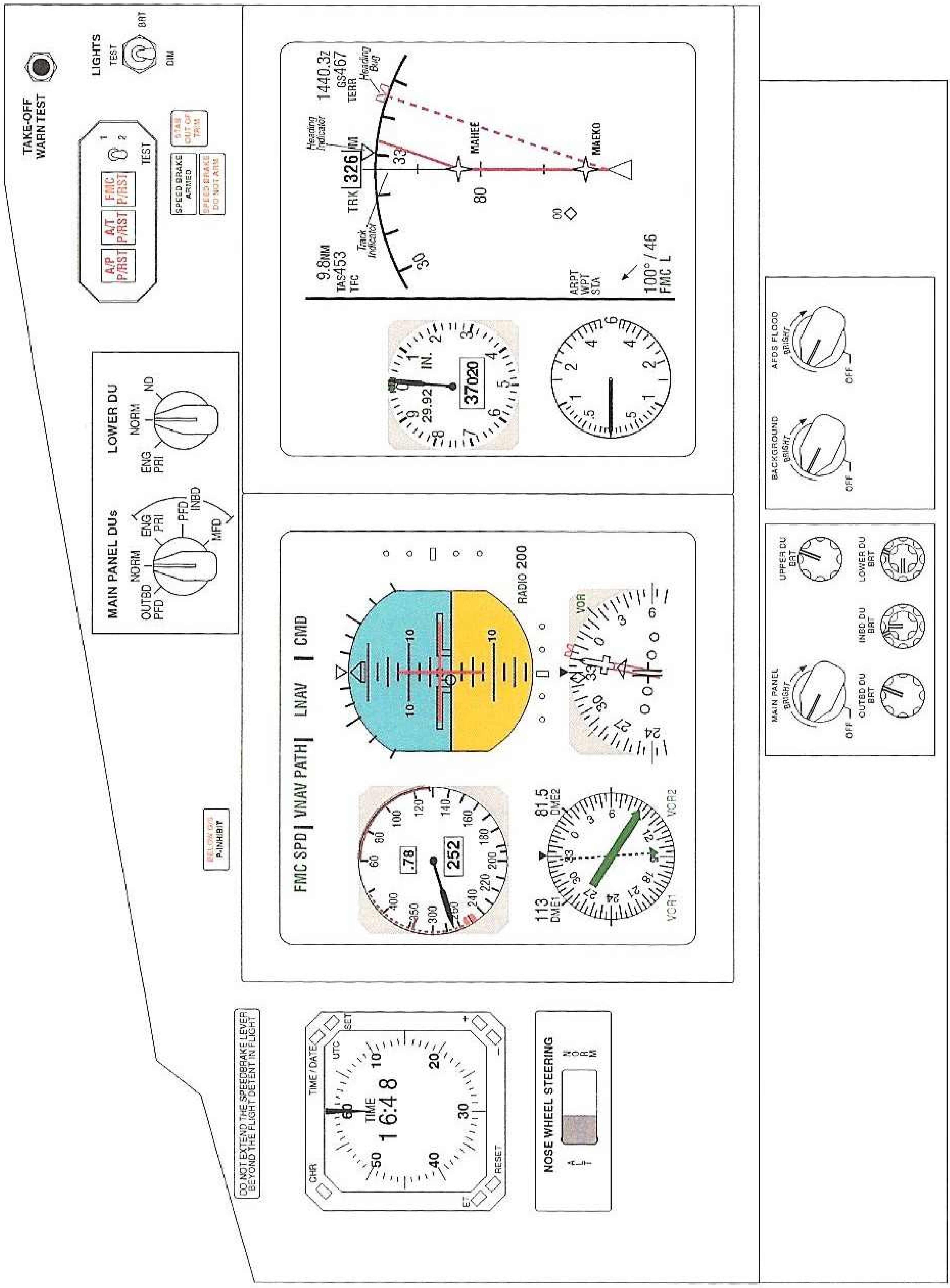
EFIS DISPLAY STUDY (Classic)



CAPTAIN'S PANEL (Round dial)

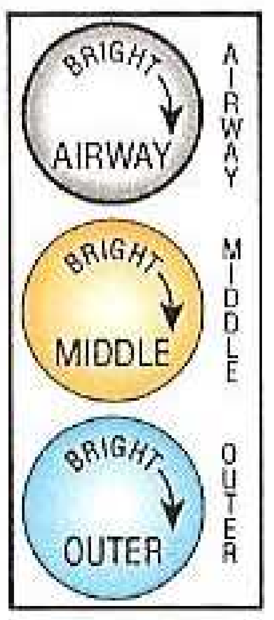


CAPTAIN'S PANEL (EFIS)



MARKER BEACON LIGHTS

NG

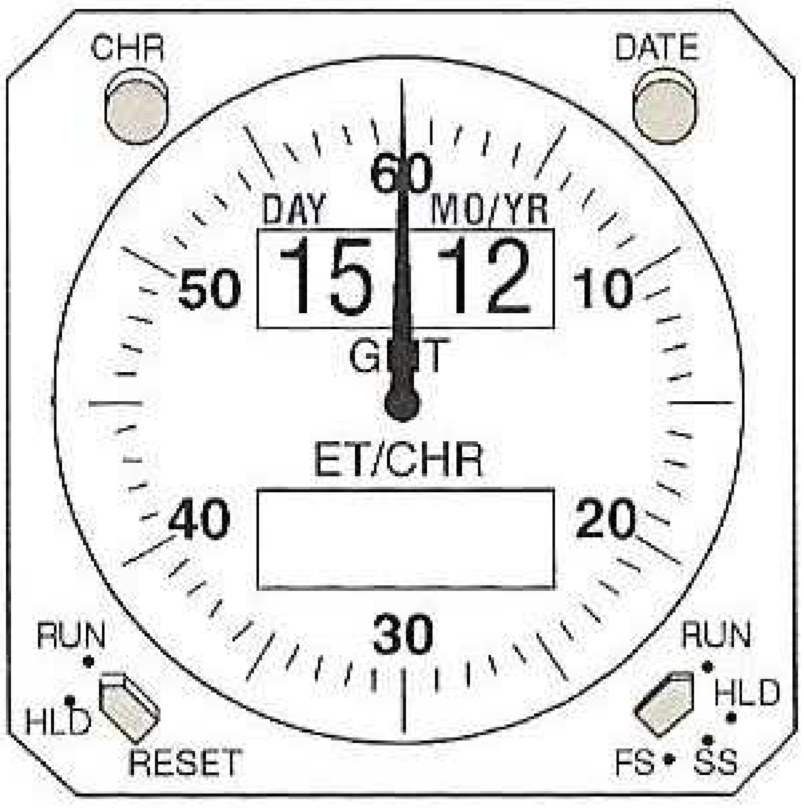


3-4-5

- marker beacon antenna receives 75 MHz and sends it to the 75 MHz filter in VOR/MB reciever 1 (band pass filters 400, 1300, and 3000 Hz)
  - OUTER (blue) - illuminates over an outer marker beacon
    400 Hz – – – –
  - MIDDLE (amber) - illuminates over a middle marker beacon
    1300 Hz – . – . – .
  - AIRWAYS (white) - illuminates over an inner, back course, or airways marker
    - 3000 Hz . . . . . .
    - use audio select panel MKR to monitor beacon audio
    - the indication flashes at the rate of the marker beacon identifier
  - (NG)
    - the left VOR receiver sends marker beacon data to the DEUs
    - lights located to CDS on left side of Captain's DEU and right side of FO DEU

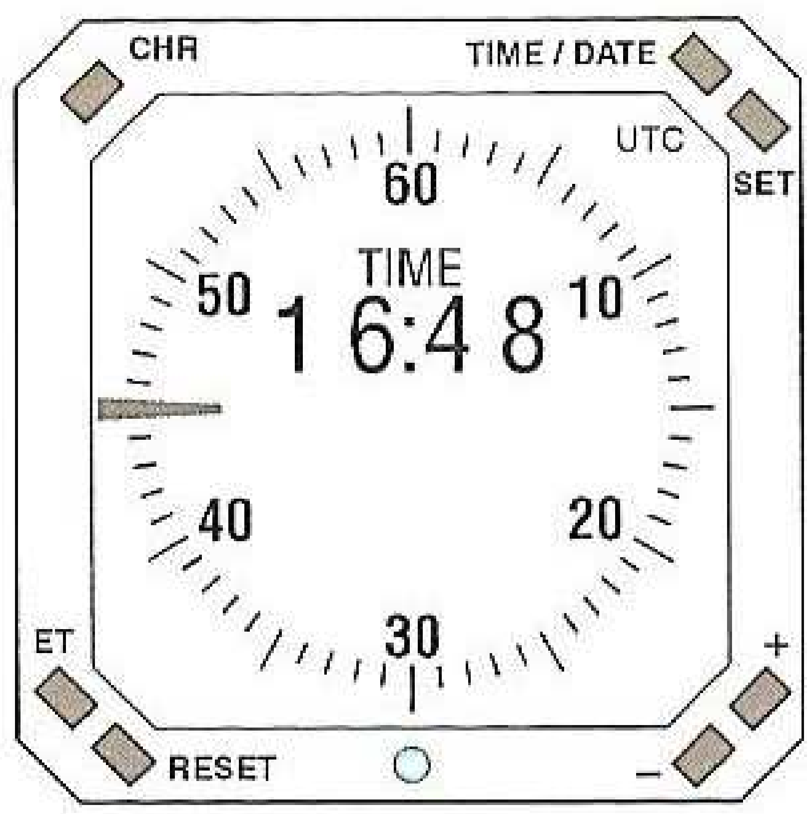
CLOCKS

- features common to all 3 clocks
- CHR (chronograph)
  - controls the start, stop and reset functions of the CHR display and second hand
  - overrides any existing ET display
  - elapsed time continues to run in the background and displays after the chronograph is reset
- TIME / DATE window
  - displays time in 24-hr format (hours and minutes) and date in numerical format
  - alternately displays day-month and year when DATE is selected



(#1)
- DATE control
  - push to display date (day, month) alternating with yr
  - push to return display to time
- ET / CHR window
  - displays elapsed time or chronograph time
  - ET display range: zero to 99 hours 59 minutes
  - CHR display range: zero to 99 minutes
- Elapsed Time control is spring loaded to HLD
  - HLD (Hold) - stops the ET display
  - RUN - starts the ET display counting time
  - RESET - returns the ET display to zero
- Time Control
  - RUN starts the TIME / DATE display counting
  - HLD (Hold) stops the TIME / DATE display, sets seconds to zero, and advances years
  - SS (Slow Slew) advances the Time / Date display minutes / months
  - FS (Fast Slew) advances the TIME / DATE display hours / days
  - (optional TIME / DATE display)
  - FS D (fast slew, day)
    - advances hours when time is selected with the date control
    - advances days when date is selected with the date control
  - SS M (slow slew, month)
    - advances minutes when time is selected with the date control
    - advances months when date is selected with the date control
  - HLD Y (hold, year)
    - stops the time indicator and sets the seconds to zero when time is selected with the date control
    - advances years when date is selected with the date control

(#2)



TIME / DATE pushbutton

- select the TIME / DATE pushbutton once to see UTC time, again to see UTC date; again to see manual time, and again to see manual date
- UTC or MAN symbol is displayed on the upper right part of the LCD display
- in MAN mode, clock time and date come from the clock. In UTC mode, clock time and date come from the GPS

SET pushbutton

- with manual time displayed
  - select the SET pushbutton once and the hours flash, again and the minutes flash
    - use the plus or minus pushbutton to adjust the hours or minutes
  - select the SET pushbutton again to run the time
- with manual date displayed
  - select the SET pushbutton once and the day flashes, again and the month flashes, and again for the year
  - use the plus or minus pushbutton to adjust the day, month, or year
  - select the SET pushbutton again to run the date

Note: a delay greater than one minute while setting the time or date results in the clock reverting to the previous time / date setting

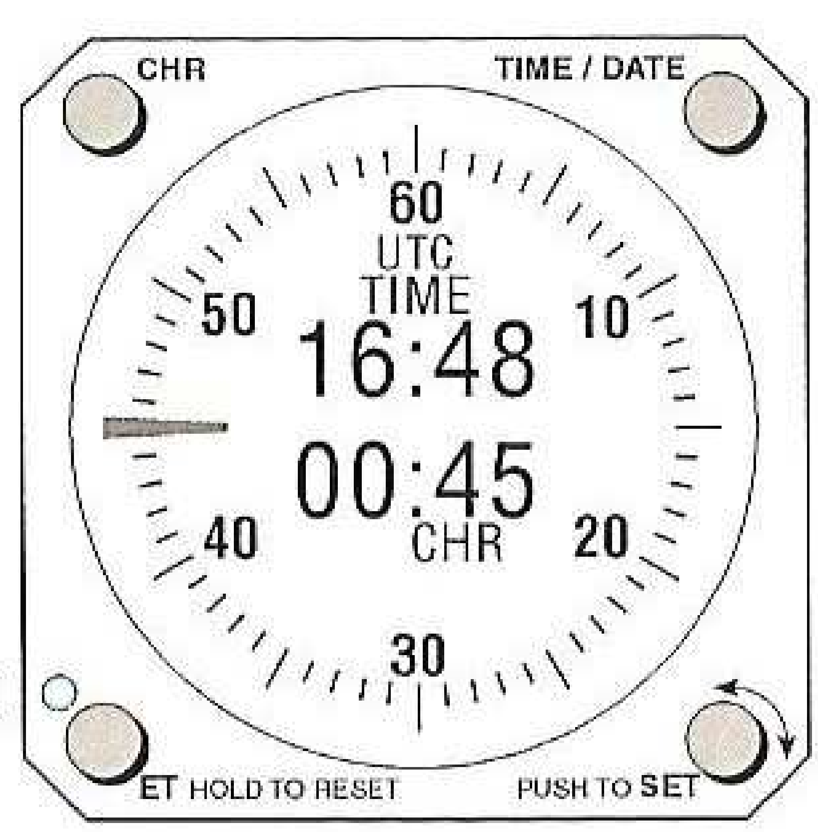
ET and RESET pushbutton

- select the ET pushbutton once to run the ET, again to hold the ET
- select the RESET pushbutton to set the ET to zero
- the RUN or HLD symbol is displayed on the lower left part of the LCD display

Plus (+) and Minus (-) Pushbuttons

- used to set the manual time and date

(#3)



TIME / DATE pushbutton

- UTC (Universal Time Coordinated) or MAN symbol is displayed
- in UTC mode, clock time and date come from the GPS
- in MAN mode, clock time and date come from the clock

ET (Elapsed Time) pushbutton

- select the ET pushbutton once to run the ET, again to hold the ET
- select the ET pushbutton again to continue the elapsed time
- select the ET pushbutton for 2 sec to set the elapsed time to 0 and clear the display
- ET and RUN or HLD symbols are displayed below the elapsed time

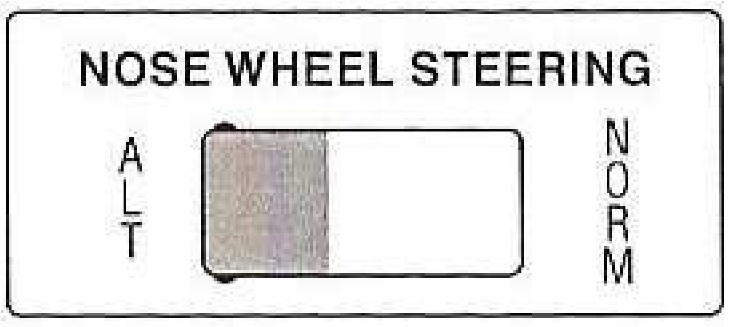
PUSH TO SET control

- with manual time displayed
  - select the SET control once and the hours flash, again and the minutes flash
    - rotate the control to adjust the hours or minutes
  - select the SET control again to run the time
- with manual date displayed
  - select the SET control once and day flashes, again for month, and again for year
    - rotate the control to adjust the day, month, or year
  - select the SET control again to run the date

Note: a delay greater than one minute while setting the time or date results in the clock reverting to the previous time/date setting

- elapsed time continues to run in the background and displays after the chronograph is reset

NOSE WHEEL STEERING



- lockout pin may be installed in the steering depressurization valve to bypass hydraulic system pressure
  - this allows airplane push back or towing without depressurizing system A

NORMAL
  - pressure for nose gear steering comes from A system extension line with gear handle down and aircraft on ground

ALTERNATE NOSE WHEEL STEERING option on (3-4-5) and standard on (NG)
  - opens landing gear transfer valve to change the pressure source of the nose wheel steering, from system A to system B, if the airplane is on the ground
  - if B system fluid is low (less than 21%), a sensor closes the landing gear transfer valve and alternate nose wheel steering will not be available

TILLER

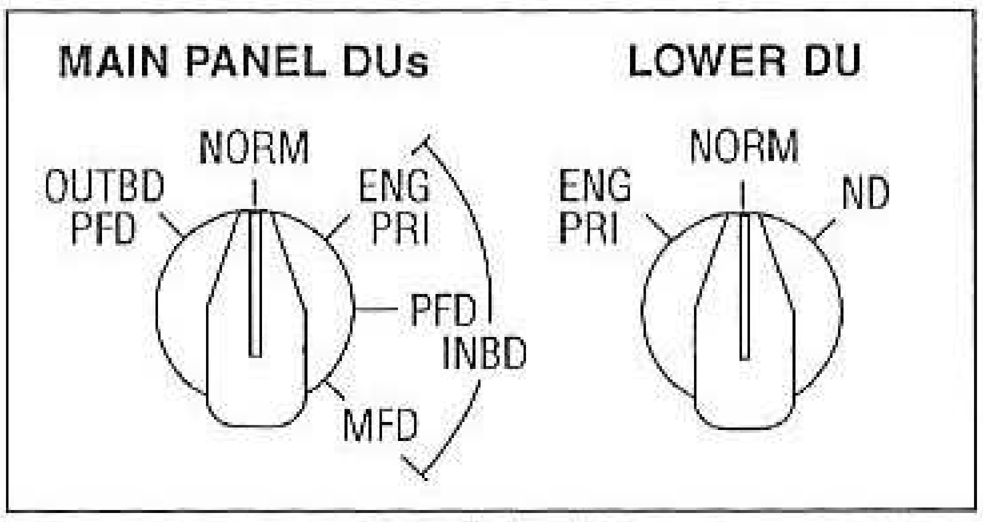
- full travel is 78° and overrides rudder pedal input
  - rudder pedals full travel on the ground is 7°
- if the steering system can not move freely, heavy pressure on the rudder pedals shears the rod that connects the rudder input crank to the steering crank; rudder will then move

AUTOLAND WARNING lights (NG option)

AUTOLAND

- above outboard DU
- flashes red and non-dimmable
- activates below 500 ft RA if
  - autopilot disconnects below 500 ft RA, or
  - stab trim warning occurs below 500 ft RA, or
  - LOC or GS ILS deviation warning occurs below 200 ft RA

DISPLAY SELECT PANELS (NG)



Captain's side

MAIN PANEL DUs

OUTBD PFD (Primary Flight Display)

(EFIS option) displays the compact EFIS on the outboard display and blanks the inboard display

(PFD-ND option) displays the PFD on the outboard display and blanks the inboard display

NORM
  - provides automatic display switching if a display unit fails

(EFIS option) EFIS displayed on the outboard and inboard display

(PFD-ND option) PFD displayed on the outboard and ND displayed inboard

ENG PRI (Primary)

(EFIS option) displays the engine instruments on the inboard display and the compact EFIS format on the outboard display

(PFD-ND option) displays the primary engine instruments on the inboard display and the PFD on the outboard display. Upper center blanks

PFD INBD

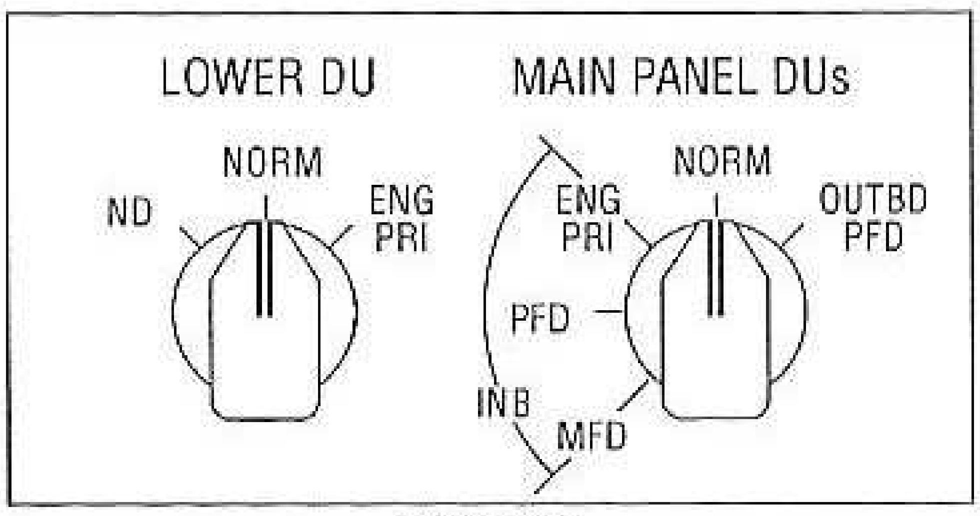
(EFIS option) displays the compact EFIS on the inboard display and blanks the outboard display

(PFD-ND option) displays the PFD on the inboard display and blanks the outboard display

MFD (multi function display)

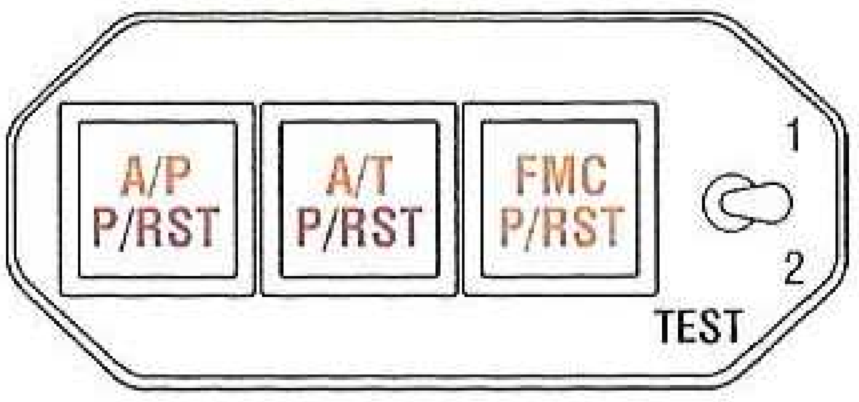
(PFD-ND option) you can use the two switches on the engine display control panel to select the MFD format. PFD is displayed on the outboard display and the inboard display blanks. The inboard display stays blank until system format (SYS) or secondary engine format (ENG) is selected.

LOWER DU
- ND
  - (PFD/ND option)
    - displays the nav display on the lower unit
- NORM
  - provides automatic switching to the lower display unit if the upper display fails
  - (EFIS option)
    - normal engine display on the upper unit and no display on the lower unit
  - (PFD/ND option)
    - on power-up, displays secondary engine instruments
    - if MFD SYS switch is pressed, displays hydraulic quantity and pressure
    - (option) brake temperature display
    - (option) flight control position display
- ENG PRI
  - displays the engine instruments on the lower display and blanks the upper display



FO's side

AUTOFLIGHT ANNUNCIATOR - EFIS and (NG)



A/P Disengage light (red/amber)
- flashes red
  - and tone sounds if A/P disengages
    - to extinguish, press light or yoke disengage switch twice
- steady red
  - ALT ACQ mode inhibited during A/P go-around if stabilizer not trimmed for single A/P operation
  - disengage light test switch held in position 2
  - automatic ground system tests fail
- flashes amber
  - if A/P automatically reverts to CWS pitch or roll while in CMD
    - to extinguish, press either light or select another mode
- steady amber
  - if disengage light test switch held in position 1

A/T Disengage light (red/amber)
- flashes red
  - if A/T disengages
- steady red
  - if disengage light test switch held in position 2
- flashes amber
  - if A/T indicates airspeed error, inflight, flaps not up, and airspeed differs from commanded value by -5 to +10 kts and not approaching commanded value
    - to extinguish press the light, press the A/T button, or place the A/T switch to arm
- steady amber
  - if disengage light test switch held in position 1

FMC Alert light (amber)
- illuminates steady amber = the FAIL light on the CDU(s) is illuminated, or
- an Alerting message exists for both CDUs
  - pressing will extinguish both pilot's FMC alert lights

TEST switch
- test positions #1 (all amber) and #2 (2 reds, 1 amber)
- a white horizontal line on a black background indicates a spare annunciator and is displayed only during a test

TAKEOFF CONFIG warning light
- activates on the ground as the throttles are advanced if the a/c is not configured for T/O
- activation is simultaneous with aural warning intermittent horn for Takeoff Config. alert
- will probably be retrofitted on older a/c

CABIN ALTITUDE warning light (red)
- illuminates at 10,000 ft if the cabin has not been pressurized
- illuminates during flight when loss of cabin pressure occurs
- activation is simultaneous with aural warning intermittent horn for Cabin Altitude alert
- new channel will add redundancy and probably be retrofitted to older a/c

SPEED BRAKE ARMED light
- illuminates when the automatic operation of the speedbrake system arms correctly
  - this occurs when at least one antiskid channel operates, or the auto speedbrake actuator is retracted, or no disagree in the wheel spin speeds and air/grond signals
- auto speedbrakes are armed anytime the speed brake handle is out of the DOWN detent
- deactivated when speed brake lever is in the DOWN detent
- if either throttle is advanced on the ground the auto speedbrake actuator retracts
  - the speedbrake handle automatically moves to the DOWN detent and all flight and ground spoilers stow

SPEED BRAKE DO NOT ARM light
- indicates non-normal condition or test inputs to the automatic speed brake system
- in the event the automatic system is inoperative, the speedbrake lever must be moved manually to the UP position after landing
- deactivated when speed lever brake is in the DOWN position
- (aircraft with winglets) illuminates for abnormal condition or test inputs to the speedbrake load alleviation system when the flaps are raised
- if the load alleviation system is inop, the auto speedbrakes are considered inop
  - reference MEL ATA - 27

(QRH) Speedbrake Do Not Arm
- speedbrake lever full forward
- manual deploy speedbrakes immediately upon touchdown

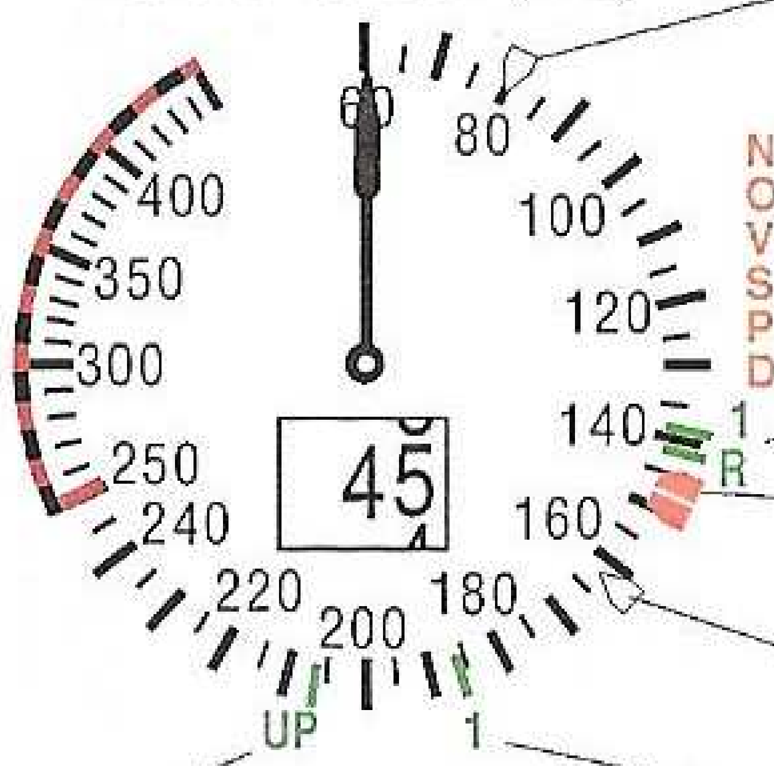
STAB OUT OF TRIM LIGHT
- with the A/P engaged, illuminated by 3 different detectors
  - illuminates if a difference of 3° between the elevator position and elevator A/P actuator is detected,
  - illuminates if stabilizer movement greater than .5° is not detected within 10 seconds of movement command
  - detects an elev A/P actuator position of greater than 5° from the neutral shift position
- delay of 10 seconds prevents nuisance warnings
- momentary illumination during large changes in trim requirements is normal
- inhibited when GS is engaged and flare is active

(QRH) Stab Out Of Trim
- hold control column firmly, disengage autopilot, and re-trim stabilizer

MACH / AIRSPEED INDICATOR (EFIS option)

NOTE: These MASI drawings use -700 flap speed placard
- MASI displays ADIRS airspeed and other airspeed related information

Before Takeoff (F.5)



80 KT AIRSPEED BUG
- displayed automatically during preflight
- removed when VREF is entered or at first flap retraction

NO VSPD displayed on the ground until V1 or VR is entered

TAKEOFF REF SPEEDS (green)
V1 (decision speed) and VR (rotation speed)
- displayed after entry on the TAKEOFF REF page or as set with the SPD REF selector
- removed at liftoff

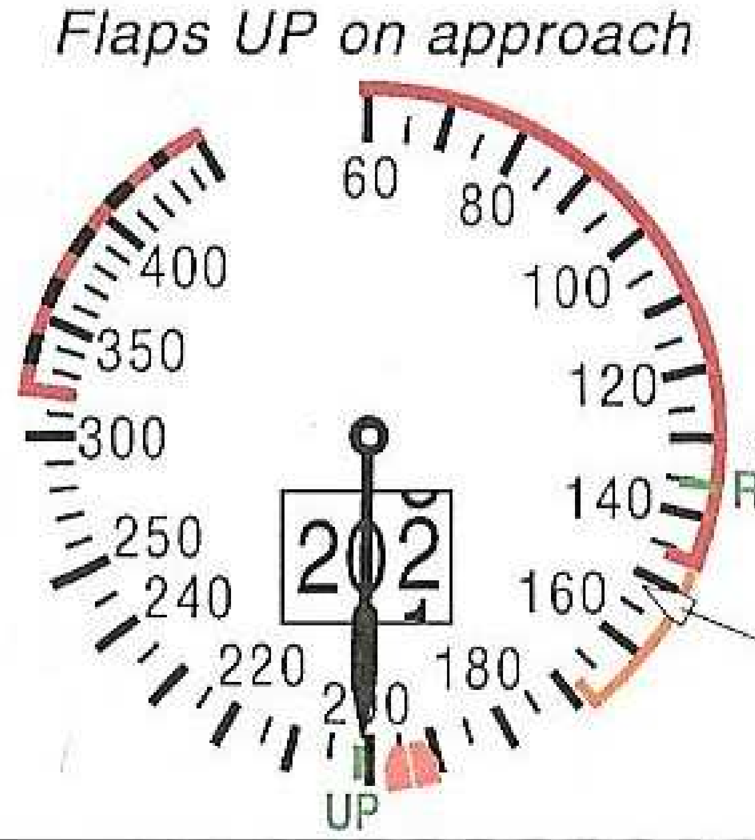
AIRSPEED CURSOR (magenta)
- indicates target airspeed and set at 100 kts at power-up
- positioned from MCP IAS/MACH window or by the FMC
- used to select V2 (SE climb speed) for takeoff

V2+15 bug (white)
- displayed after selection of V2 (DEU calculates V2+15)
- removed at first flap retraction

UP bug (green)
- displayed after ZFW is entered and TOGW is calculated, or after TOGW is set with the speed reference selector

FLAP MANEUVER SPEED (green)
- indicates flap maneuver speed for the displayed flap positon
- when the V2+15 bug is displayed for takeoff, the flap maneuver speed bug for the current flap setting is not displayed, except for flaps 1 takeoff

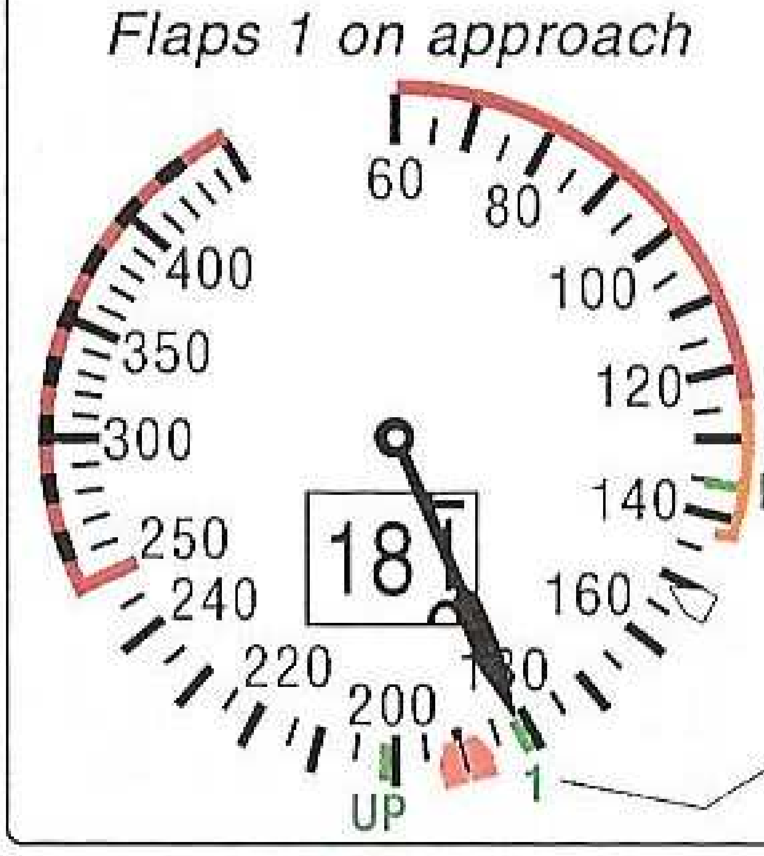
Flaps UP on approach



VREF (green)
- indicates the reference speed as selected on the APPROACH REF page or as set with the SPD REF selector

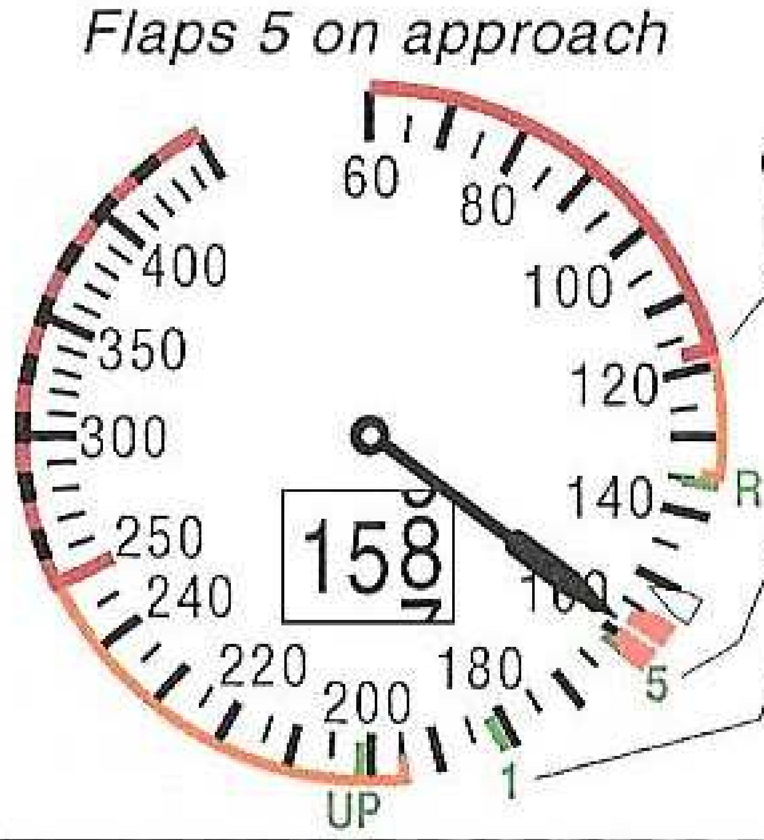
VREF+15 (white)
- displayed after selection of VREF

Flaps 1 on approach



FLAP MANEUVER SPEED
- indicates flap maneuver speed for the current flap handle position
- form habit to check gauge

Flaps 5 on approach



STICK SHAKER SPEED (red)
- top of bar indicates the speed at which stick shaker occurs
- reflects effects of extending the flight spoilers, and also reacts to wing loading (red arc increases)

FLAPS MANEUVER SPEEDS (green)
- indicates flap maneuver speed for the current flap handle position (5) and next normally retracted flap position (1)
- FMC actually passes weight to CDS which has its own weight based equation for each model 737
- numbered flap maneuver speed bugs are removed when flap lever is moved to flaps 30 or 40
- if any bug is within 4 kts of the VREF bug, then that flap bug will not be displayed
- when the V2+15 bug is displayed for takeoff, the flap maneuver speed bug for the current flap setting is not displayed
- maneuver speed bug does not move in going from 5 to 10

-700

LANDING GEAR LIMIT (IAS)
OPERATING
EXTEND 270-.82M
RETRACT 235K
EXTENDED 320K-.82M

FLAPS LIMIT (IAS)

1-250K	15-195K
2-250K	25-170K
5-250K	30-165K
10-210K	40-156K

230K ALT FLAP EXTEND

Flaps 15

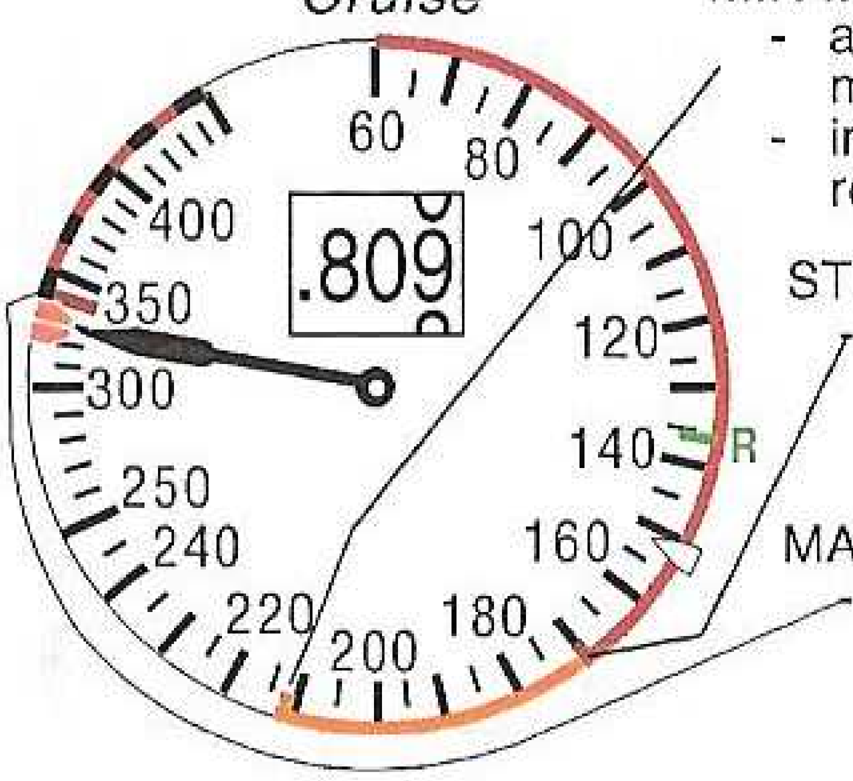
Current calibrated airspeed (white)
- when current airspeed decreases to the min maneuver speed amber bar, airspeed readout box turns amber and flashes 10 sec.
- returns to white when airspeed is above min maneuver speed

FLAP EXTENSION SPEED (amber)
- when flap handle is moved from up, the start of the arc indicates flap extension placard speed for the **next normal flap setting** (30 in this case) 2, 10, 25 not normal
- use this tool so you don't overspeed flaps
- the arc is removed when the flap handle is moved to the landing flap selected on the APPROACH REF page or when the flap handle has been moved to flaps 30 or 40

MINIMUM MANEUVER SPEED (amber)
- top of amber bar indicates minimum maneuver speed for the currect flap position (not handle)
- at high altitude, gives a .3G maneuver margin to low speed buffet, and is not available if the FMC gross weight is not available
- reflects the effect of extending the flight spoilers (will increase)
- inhibited on takeoff until valid VREF is entered

VTARGET
- the minimum final approach speed is VREF+5
- the +5 is to ensure that V2 is met in case of a go-around
- on a go-around, initial climb is VREF+20
- the white triangle is set to VREF+15 which will provide maneuver protection up to 30° of bank with flaps 15

MAX SPEED (red and white)
- max speed for present flap configuration (30) Note yellow arc to 156



MIN MANEUVER SPEED (amber)
- amber index mark indicates min maneuver speed (1.3G)
- inhibited on takeoff until flap retraction or valid VREF entered

STICK SHAKER SPEED (red)
- red index mark indicates the speed at which stick shaker occurs

MAX OPERATING SPEED
- start of the arc indicates the maximum speed as limited by Vmo/Mmo, landing gear placard speed, or flap placard

HIGH SPEED BUFFET (amber)
- at high altitudes and flaps up, the start of the arc indicates the airspeed that provides a .3 g maneuver margin to high speed buffet (very hard to see and poor design)
- may be displayed at high altitude with flaps up, at relatively high gross weights

FLAGS AND WARNINGS

SEL SPD flag displayed if airspeed cursor is inop

SPD flag displayed if Mach/airspeed indicator is inop

SPD LIM flag - displayed if stick shaker warning or max operating speed has failed (red stick shaker speed or red/white max operating speed arc is removed)

IAS DISAGREE
- displayed if CA and FO airspeeds disagree by more than 5 kts

IAS DISAGREE ALERT (amber)
- indicates the selected source of airspeed for the Captain's and First Officers's

- one mach airspeed indicator may be inop provide one Mach/Airspeed warning and Mach trim system operate normally

(L/OP) Max Speeds
- Turbulent air penetration speed
  (3-4-5) 280 kt / .73 Mach (NG) 280 kt / .76 Mach
- Max Tire Speed 195k

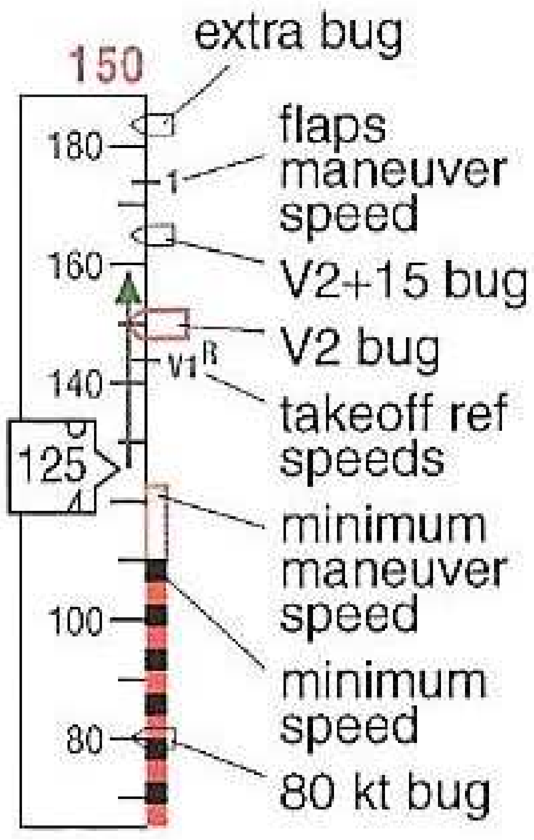
(QRH) Airspeed Unreliable
- recognized by aircraft pitch not consistent with existing phase of flight, altitude, thrust, weight, and/or noise or low frequency buffeting

AIRCRAFT ATTITUDE / THRUST .... ADJUST
PITOT HEAT .... CONFIRM ON
MACH / AIRSPEED INDICATORS .... CHECK

- erroneous or unreliable airspeed indications may be caused by blocked/damaged or frozen pitot-static systems or a severely damaged or missing radome
- adjust pitch and power to maintain aircraft control
- include/check the standby flight instruments
- crosscheck groundspeed and wind information provided by the IRS and the FMC to determine airspeed accuracy if indicated airspeed is questionable

SPEED TAPE (PFD ND option)

TAKEOFF



Flaps maneuver speed (green)
- indicates flap maneuvering speed for the current flap position and next normally retracted flap position (flaps 2 is not normal)
- displayed automatically after gross weight is entered in the CDU or manually after takeoff gross weight is set with the speed reference selector
  - FMC actually passes weight to CDS which has its own weight based equation for each model 737
- when the V2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed, except for flaps 1 takeoff
- numbered flap maneuvering speed bugs are removed when flap lever is moved to flaps 30 or 40
- if any bug is within 4 kts of the Vref bug, then that flap bug will not be displayed

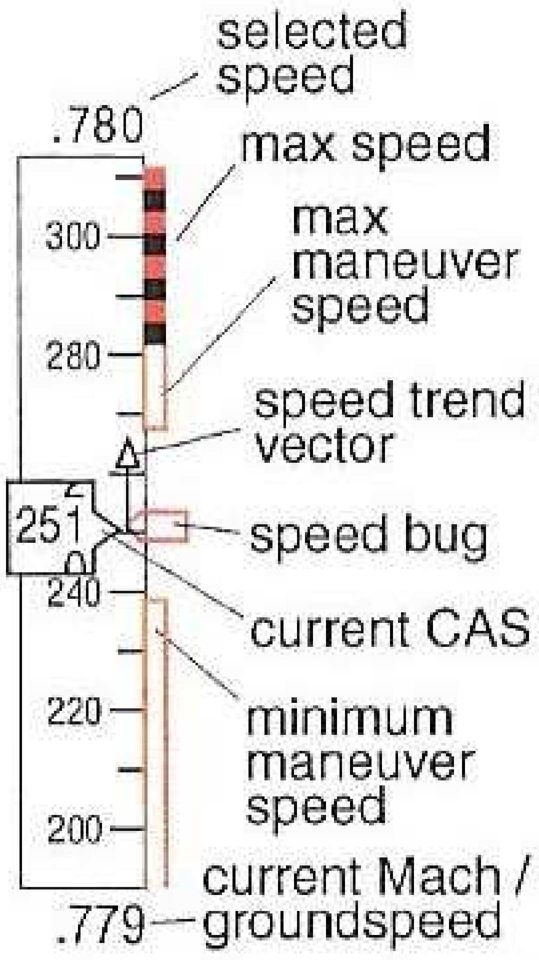
Takeoff ref speeds (green)
- V1 (decision speed) and VR (rotation speed)
  - displayed after entry on the TAKEOFF REF page or as set with the speed reference selector
  - NO VSPD (amber) displayed on the ground if V1 or VR is not entered
  - displayed for takeoff when the speed is greater than 80 kts
  - removed at liftoff
  - V1 speed is displayed at the top of the airspeed tape when selected and value is off-scale
- V2 (selected speed - V2) (ex: 150)
  - controlled by the MCP speed knob
  - blanked if not within the displayed range
- V2+15 bug (white)
  - DEU calculates V2+15 and shows it on the speed tape
  - removed at first flap retraction or when Vref is entered in the CDU

Minimum maneuver speed (amber)
- top of hollow yellow bar indicates minimum maneuver speed
- shows lowest speed before start of stick shaker
- at high altitude, gives a .3G maneuver margin to low speed buffet, and is not available if the FMC gross weight is not available
- reflects the effect of extending the flight spoilers
- inhibited on takeoff until valid Vref is entered or first flap retraction

Minimum speed (red and black)
- top of bar indicates the speed at which stick shaker occurs

80 kt airspeeed bug (white)
- displayed automatically during preflight
- removed when VREF is entered or at first flap retraction

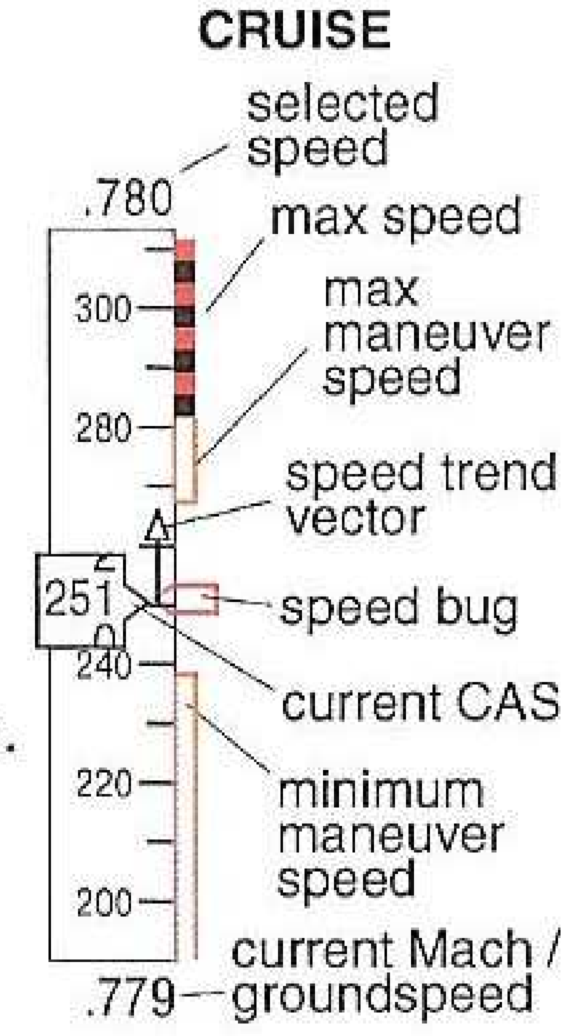
CRUISE



Selected speed (magenta)
- indicates the airspeed that is manually selected in the IAS/MACH window, or commanded by the FMC

Max speed (red and black)
  - bottom of bar indicates max speed as limited by the lowest of the Vmo / Mmo, gear placard, or flaps placard speeds

Max maneuver speed (amber)
- bottom of the bar indicates the airspeed that provides a 0.3g maneuver margin to high speed buffet
- may be displayed at high altitude with flaps up, at relatively high gross weights



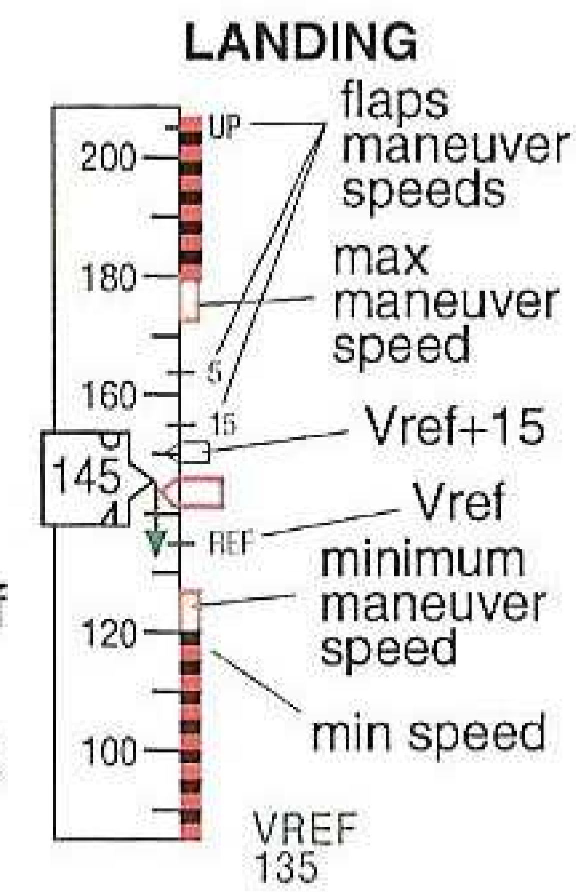
Speed trend vector (green)
- tip of arrow indicates predicted airspeed in 10 secs based on present acceleration or deceleration
- not displayed unless magnitude is greater than 4 kt
- removed when magnitude becomes less than 3 kt

Speed bug (magenta)
- manually entered speed via IAS/MACH window or FMC commanded speed

Current calibrated airspeed (white)
- when current airspeed decreases to the min maneuver speed amber bar, airspeed readout box turns amber and flashes 10 sec.
  - returns to white when airspeed is above min maneuver speed

Minimum maneuver speed (amber)
- top of the bar indicates minimum maneuver speed
- inhibited on takeoff until first flap retraction

Current Mach (white)
- displays when airspeed is M.40 and above
- blanks when airspeed decreases below M.40
- (option) displays groundspeed when airspeed decreases below M.40
  - white box displayed for 10 seconds around the numeric value during transition



Flaps UP maneuver speed (green)
- displayed when flaps are up
- not displayed above 20,200 ft

Max maneuver speed (amber)
- bottom of the bar indicates the airspeed that provides a 0.3g maneuver margin to high speed buffet
- when flaps are extended, bottom of the bar indicates flap limit placard speed for the next normal flap setting
  - the display logic is based on a normal flap setting sequence of 1, 5, 15, 30
  - the bar is removed when the flap lever is moved to the landing flap selected on the APPROACH REF page or when the flap lever is moved to flaps 30 or 40

Vref+15 (white)
- displayed after selection of Vref

Minimum speed (red and black)
- top of barber pole indicates speed at which stick shaker occurs
- reflects effects of extending the flight spoilers, and also reacts to wing loading

REF Landing Reference Speed (green)
- indicates the reference speed as selected on the CDU APPROACH REF page or as set with the speed reference selector on the engine display control panel
- REF is displayed at bottom of the airspeed tape when the selected value is off-scale

VREF 135 Speed Reference Display (green)
- displayed if the airspeed and/or weight is entered via the speed reference selector on the engine display control panel:
  - on the ground, V1, VR, and takeoff gross weight may be selected
    - if VREF is selected, INVALID ENTRY is displayed
  - in flight, VREF and landing gross weight may be selected
    - if V1 or VR is selected, INVALID ENTRY is displayed
  - removed when the speed reference selector is moved to the SET position

RADIO DISTANCE MAGNETIC INDICATOR (RDMI) (NG)

- HSI and RDMI compass cards are "ON SIDE"
  - compass card inputs from respective IRS / ADIRU

DME INDICATORS (1 and 2)
  - pilot can tune one DME station with each Nav radio panel

BEARING POINTERS
  - narrow pointer: uses signals from the VHF NAV #1 receiver or ADF #1 receiver
  - wide pointer: uses signals from the VHF NAV #2 receiver or ADF #2 receiver
  - signals to the VOR bearing pointers are not affected by the VHF NAV transfer switch (i.e. if BOTH ON 2, your narrow VOR arrows on both RMDIs are inop)
  - the transfer switch has nothing to do with ADF's. ADF #1 always drives narrow needles in RMDIs; #2 always drives wide needles
  - ADF / VOR bearing pointer switches
    - ADF or VOR selected from EFIS control panel
    - VOR source is green, ADF source is cyan

Loss of Heading
  heading display is removed

Loss of DME (invalid DME signal or power failure)
  amber DME flag appears

Loss of NAV (unreliable signal to pointer or power failure)
  amber VOR or ADF flag appears

(L/OP) Autopilot
- do not use the autopilot or autothrottle for approach if associated RA is inop

FLIGHT MODE ANNUNCIATOR (FMA)
- FMA annunciators include autothrottle, roll, and pitch
- a mode change highlight box shows around the mode for 10 seconds when the mode changes

Examples of FMA displays

Level Change Climb/Descent
  A/T (climb) = N1
  A/T (descent) = RETARD then ARM
  Pitch = MCP SPD

Vertical Speed Climb/Descent
  A/T = MCP SPD
  Pitch speed = V/S

Temporary Level-off during Climb/Descent
  Pitch mode = VNAV ALT

Altitude Hold switch
  Pitch = ALT HOLD

Heading Select switch
  Roll mode = HDG SEL

VNAV Path Descent
  Pitch mode = VNAV PTH

Go Around (GA) TOGA
  A/T = GA
  Pitch = TO/GA
  Roll = (blank) maintains ground track

FMA annunciations

A/T	ROLL	PITCH
AUTOTHROTTLE ENGAGED MODE	**ROLL ENGAGED MODE**	**PITCH ENGAGED MODE**
N1 (g)	HDG SEL (g)	TO/GA (g)
GA (g)	VOR/LOC (g)	V/S (g)
RETARD (g)	LNAV (g)	MCP SPD (g)
FMC SPD (g)	B/CRS (g)	ALT/ACQ (g)
MCP SPD (g)		ALT HOLD (g)
THR HLD (g)	**ROLL ARMED MODE**	G/S (g)
ARM (w)		VNAV SPD (g)
	LNAV VOR/LOC (w)	VNAV PTH (g)
A/P STATUS	LNAV (w)	VNAV ALT (g)
CMD (g)	LNAV B/CRS (w)	
FD (g)	**PITCH**	
	CWS PITCH ENGAGED	**ARMED MODE**
		G/S (w)
	CWS P (y)	V/S (w)
	CWS R (y)	VNAV (w)
		G/S V/S (w)

(green = (g) white = (w) amber = (y)

ATTITUDE DIRECTOR INDICATOR

Bank Scale (white)
- provides fixed reference for the bank pointer; marks at 0, 10, 20, 30, 45, and 60°

Pitch Limit Indicator (amber) displayed when flaps are not up
- indicates pitch limit (stick shaker activation for existing flight conditions)
- Option - PLI pop-up displayed at slow speed with flaps up

Bank Pointer
- indicates bank angle; fills and turns amber if bank angle is 35 degrees or more

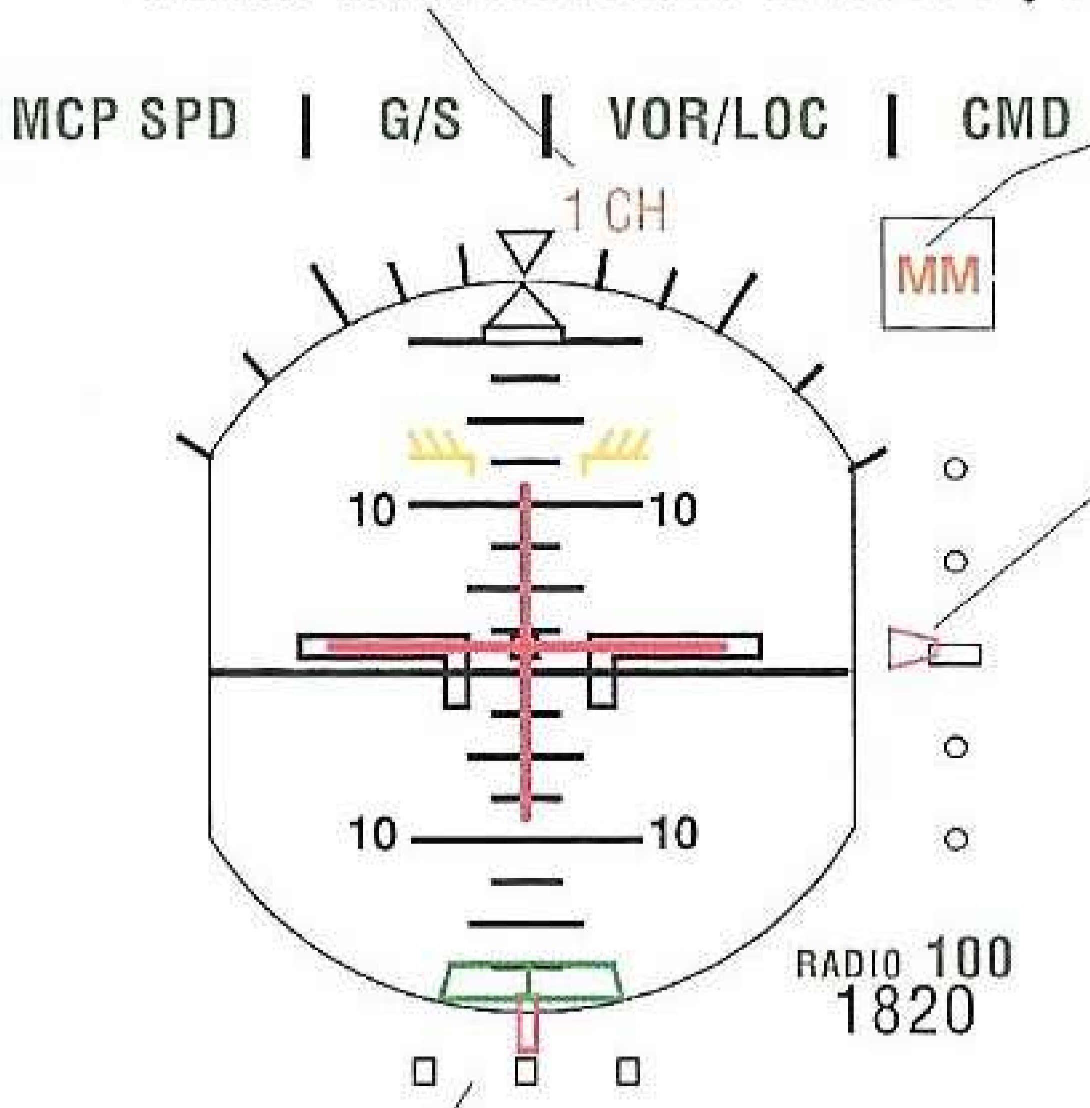
Slip/Skid Indication
- displaces beneath the bank pointer to indicate slip or skid
  - fills white at full scale deflection
  - turns amber if bank angle is 35° or more
  - fills amber if the slip/skid indicator is also at full scale deflection

Flight Path Vector (FPV) Indication (white)

Option - displays flight path angle and drift when selected on the EFIS control panel
  - flight path angle is displayed relative to the horizon line
  - drift angle is displayed relative to display center

1 CH for single A/P ILS approach
- annunciates after localizer capture an dremains on for entire appraoch
- for dual A/P ILS approach, annunciates after localizer capture and extinguishes after 2nd A/P engages, FLARE armed is annunciated, and pitch monitor confidence test is successfully completed

Marker Beacon symbol
- flashes when over one of the marker beacons:
  OM (cyan) - an outer marker beacon
  MM (amber) - a middle marker beacon
  IM (white) - an airway or inner marker



Glide Slope Pointer and Deviation Scale

The pointer:
- is in view when the glide slope signal is received
- glideslope capture occurs at 2/5 dot below glideslope
- is not displayed when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse)

The scale:
- is in view when the localizer frequency is tuned
- each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second GS deviation alerting display on each attitude indicator
- 1 dot = .35° deviation

Localizer Pointer and Deviation Scale

The pointer:
- indicates localizer position relative to the airplane
- in view when the localizer signal is received
- capture point is variable and depends on intercept angle and closure rate but is not later than 1/2 dot

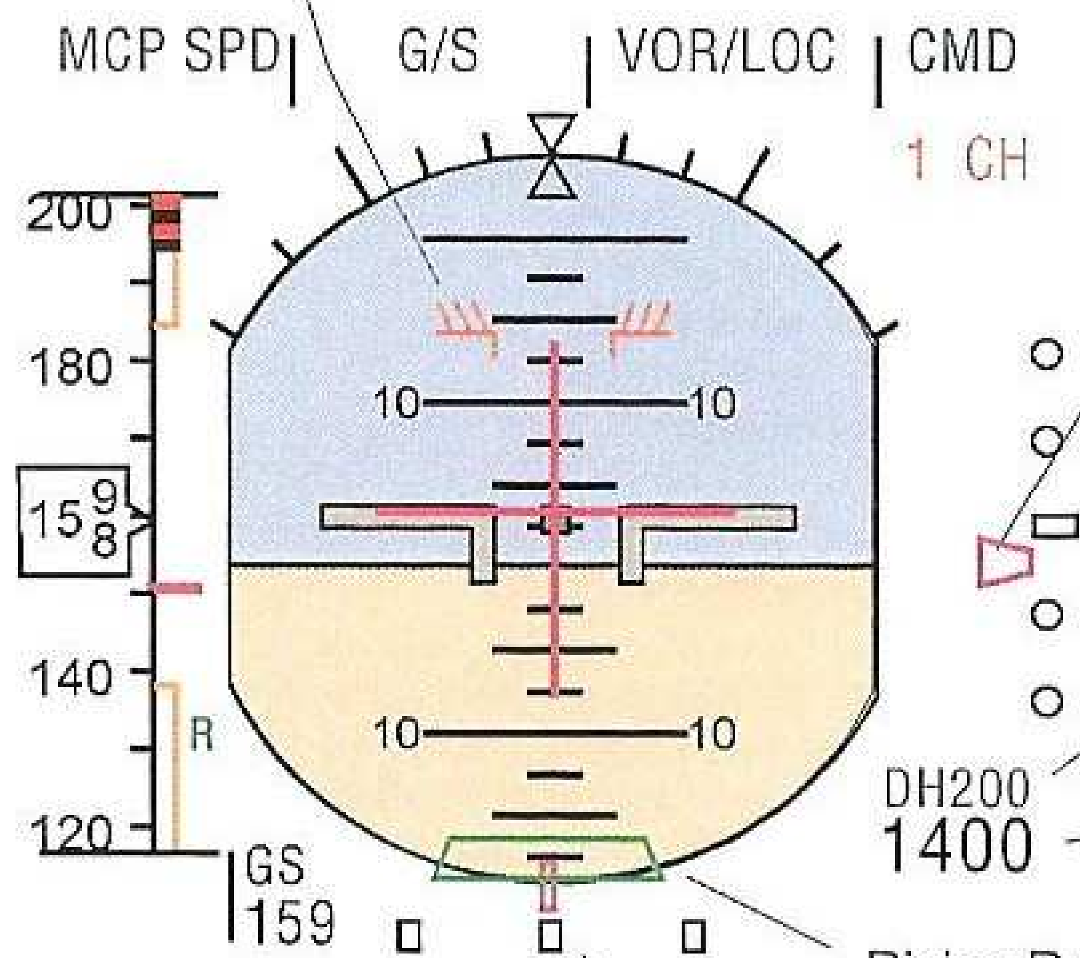
The scale:
- is in view when the localizer frequency is tuned
- expands when the localizer is engaged and deviation is slightly more than one–half dot
- each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC deviation alerting display on each attitude indicator
- 1 dot (normal) = 1° deviation / (expanded) = .5°

Expanded Localizer Indications

Expanded Localizer Scale
- displayed when the autopilot or flight director is in LOC mode, deviation is slightly more than one half dot and track is within 5 degrees of the MCP selected course
- as deviation increases, the deviation pointer remains filled in solid magenta and parks at the limit of the expanded scale. Once the deviation reaches the equivalent of 2.4 dots from center on the standard scale, the pointer becomes unfilled
- reverts to standard scale when out of LOC mode, and groundspeed is less than 30 knots or radio altitude is greater than 200 feet
- a rectangle equals 1/2 dot deviation

737-500 ILS display

Pitch Limit Symbol
- indicates pitch attitude corresponding to stick shaker activation



Glideslope pointer and deviation scale
- pointer is not displayed when the glideslope signal is unusable or when track and the front course on the MCP differ by more than 90° (backcourse)
- if the Captain or FO G/S deviation exceeds one dot, the respective G/S scale changes from white to yellow and the F/S pointer flashes
- G/S deviation warning does not occur below 100 ft RA, however if the warning was triggered prior to descent below 100 ft RA, the warning continues to operate below 100 ft RA

Decision Height
- displays selected DH as set on the EFIS control panel when RA is above 1,000 ft AGL
- blank when negative HD is selected

Radio Altitude
- displays radio altitude below 2,500 ft AGL
- changes color from white to yellow when below selected DH on descent
- changes to white when passing selected DH plus 75 ft during go-around, after touchdown, or after pressing RST switch on EFIS control panel

Ground speed displays FMC/IRS ground speed
Mach displayed when above .40 Mach

Localizer pointer and deviation scale
- when LOC is engaged and deviation is slightly more than 1/2 dot, scale expands to this view
- pointer is blank when ILS LOC signal is too weak to be usable
- if the Captain or FO LOC deviation exceeds one-half dot on the expanded scale or one-fourth dot standard scale, the respective LOC display changes from white to yellow and the rising runway stem flashes

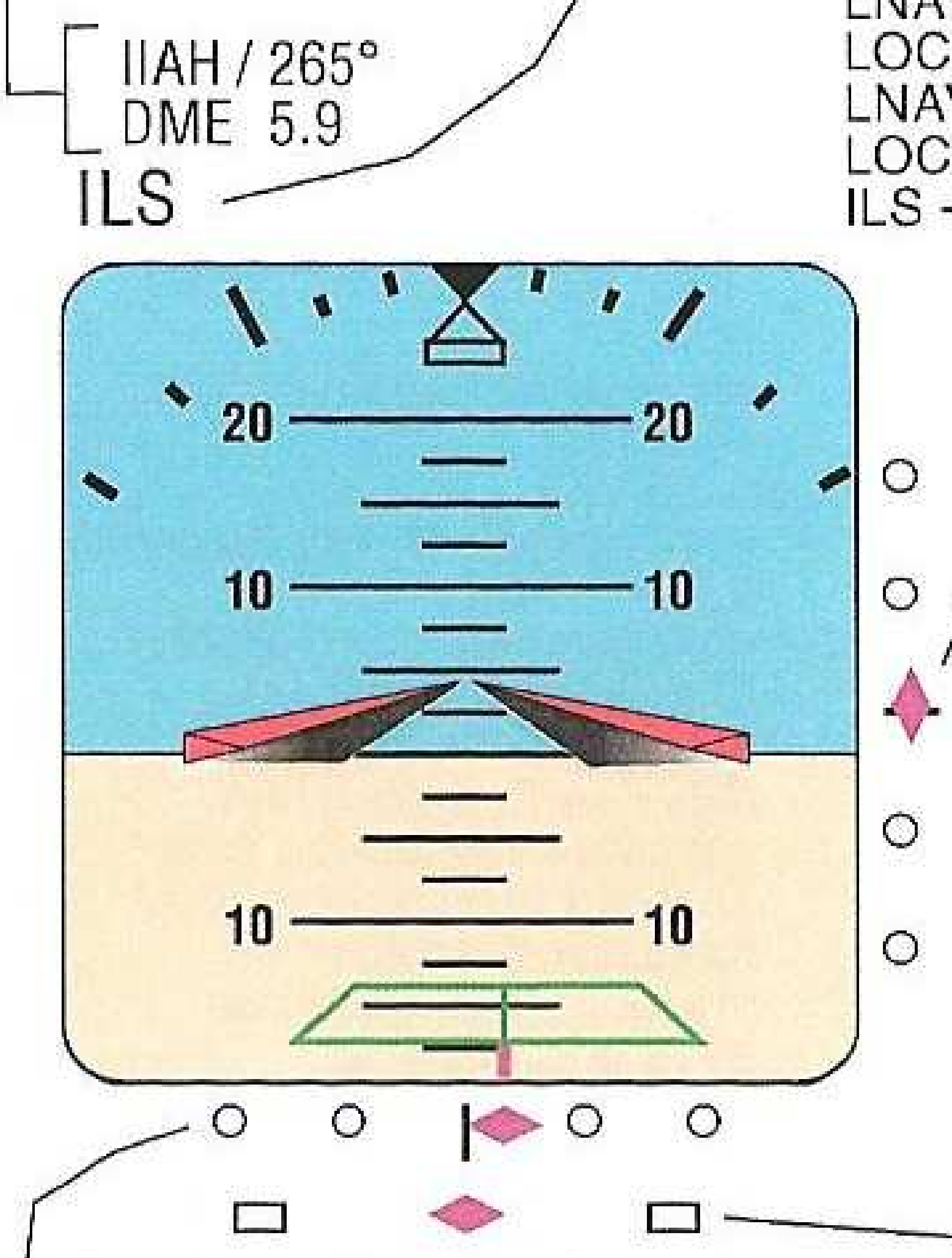
Rising Runway
- displayed from respective NAV receiver
- in view below 2500 RA, when the localizer pointer is in view, and a valid ILS frequency is selected
- rises towards aircraft symbol when radio altitude is below 200 ft AGL
- zero RA is indicated when the top of the rising runway symbol touches the base of the aircraft symbol
- loss of respective RA prevents the rising runway indication, however localizer function is not impaired

737 - NG ILS display

Approach Reference
- displays the selected ILS identifier or frequency, approach front course, and ILS/DME distance
- if the Captain's and FO's tuned ILS frequencies disagree, the frequency turns amber with an amber horizontal line through it
- if the approach courses entered in the MCP disagree, the course turns amber with an amber horizontal line through it

Rising Runway
- displayed when localizer signal is usable, pointer is in view and RA is less than 2500 ft
- moves toward the airplane symbol as the altitude decreases from 200 ft to 0
- at 0 ft the rising runway shows at the bottom of the airplane symbol. The rising runway symbol also moves left and right to stay aligned with the ILS localizer deviation pointer

Scale ID (white)
- displayed above the left corner of ADI
- indicates the source of deviation for each scale
- displayed when LNAV, VNAV, ILS, or LOC is engaged
- possible annunciation combinations include:
  LNAV/VNAV - LNAV and VNAV deviations
  LOC/VNAV - Localizer with VNAV deviation
  LNAV/G/S - LNAV deviation with Glideslope
  LOC/GP - Localizer with FMC glidepath
  ILS - ILS approach



Glide Slope Pointer and Deviation Scale

The pointer:
- is in view when the glide slope signal is received
- fills in solid magenta when within 21/2 dots from center
- is not displayed when the track and the front course on the mode control panel differ by more than 90° (backcourse)

The scale:
- is in view when the localizer frequency is tuned
- at low radio altitudes, with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive glide slope deviation
- each pilot's deviation alerting system self-tests upon becoming armed at 1500 ft radio altitude. This self-test generates a two second GS deviation alerting display on each attitude indicator
- 1 dot = .35° deviation

Localizer Pointer and Deviation Scale

The pointer:
- indicates localizer position relative to the airplane
- in view when the localizer signal is received
- fills in solid magenta when within 21/2 dots from center

The scale:
- is in view when the localizer frequency is tuned
- expands when the localizer is engaged and deviation is slightly more than one–half dot
- at low radio altitudes, with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive localizer deviation
- below 1,000 feet AGL, with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured
- each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC deviation alerting display on each attitude indicator
- 1 dot (normal) = 1° deviation / (expanded) = .5°

Expanded Localizer Indications

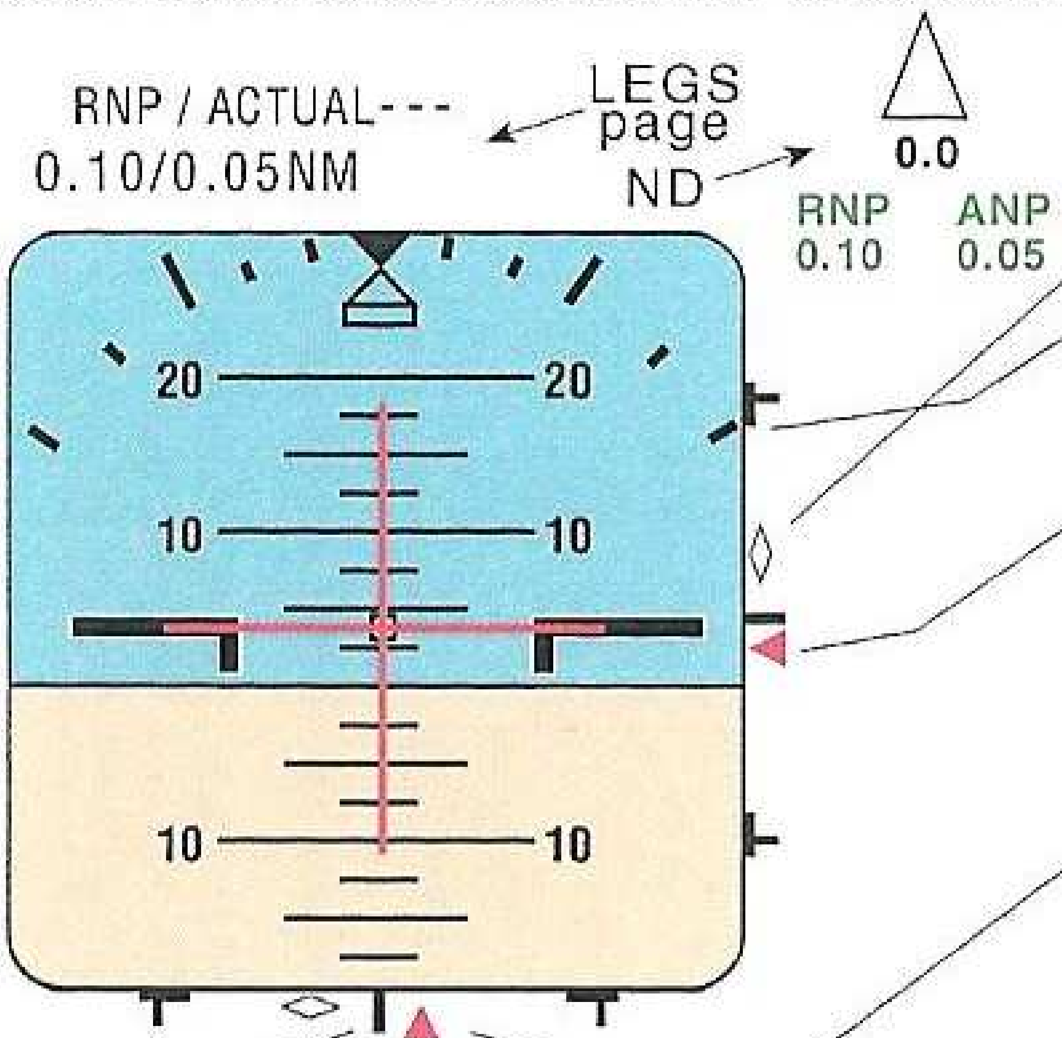
Expanded Localizer Scale
- displayed when the autopilot or flight director is in LOC mode, deviation is slightly more than one half dot and track is within 5° of the MCP selected course
- as deviation increases, the deviation pointer remains filled in solid magenta and parks at the limit of the expanded scale. Once the deviation reaches the equivalent of 2.4 dots from center on the standard scale, the pointer becomes unfilled
- reverts to standard scale when out of LOC mode, and groundspeed is less than 30 knots or RA is greater than 200 ft
- a rectangle equals 1/2 dot deviation

ADI - RNP APPROACH -Nav Performance Scales (NPS)

Two concepts need to be understood when discussing Required Nav Performance (RNP) operations: the navigation performance required for a defined flight leg (RNP) and the Actual Nav Performance (ANP) of the nav system at the present time. The ANP value must always be less than the RNP value.

RNP Approach is defined by its RNP value, expressed in lateral distance from the centerline. A .1 (“point one”) RNP approach (there are also .3) requires the aircraft to remain .1 nm either side of centerline at least 95% of the time. A missed approach is accomplished if this distance is exceeded. There is also an added buffer zone of 1 x RNP outside the normal approach corridor that separates the aircraft from terrain.

In the example below, the .1 RNP approach path width is 608 ft (1 x RNP) on each side of the centerline.(6076 ft/nm) Terrain would be at least 2 x RNP of centerline, or 1216 ft.



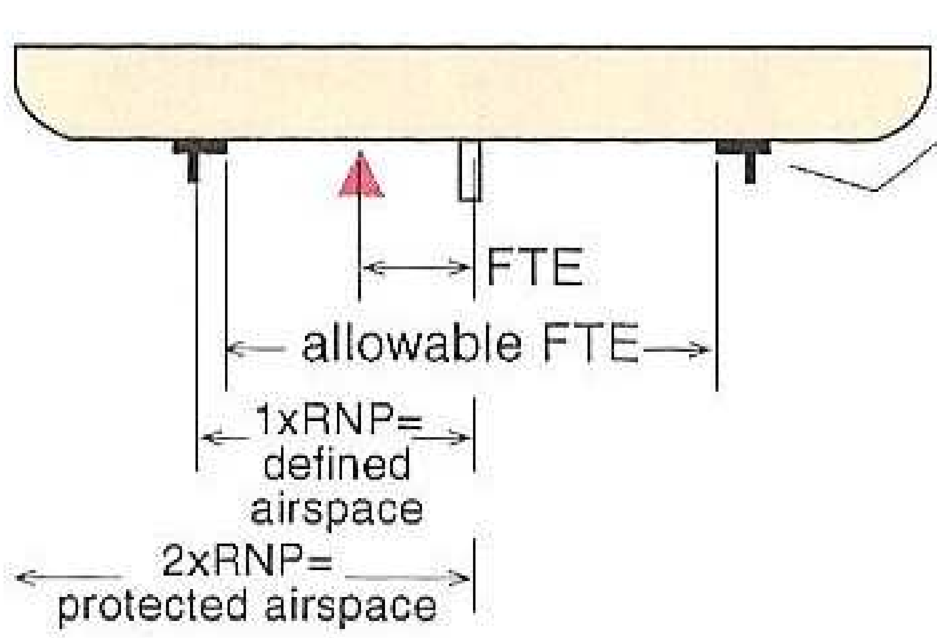
Anticipation Cues (ghost pointers)
- an unfilled white diamond symbol
- when an ILS is tuned, ghost pointers, which resemble raw data ILS deviation pointers, appear where the ILS deviation pointers typically would be observed
- LNAV and VNAV scales continue to be active as long as LNAV and VNAV are in the active mode
- as the current path converges to the final path, the ghost pointers move toward their respective scale centers.
- if the approach mode is armed, the FMAs will change to the appropriate ILS modes for the final approach guidance as the ILS localizer and glide slope are capture
- the traditional ILS deviation scales then replace the LNAV and VNAV scales

Vertical Deviation NPS Scale
- vertical NPS deviation scale represents current FMC vertical RNP

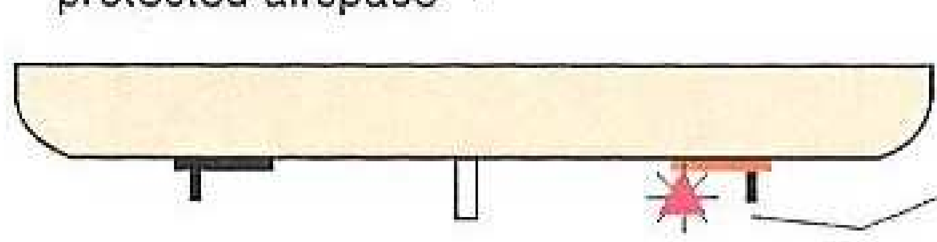
Lateral and Vertical Deviation Pointers
- filled magenta pointer when it is not parked at deflection limit
- unfilled pointer outline when at deflection limit
- indicates lateral / vertical paths relative to the a/c

Lateral Deviation NPS Pointer and Scale
- active anytime LNAV is in the engaged FD or autopilot mode
- the distance the deviation pointer is from the centerline represents the flight technical error (FTE). (Think of it as cross-track error)
- off-center maneuvering is allowed all the way out to the respective ANP bar, so the greater the RNP and the smaller the ANP, the more room for maneuvering
- in the final approach environment, where RNP may be 0.1 nm and ANP may be 0.08 nm, the allowable FTE from centerline would be only 0.02 nm, or 120 ft.

NPS Deviation Scale (Normal)
- displayed when LNAV or VNAV is engaged and an approach mode is **not** engaged
- lateral NPS deviation scale represents current FMC lateral RNP
- the RNP ticks and the ANP bars provide an indication of the RNP - ANP relationship



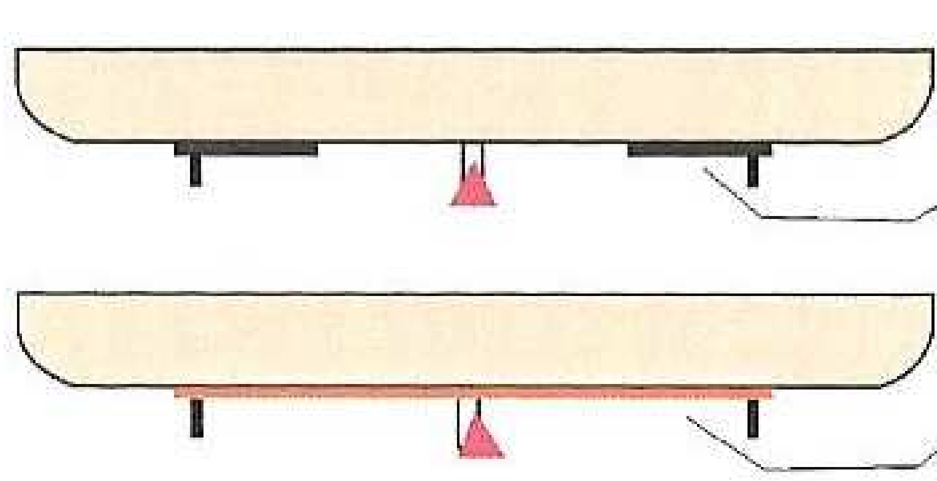
ANP Bars (Normal)
- lateral and vertical indication of available Flight Technical Error remaining based on total system error
- lateral ANP bars displayed in all phases of flight
- vertical ANP bars displayed only after reaching T/D
- originate from outer scale and expand inward as a function of increasing ANP relative to RNP
- as ANP approaches zero, bars fully retract indicating a wide area available for maneuvering (FTE)
- the further apart the bars are, the lower the ANP



NPS Pointer (Abnormal)
- will flash for 10 sec. if deviation overlaps ANP bar for 10 continuous sec.
- ANP bar turns from white to amber if deviation overlaps the ANP bar for 10 continuous sec.

RNP DEFAULT VALUES		
PHASE	*LATERAL*	*VERTICAL*
Enroute	*2.0*	*400'*
Terminal	*1.0*	*400'*
Approach	*0.1*	*125'*

RNP tells the flight crew how accurate the nav system needs to be. ANP tells the flight crew how accurate the system currently is.

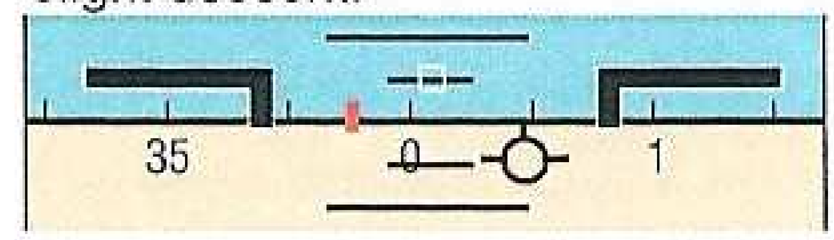


ANP Bars (Abnormal)
- this drawing represents degraded ANP
- as ANP grows, the maneuvering area shrinks
- as the ANP approaches RNP, the bars begin to close, representing a narrowing of the area available for FTE
- will touch at center of scale when ANP equals RNP
- if ANP exceeds the RNP the UNABLE REQD NAV PERF–RNP message will be displayed

HORIZON HEADING SCALE

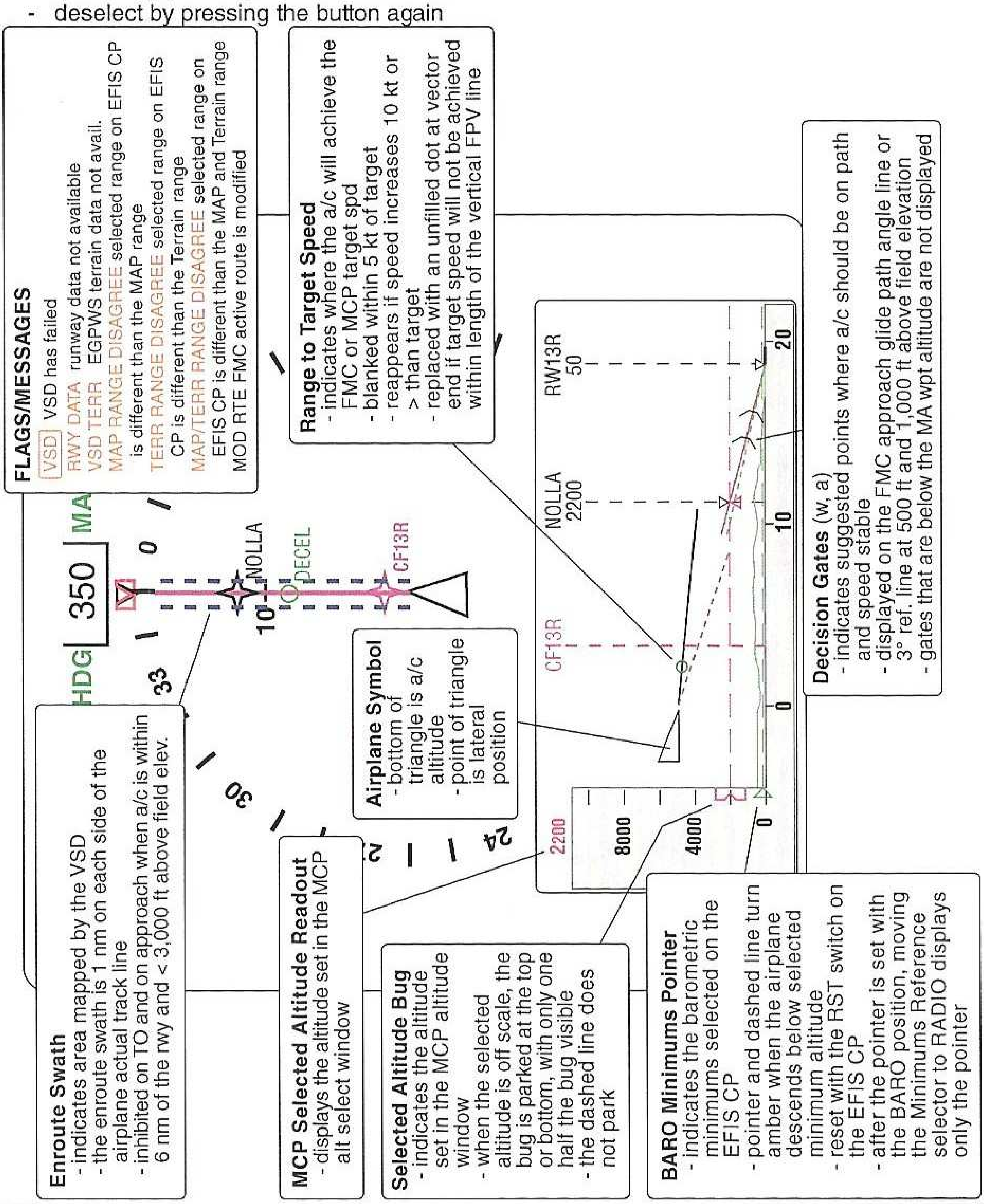
- displayed when FPV button is pushed
  - the current bank angle must be less than 50°
    - for bank angles over 50°, the scale is removed to avoid confusion between heading ticks and pitch ticks in the event of unusual attitude recovery
  - pitch must be less than 20°
- magnetic heading is displayed in 5° increments on the horizon line
- labeled every 10° / magnetic heading bug (MCP) is displayed in magenta

Aircraft is on a heading of about 002°. Heading bug is set to 357°. The FPV tells us the wind is from the left and the aricraft is in a slight descent.

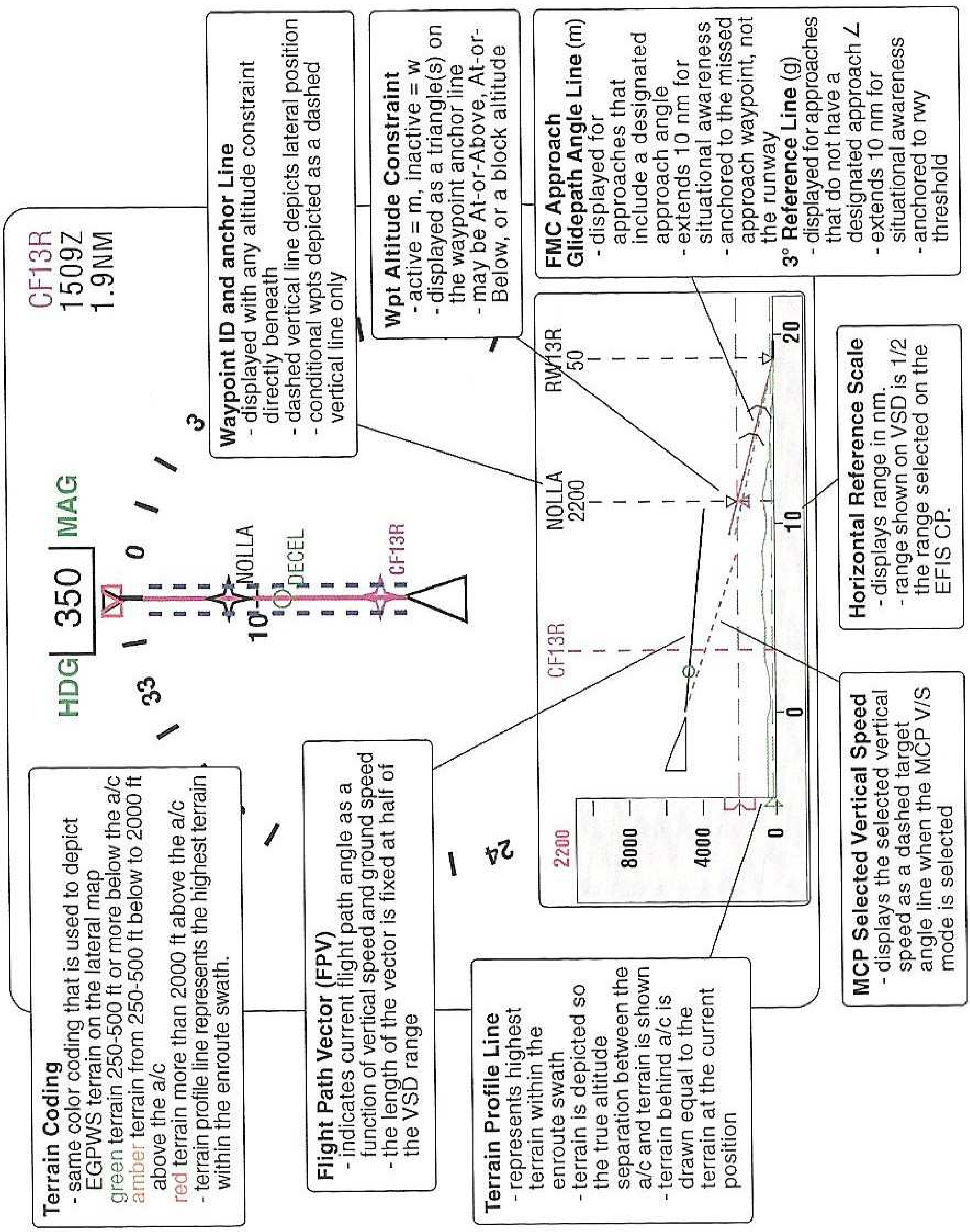


VERTICAL SITUATION DISPLAY (VSD)

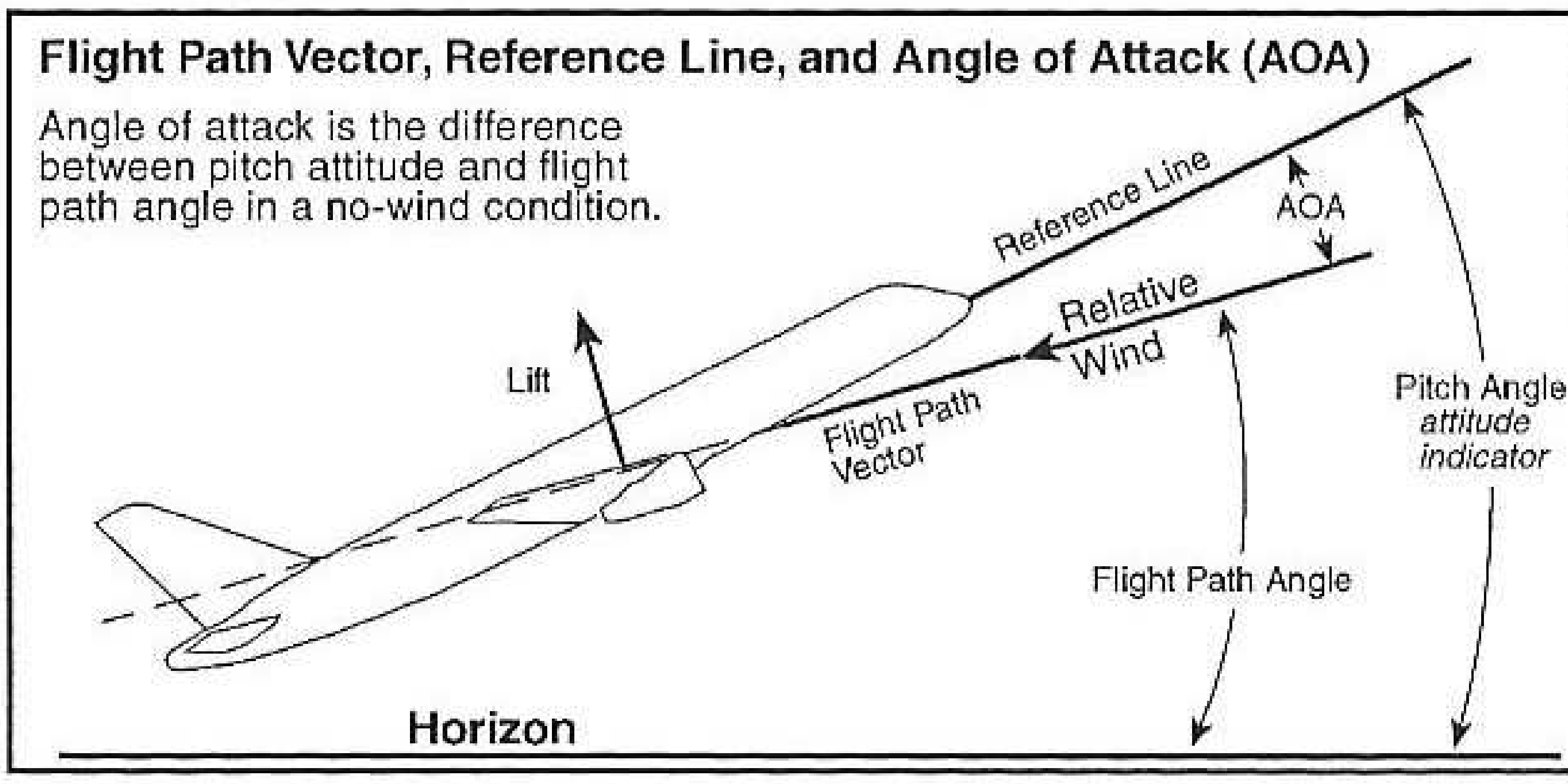
- represents a profile view of the airplane and its environment along the current track
- turn on by pressing CTR MAP button twice
- deselect by pressing the button again



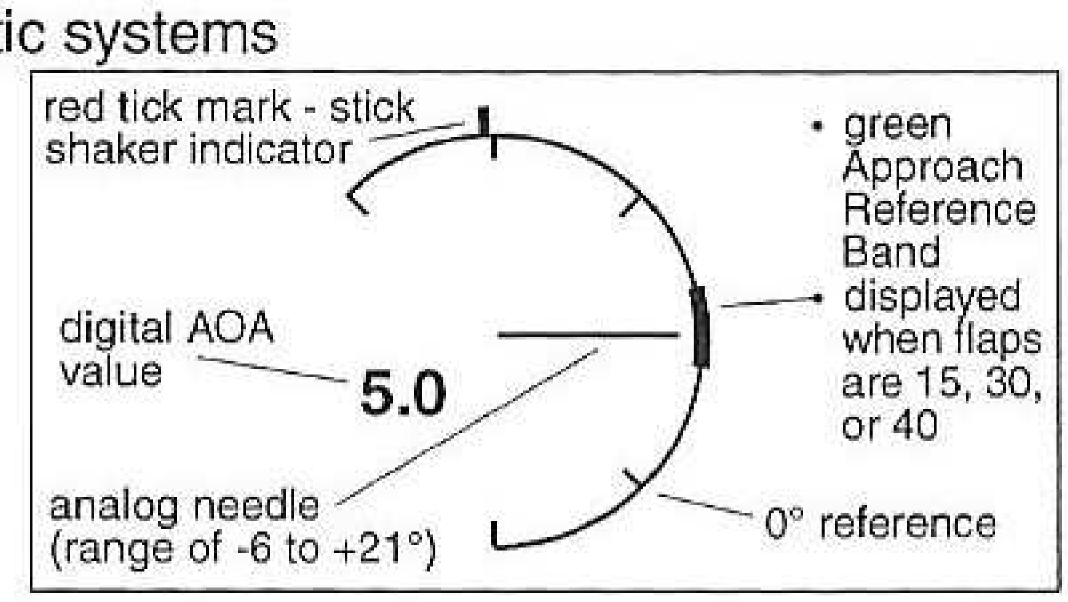
VERTICAL SITUATION DISPLAY (VSD) (continued)



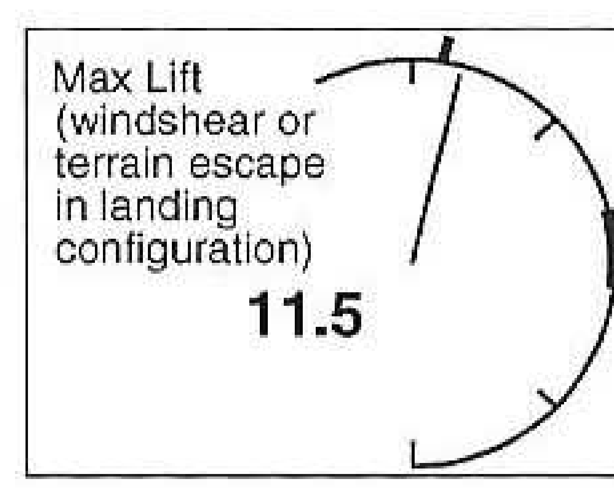
ANGLE OF ATTACK INDICATOR (NG) (option)



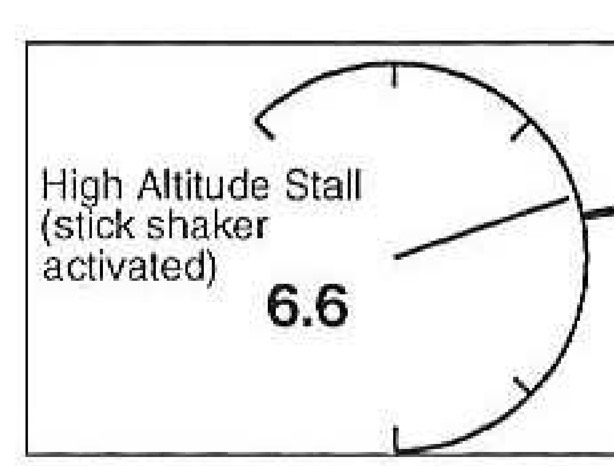
- most of this information comes from the Boeing Aero Magazine
- I have no practical experience with this instrument. Special thanks to Capt Dave Gorrell for his input.
- angle of attack is the angle between the relative wind and the chord line of the wing
- at a given airspeed, as the AOA is increased, lift also will increase and airspeed will decrease
- at the same airspeed, a heavy airplane of the same configuration must fly at a higher AOA than a light one
  - or it must fly at a higher airspeed if maintaining the same AOA
- as an airplane decelerates, the AOA must increase to maintain the same lift, so in the normal operational range, there is a relationship among lift, speed, and AOA
- AOA is the primary indicator of any specific wing's performance
- the AOA indicator displays aircraft body angle of attack, stick shaker angle of attack, and appropriate range of approach angle of attack (ref: figure)
- it is located in upper right corner of the PFD, above the ADI
- the AOA indicator is independent of the pitot-static systems



- during normal operation the Approach Reference Band moves with flap handle position, or if using alternate flaps, by the actual flap position
  - when the flap handle is in a landing flap detent, a green band 3° wide is centered at an AOA equivalent to Vref +5 approach, assuming a nominal gross weight, mid-CG, no sideslip, stabilized 3° glideslope, and no system error



- if the AOA is counter-clockwise of the approach band, the speed is too slow (as AOA increases, the needle moves CCW)
  - consider... VREF set correctly? Speedbrakes extended? Aircraft heavier than planned? Incorrect ZFW entered?
  - if the AOA shows above the 3 o'clock position on approach, add power and lower the nose!
- if the AOA is clockwise of the approach band, speed is too fast
  - consider... VREF set correctly? Are flaps set correctly? Aircraft lighter than planned?



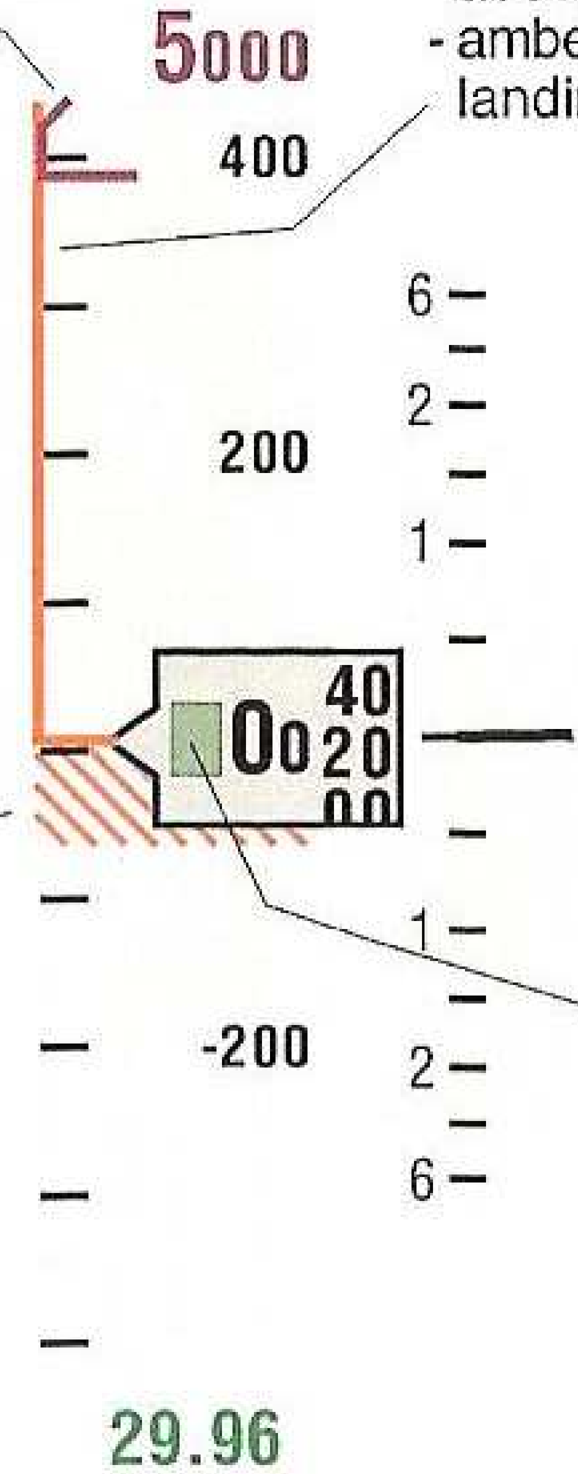
- potential uses for AOA
  - most useful in high-AOA, low-speed parts of the envelope
  - the AOA needle and digits will remain stable and the indicator will be useful as a backup for unreliable airspeed, pitot or static failure provided the AOA vanes are undamaged
  - on approach, reference green band should be used as a cross-check to detect large weight error, configuration or reference speed errors, and to reduce the probability of tail strikes on landing
  - pitch attitude remains the control instrument using AOA as a cross-check
  - AOA indicator can be used as an additional means to check for large errors
  - ability to fly the airplane very close to the edge of the envelope to extract max lift, most useful in terrain or windshear escape situations

ALTITUDE TAPE

ALTITUDE INDICATIONS ON GROUND

Altitude Select Bug (magenta)
- when the selected altitude is off scale, (5000) the bug is parked at the top or bottom of the tape with only one half the bug visible

Landing Altitude Reference Bar
- indicates height above touchdown
- white bar 500 to 1,000 feet above landing altitude
- amber bar 0 to 500 feet above landing altitude



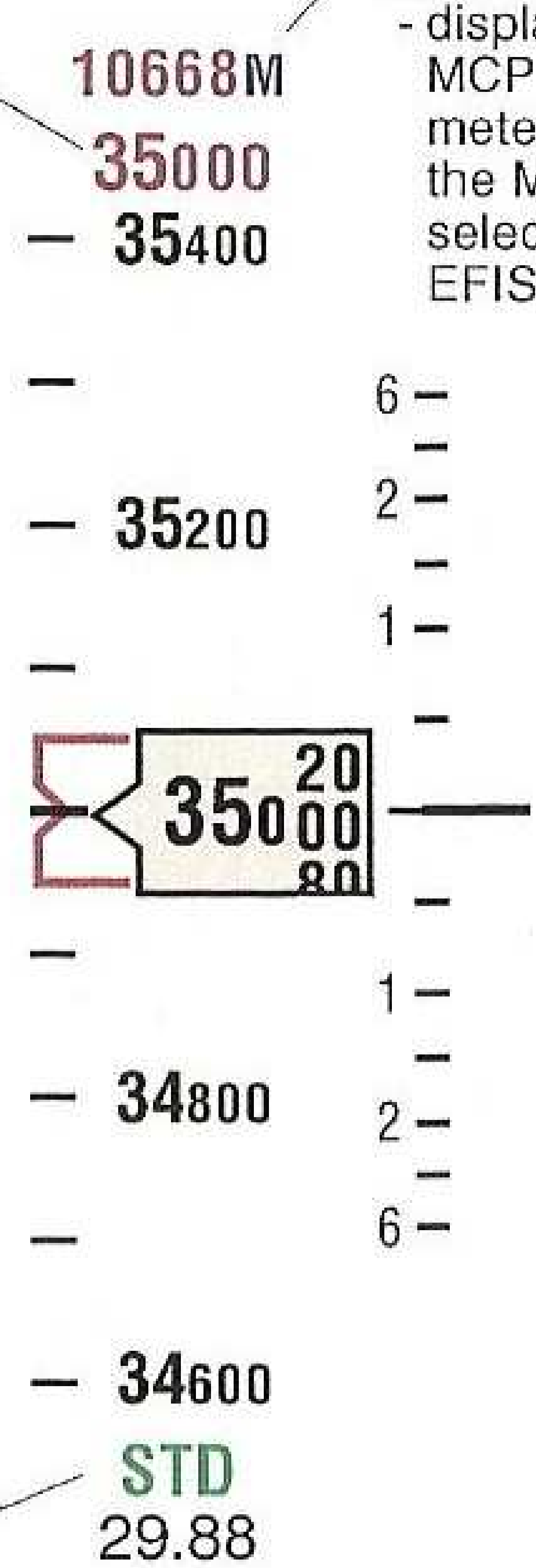
Landing Altitude (amber)
- the crosshatched area indicates the FMC landing altitude for the departure runway or airport until 400 nm from departure or one-half the distance to destination, whichever occurs first

For positive values of altitude below 10,000 ft a green crosshatch symbol is displayed

ALTITUDE INDICATIONS - CRUISE

Altitude Select Bug (magenta)
- indicates the altiitude set in the MCP altitude window
- the selected altitude appears in white box during an altitude alert

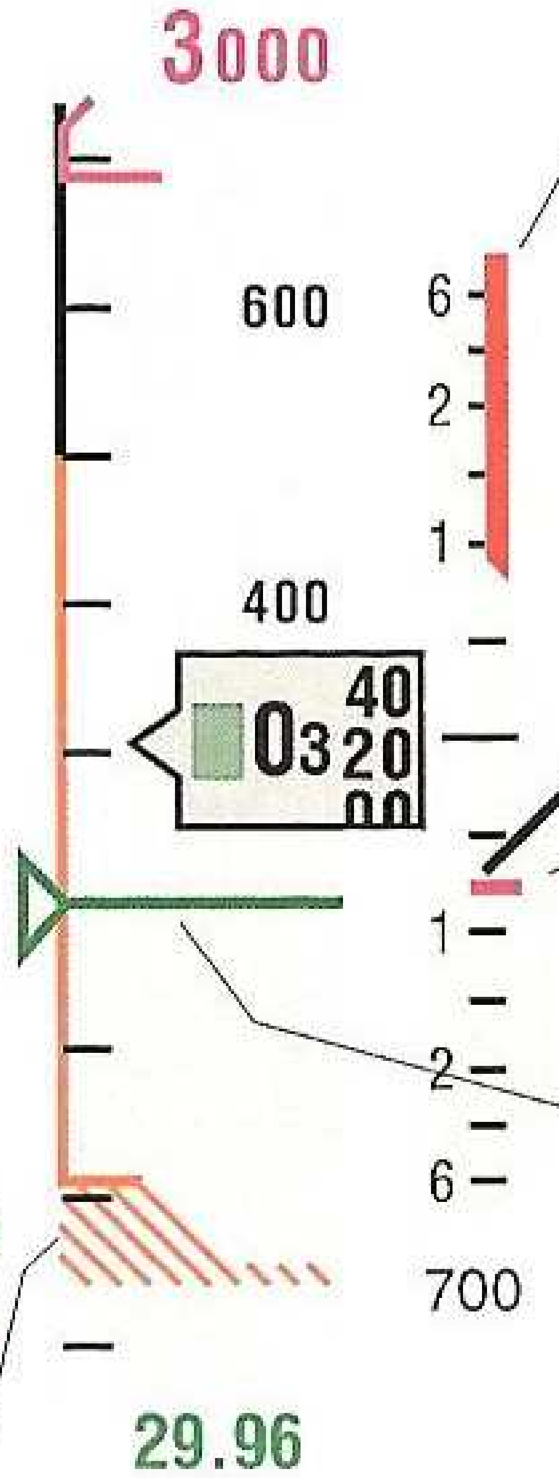
Metric Selected Altitude
- displays the MCP altitude in meters when the MTRS is selected on the EFIS CP



Barometric Setting (green)
- indicates the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS CP
- display is boxed amber if numeric is set and airplane is climbing above the transition altitude, or if STD is set and descending below transition flight level
- STD is displayed when the Baro Standard (STD) button is pressed on the EFIS CP
- when STD is displayed a baro setting can be preselected on the EFIS CP baro selector and is displayed in small white characters below STD

ALTITUDE TAPE

ALTITUDE INDICATIONS - LANDING



Minimums Reference (green)
- displays approach minimum reference set by the MINS selector on the EFIS CP
- displays BARO when the selector is set to BARO (MSL)
- displays RADIO when the selector is set to RADIO (AGL)

Turns amber and flashes for 3 seconds when the airplane descends below the selected minimum altitude

Landing Altitude Indication (amber) crosshatched area indicates
- the FMC landing altitude for the destination runway or airport

TCAS Vertical Speed Tape (red)
- tape turns red to indicate vertical speed values to avoid or exit during a TCAS resolution advisory
- vertical speed pointer is red if it is within the vertical speed tape range

Vertical Speed Indications
- indicates current vertical speed
- if the current vertical speed is greater than 400 fpm the vertical speed is also displayed above or below the scale (ex: 700) in white

Selected Vertical Speed (magenta)
- indicates the speed selected in the MCP vertical speed window with V/S pitch mode engaged

Baro Minimums Pointer (green)
- indicates the barometric minimums selected on the EFIS CP
- pointer and line turn amber when airplane descends below selected minimum altitude
- reset with the RST button on the EFIS CP
- after the pointer is set with the BARO position, moving the Minimums Reference selector to RADIO displays only the pointer

Navigation System Notes
- NAV-GS ind 1 dot = 400 ft +/- 40 ft change
- Nav alert light = 10 sec to WPT
  - WPT bearing pointer indicates bearing to next WPT
  - in VOR the bearing pointer is stowed at the 90° position
- in Nav, heading for left HSI and RMI come from left IRS and vice versa
- (non-EFIS) difference between L and R headings causes comparator to illuminate

ALTIMETER (NG)

ALTIMETER (EFIS option-NG)

- disoays ADIRS altitude and other related information
- electric, for Captain and FO
- range of -1,000 to 50,000 ft
- ALT DISAGREE advisory triggered at 200 ft difference

(L/OP) Instr. and Nav, Altimeter Differences

Max difference between:

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

ALT	CDS/CDS	CDS/STDBY	ALT	CDS/CDS	CDS/STBY
Sea Level	50 ft	50 ft	30,000 ft	120 ft	(see note)
10,000 ft	60 ft	120 ft	41,000 ft	170 ft	(see note)

(L/OP) Instr., Altimeter Differences-RVSM

- Max difference on ground between:

FIELD ALT	CDS / CDS	CDS / field elevation
SL to 5,000 ft	40 ft	75 ft
10,000 ft	60 ft	75 ft

- Max allowable in-flight difference between Captain and FO altimeters for RVSM operations is 200 ft

ALTITUDE POINTER
- makes one revolution each one thousand feet

DIGITAL COUNTER
- displays altitude in increments of thousands, hundreds, and twenty feet
- warning flag "OFF" appears whenever the ADC signal is lost or malfunction exists
- green flag appears in the left window when altitude is below 10,000'
- a "NEG" flag appears in the two left-hand windows when altitude is below zero feet

BAROMETRIC SETTING WINDOW
- reflects barometric correction (in inches or millibars) as selected on EFIS CP

REFERENCE ALTITUDE MARKER
- indicates the baro minimums as set by the minimums selector on the EFIS CP

METRIC SELECTED ALTITUDE READOUT
- displays the MCP altitude in meters when MTRS is selected on EFIS CP

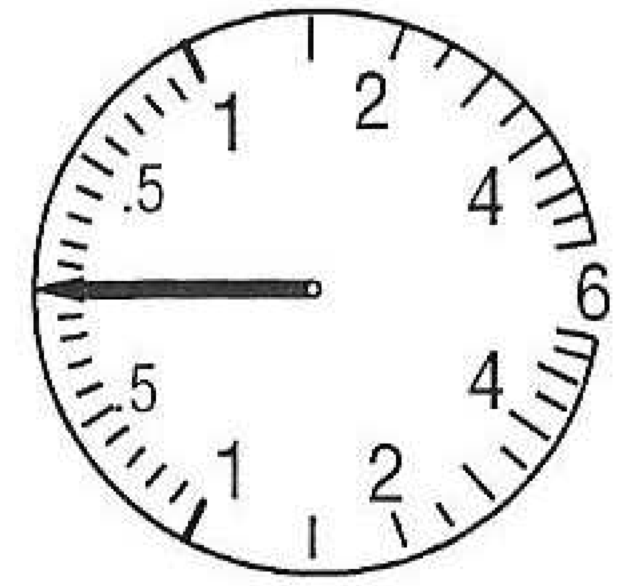
ALT ALERT LIGHTS (amber) (EFIS display option) **(two)**

ALT ALERT

- alerts when approaching or departing an MCP selected altitude
- inhibited with flaps 25 or greater, or if GS captured
- acquisition alerting: 900' (750' option) before reaching selected altitude, (option) momentary tone sounds (EFIS) both ALT ALERT illuminate, (PFD) white box appears around the selected altitude and box around current altitude turns bold
- (EFIS) 300' from selected altitude lights extinguish
- (PFD) 200' from selected altitude white box around selected altitude is removed and box around current altitude returns to normal
- deviation alerting: momentary tone sounds and (EFIS) ALT ALERT lights flash (PFD) box around current altitude turns amber and flashes
- flashing continues until deviation becomes less than (EFIS) 300' (PFD) 200' or deviation becomes more than 900' (750 option) or new altitude selected on MCP

VERTICAL SPEED INDICATOR

VERTICAL SPEED POINTER (VSI)
- displays ADIRS instantaneous vertical speed
- depicts rate of climb or descent from 0 to 6,000 fpm



RADIO ALTIMETER (RA) (NG)

2 display options
- radio altitude displayed on ADI below 2500 ft AGL
- digital display from 2500 to 1000 ft AGL
- round dial display below 1000 ft AGL
  - pointer replaces digital display of selected radio minimum altitude
  - the circumference of the dial is added-to, or taken-away-from, to depict the aircraft's radio altitude

BARO ALTITUDE APPROACH MINIMUMS (green)
- displayed in feet MSL
- selected minimums as set on the EFIS CP

RADIO ALTITUDE APPROACH MINIMUMS (green)
- displayed in feet AGL
- selected minimums as set on the EFIS CP

RADIO and BARO Approach Minimums
- readouts turn amber and flash for 3 seconds when descending through the selected minimum altitude; dial become steady amber after 3 seconds
- changes back when passing the selected minimum altitude plus 75 ft during go-around, at touchdown, or after pressing the RST switch on the EFIS CP

- radio altimeter indicator or receiver / transmitter may be inop provided:
  - both systems required for CAT II / IIIA minima
  - one Receiver / Transmitter / Indication may be inoperative deactivated provided aircraft limited to CAT I approaches
  - all 737s have two (2) Receiver / Transmitters installed

  (NG)
  - reinitialize the Flight Control Computer (FCC) associated with the inoperative radio altimeter by momentarily opening and then closing the applicable P6-2/P18- 1 panel FCC CB
  - refer to MEL 32-17 Proximity Switch Electronics Unit (PSEU) System, since an invalid radio altimeter signal will generate a dispatchable PSEU fault
  - perform a test of both stall warning systems. One (1) operative stall warning system (test passed) allows dispatch, provided all provisos for stall warning inoperative are followed

(MEL) Radio Altimeter Indicator or Receiver/Transmitter - ATA 34
- 2 indicators must be operative for CAT II, CAT II Autoland, and CAT IIIA
- 2 receiver/transmitters must be operative for CAT II, CAT II Autoland, and CAT IIIA
- both indicators may be inop provided associated receiver/transmitter operates normally and approach minimums do not require its use
- if RAs fail below 400 ft, the A/P will limit bank angle to a max of 8°
- #1 R/T may be inop provided GPWS modes 1-4 are not used and predictive windshear mode considered inop and repairs made in 2 days
- #2 R/T may be inop provided approach minimums or procedures do not require its use
  - VSI flag (amber) in view if VSI has failed

Radio Altimeter - PFD/ND Options

OPTION 1

Selected Radio Altitude Approach Minimums as set on the EFIS CP
- blank when an altitude less than 0 ft is selected

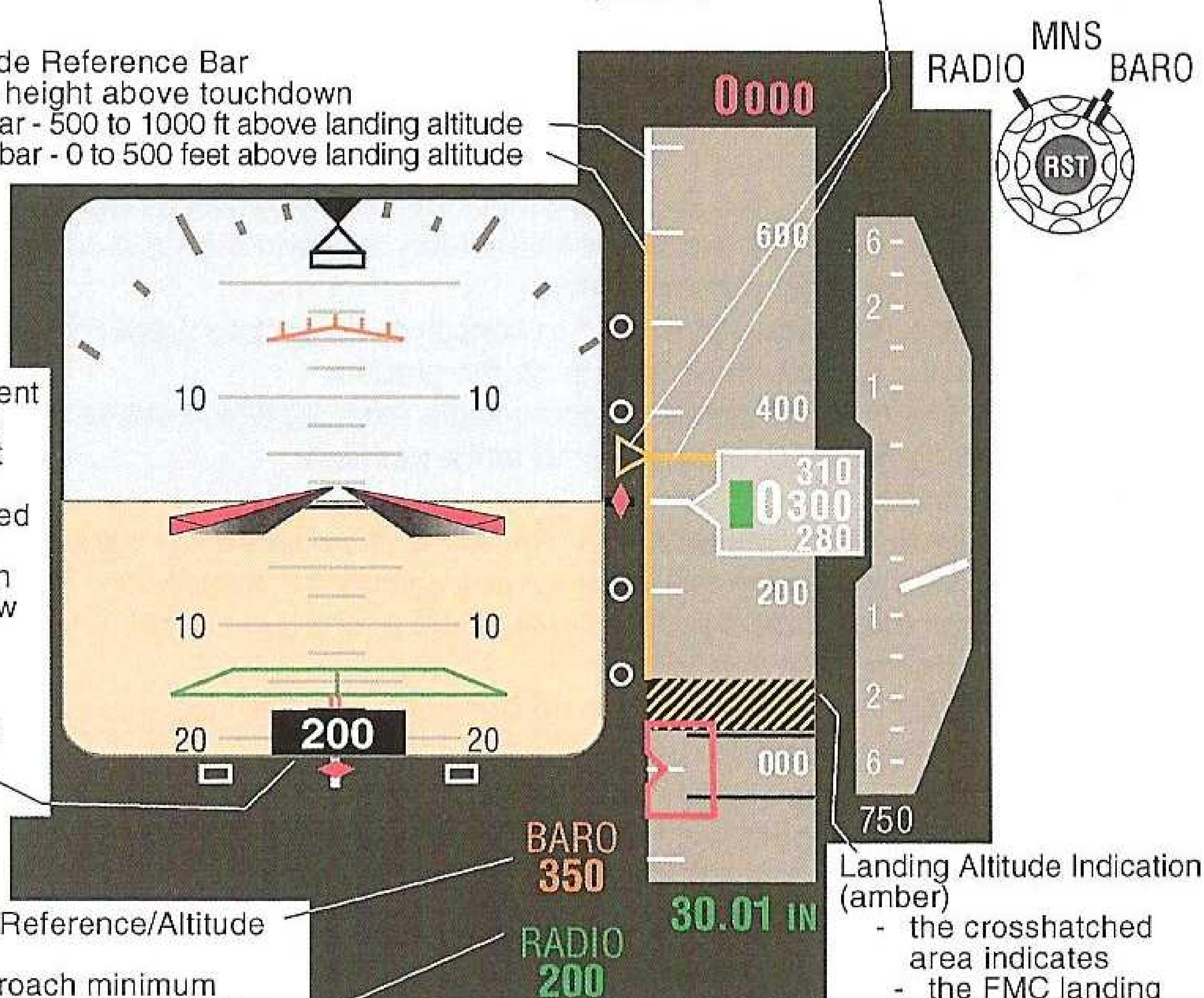
Radio Altitude displayed below 2500 ft AGL (blanked above 2500 ft AGL)
- digital display from 2500 to 1000 ft AGL / round dial display below 1000 ft AGL
- pointer replaces digital display of selected radio minimum altitude
- the circumference of the dial is added to, or taken away from, to depict the aircraft⊠s radio altitude

Radio Altitude Height Alert (ALT)
- displayed when radio altitude is less than or equal to 1000 ft
- blanked when descent continues below 500 ft AGL, or after pressing the RST switch on the EFIS control panel

Rising Runway
- shows in two colors, a magenta stem with a green trapezoid box on the top. The rising runway shows at the bottom of the ADI when the radio altitude is less than 2500 ft, or when the ILS localizer deviation shows on the ADI
  - will not show when the ILS is not captured
- moves toward the airplane symbol on the ADI as the altitude decreases from 200 ft to 0. At 0 ft the rising runway shows at the bottom of the airplane symbol. The rising runway symbol also moves left and right to stay aligned with the ILS localizer deviation pointer

BARO Minimums Pointer (gr./amber "wineglass")
- indicates the BARO minimums selected on the EFIS CP
- pointer and line turn amber when airplane descends below selected minimum altitude (in example)
- reset with the RST switch on the EFIS CP
- after the pointer is set with the BARO position, moving the Minimums Reference selector to RADIO displays only the pointer
- BARO mins pointer does not turn amber if the EFIS CP MNS selector is in the RADIO position

Landing Altitude Reference Bar
- indicates height above touchdown
  - white bar - 500 to 1000 ft above landing altitude
  - amber bar - 0 to 500 feet above landing altitude



OPTION 2

Radio Altitude
- displays current radio altitude below 2500 ft AGL
- box highlighted white for 10 seconds upon descent below 2500 ft
- turns amber when below radio altitude minimums

OPTION 2

BARO Minimums Reference/Altitude (green/amber)
- displays approach minimum reference and altitude set by the BARO MNS selector on the EFIS CP
- minimums are in ft MSL

RADIO Minimums Reference/Altitude (green/amber)
- displays approach minimum reference and altitude set by the RADIO MNS selector on the EFIS CP
- minimums are in ft AGL
- blank when an altitude less than 0 ft is selected

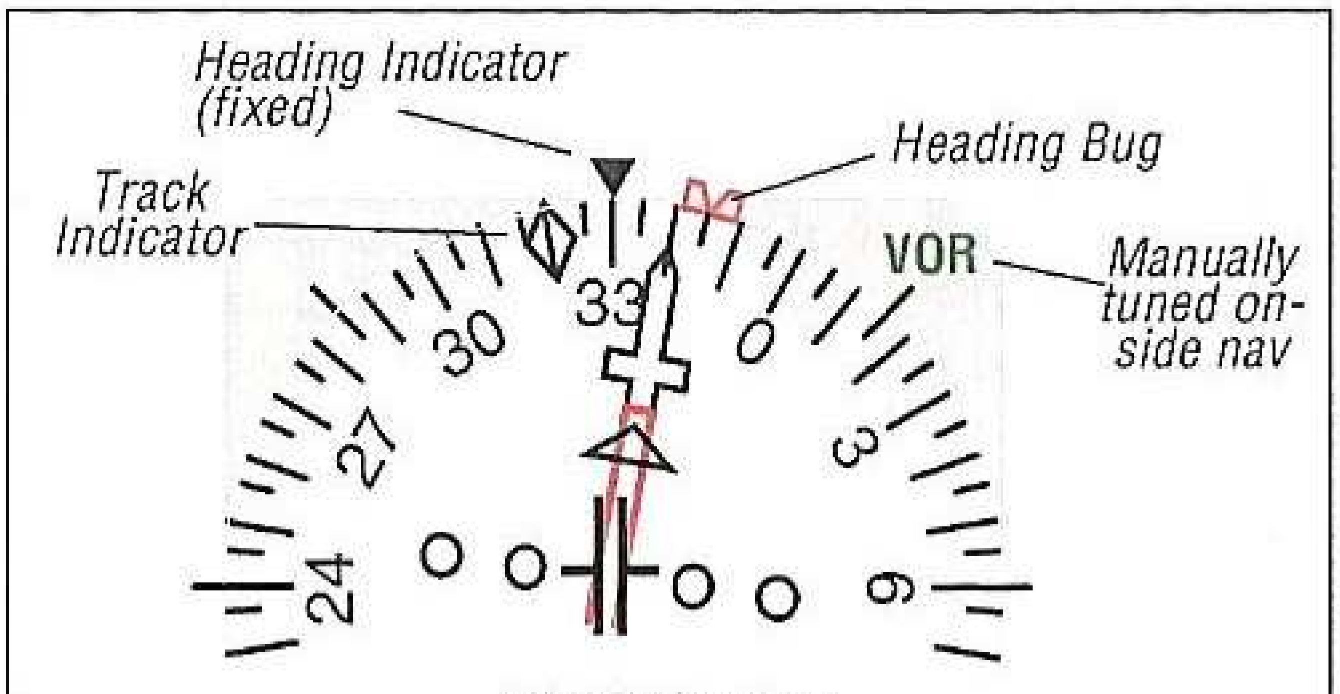
Features common to both BARO and RADIO MNS display
- *turns amber and flashes for 3 sec. when airplane descends below the selected minimum altitude*
- *changes back to green*
  - *when passing the selected minimum altitude plus 75 ft during a go-around*
  - *at touchdown*
  - *after pressing the RST switch on the EFIS CP*

Landing Altitude Indication (amber)
- the crosshatched area indicates
- the FMC landing altitude for the destination runway or airport, or
- the landing altitude for departure runway or airport until 400 nm from departure or one-half the distance to destination, whichever occurs first

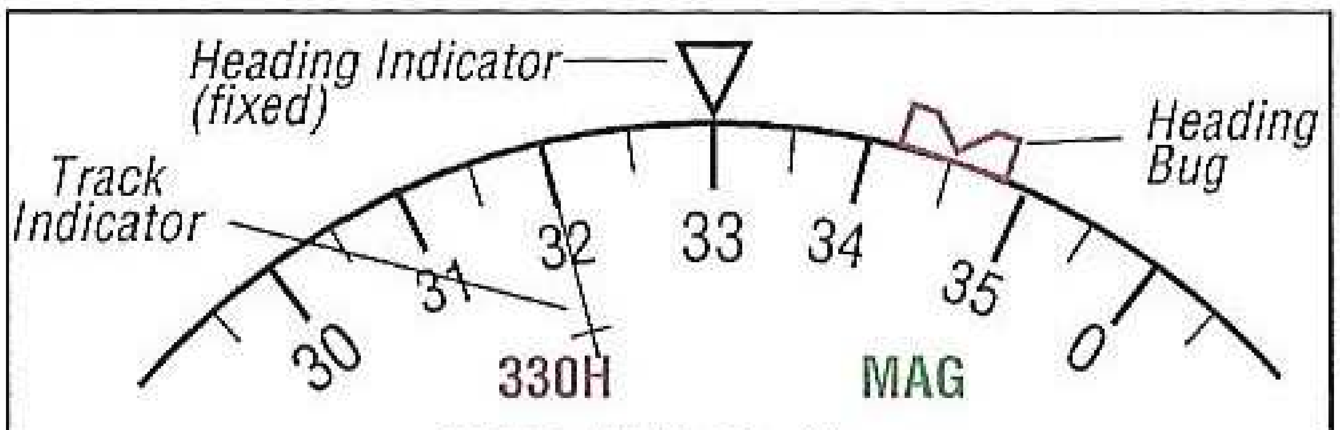
Radio Altimeter Notes

- with a radio altimeter inop, the A/P will disconnect 2 sec after LOC and GS capture; however if the radio altimeters indicate different values, there is no comparator check done and no fail flag for erronous readings (Amsterdam)
- radio altimeter (RA) measures the vertical distance from the aircraft to the ground
- normally used to determine DH when a DA(H) is specified for CAT II or III approaches or to determine alert height (AH) for CAT III approaches
  - not used for determining MDA(H) on instrument approach
- range of -12 to 2500 ft. The RA does not show above 2500 ft
- antennas (4) are on the bottom of the fuselage
- RA #1 to FCC A and RA #2 to FCC
- the RA system supplies radio altitude data to:
  - Weather radar R/T
  - TCAS computer
  - DEU 1 and the DEU 2
  - A/T computer
  - GPWC
  - FDAU
  - DEU 1 and the DEU 2
- RA system has two receiver/transmitters (R/Ts)
- both systems required for CAT II / IIIA minima, and RNAV/RNP
- do not use the associated AFDS or the autothrottle for approach if a RA is inop
  - if #1 RA system is inop, autopilot A should not be used for approach
    - autothrottle automatic retard during landing flare is inop (check AA application)
  - if #2 RA system is inop, autopilot B should not be used for approach
- RA Receiver/Transmitter Outputs
  - each FCC uses radio altitude from its on-side RA receiver/transmitter
    - the FCCs use RA in the approach control and low altitude flight calculations
  - the A/T uses RA in the *TO/GA calculation*
  - the DEUs use RA data to show on the DUs
  - weather radar R/T uses RA to turn on or off the predictive windshear function
  - GPWC uses RA in its ground proximity alert and warning logic calculations
  - FDAU records radio altitude values
  - TCAS computer uses RA to set the sensitivity levels for intruder advisory calculations and to find if an intruder aircraft is on the ground
- the RA receiver/transmitter has a non-volatile memory which stores fault information from the last 63 flights. It can store up to 13 faults per flight
- RA Data Invalid
  - invalid RA data causes an amber RA flag to show in the RA position
  - invalid RA also causes the rising runway symbol to be removed. The invalid data occurs when the RA receiver/transmitter finds a failure in the RA system
- Radio Minimums Data Invalid
  - invalid EFIS CP data causes the amber DISPLAYS CONTROL PANEL flag to show and the letters RADIO and the radio minimums value to be removed
    - the vertical speed indication (VSI) is grey. There is no VSI fail flag for this condition
- dispatch with an inop RA will result in the same side AFDS limiting the bank angle to 8° in LNAV mode. The opposite side AFDS (operative radio altimeter) is not affected.
  - use of the AFDS is at the discretion of the flight crew, since the AFDS may not command sufficient bank angle to execute proper departure and/or approach
  - Failure of #1 RA will result in failure of both stick shakers to self test
  - with a RA inop the A/P will disconnect 2 seconds after LOC and GS capture
- one Receiver/Transmitter (R/T) may be inop provided
  - other RA system R/T is operative and
  - approach minimums do not require its use and
  - perform procedures outlined in MPM 34-15a or 15b and
  - HUD LMP status is downgraded in accordance with MEL item 22-89a unless other MEL placards require a lower setting
  - additional items related to #1 RT
    - HUD system is placarded inoperative in accordance with MEL item 34-25 and
    - HUD combiner is kept stowed

ELECTRONIC HSI (EHSI)



EFIS Option



PFD / ND Option

TRACK AND HEADING INFORMATION

- only on EFIS series aircraft
- has integral light sensor and remote light sensor (glare shield) to adjust brightness, along with brightness controls on EFIS Control Panel
- displays are predicated in one of two ways: "heading up" or "track up"
    - Heading Up is data referenced to the aircraft heading as shown at the 12 o'clock position on the compass rose
    - track up is data referenced to the aircraft track as shown at the 12 o'clock position on the compass rose
- heading reference is supplied to each EHSI from the respective IRS
- track reference is supplied by the FMC
    - if FMC track data is unreliable, the respective IRS provides the data
- will lose color if you have an equipment cooling failure light
- functionally equivalent to HSI (above), with many additional features, as follows:

EHSI SYMBOLOGY

- COLORS:
    - green: indicates active or selected mode and/or dynamic conditions
    - white: indicates present status situation and scales
    - pink (magenta): indicates command information, pointers, symbols, fly-to conditions, and weather radar turbulence
    - blue (cyan): indicates non-active and background information
    - red: indicates warning
    - yellow: indicates cautionary information, faults, flags
    - black: indicates blank areas; off condition
- SYMBOLOGY SYMBOLS
    - the EHSI is equivalent to the standard HSI when using the FULL VOR/ILS mode, and symbology is similar
    - in the other modes, there are many new symbols and displays, giving a wealth of information to the pilot. Some of the more pertinent details are as follows:
    - index pointer at top shows current heading (HDG) or track (TRK), and is relative to magnetic north (M)
    - ETA at top right for next active waypoint
    - Weather radar codes at top right (GAIN / MODE / TILT):
    - VAR: gain is not in AUTO detent

EHSI TRACK UP / HEADING UP DISPLAYS (optional)

- Track Up orientation displays the aircraft track at the 12 o'clock position of the EHSI
- all NAV mode and MAP mode displays are "track-up" oriented displays
- Heading Up orientation displays the aircraft heading at the 12 o'clock position

(3-4-5) the FULL and EXP VOR/ILS modes are "heading-up" oriented displays

(NG) the APP and VOR modes are "heading-up" oriented displays

- the PLAN mode is oriented to True North

EHSI ANNUNCIATIONS

Approach Reference displays the selected ILS identifier or frequency, approach front course, and ILS/DME distance. If the tuned ILS frequencies disagree, the frequency turns amber with an amber horizontal line through it. If the approach course entered in the MCP disagree, the course turns amber with an amber horizontal line through it.

IJYV / 265°
DME 14.5

Glideslope Pointer (M) and scale (W) displays glideslope deviation Scale with Loc freq. tuned. Pointer in view when signal is received. Fills solid magenta when within 2.5 dots from center. Not displayed when the track and the front course on the MCP differ by more than 90° (Back Course)
Reference Notes 1 and 2 under ILS Localizer.

GPWS (red) WINDSHEAR or PULL UP

WINDSHEAR
PULL UP

Heading bug (magenta) open gun sight in with reference line (—), from MCP selection (not in "Plan" view). Select "Hdg", turn dial in direction of turn, and even if goes past 180°, it will take you in the direction you turned the knob. If selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

Heading pointer (white triangle); shows heading; shows drift angle from current track; place heading bug over the heading pointer

Heading (selected) digital display of the selected heading bug on the bottom of the PFD

155H

ILS Localizer or VOR course deviation indication (M) and scale (W) dispalys LOC or VOR course deviation. Deviation indicator points in direction of VOR or ILS selected course. For ILS deviation, indicator fills (M) when less than 2.5 dots from center. Scale in view when loc frequency is tuned. Scale expands when the localizer is engaged and deviation is slightly molre than one-half dot. Below 1,000 ft AGL, with LNAV engaged and LOC armed, the loc scale turns amber and the pointer flashes if the loc is not captured.
Note 1: At low RA, with AP engaged, the scale turns amber and the pointer flashes to indicate excessive localizer deviation.
Note 2: Each pilot's deviation alerting system self-tests upon becoming armed at 1500 ft RA. This self-test generates a 2 sec LOC/GS deviation alerting display on ech attitude indicator.
Lateral Deviation Bar: shows course deviation; ILS 1 dot = 1°; VOR 1 dot = 5°

MAGNETIC / TRUE HEADING ANNNUNCIATION (green) displays selected heading reference: MAG indicates display is oriented relative to magnetic north; TRU indicates display is oriented relative to true north; a white box is displayed continuously around TRU; transition from TRU to MAG results in a green box around MAG for 10 sec; when TRU is displayed and the airplane descends more than 2000 ft at a descent rate greater than –800 fmp, an amber box is drawn around TRU; the box flashes for 10 sec, then turns steady amber

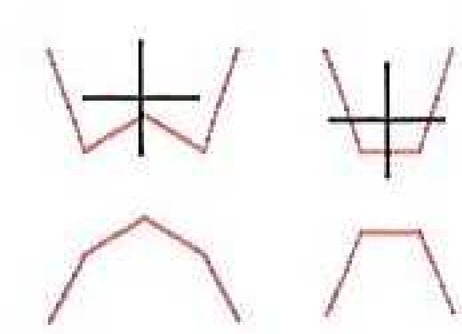
MAG

Radio Altitude displays current RA below 2500 ft. Box is highlighted white for 10 sec upon descent below 2500 ft; turns amber when below RA minimums

1200

Track Pointer (white - looks like a cross) indicates current track

Traffic Alert and Collision Avoidance System Pitch: The area(s) inside the red lines indicate(s) the pitch region(s) to avoid in order to resolve the traffic conflict. The airplane symbol must be outside the TCAS pitch command area(s) to ensure trafffic avoidance.



MAP MODES

ADF pointer head and tail (1 & 2)
- indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel

ADF bearing pointer
- indicates relative bearing to ADF; available in all modes (option)

ADF Bearing: if POS Map switch on = bearing line to tuned ADF

Airplane symbol (triangle)
(MAP modes); airplane position at tip;
(FULL compass rose); airplane position at center

Airplane symbol
- indicates actual position and track along the flight plan route in Plan mode only.
- Inhibited north of 82N latitude and south of 82S latitude

Airport Identifier and Runway
- in ranges 80, 160, or 320 NM, shows origin or destination runway line and number

KIAH
RW27

Airports
- blue circles; origin and destination always show, others show if ARPT switch on

O KIAH

Altitude profile points and identifiers
- indiicates approximate map position of the FMC calculated top-of-climb, top-of-descent, step-climb, and eod of descent points
- indicates intermediate T/D points for level flight segments during descent
- indicates the beginning of a deceleration segment resulting form deceleration to a holding pattern, a wpt speed restriction or flaps up maneuvering speed
- indicates airport speed restriction deceleration point (no identifier)

O T/D
O T/C
O S/C
O E/D
O T/D-XXXXX
O DECEL

Altitude Range Arc
- predicted point to reach MCP altitude, based on present vertical speed and ground speed. Blanks upon reaching selected altitude

Expanded compass arc of 65-70°: APP and VOR

Fix Radial and DME Circle
- shows downtrack bearing line and DME reference circle on fixes identified on Fix page of FMC

Fix Symbol
- circle around fix identified on Fix page of FMC

Full compass rose (FULL VOR/ILS, FULL NAV, CTR MAP) to 360°

Groundspeed / True Airspeed

Heading Bug (selected)

Heading Pointer

Holding Pattern
- active is magenta; Modification is white; Inactive is blue
- appears as a fixed size if the selected range is greater than 80 nm
- scaled predicted ground track if range is 80 NM or less and within 3 mins of the holding fix

LNAV Route

Mag / True reference

Map Source Annunciation

PLAN Mode displays
Range Circle
Airplane symbol
True North Up arrow

NAV / ADIRU position difference
- numbers show NM difference between the FMC system positions and the L or R IRS's position; arrows: show relative bearing to the associated IRS present position

Nav Aids
STA off = only tuned stations show in green
STA on = all stations in data base show blue, only high altitude nav aids on ranges 80 or greater; Manually Tuned VOR Radials: shows MCP course and reciprocal

Off Route Waypoints
- blue triangles if selected
- only on 40 or less range

Position Difference Display: (EFIS option only)
- numbers show NM difference between the FMC system positions and the L or R IRS's position
- arrows: show relative bearing to the associated IRS present positioN

MAP MODES (continued)

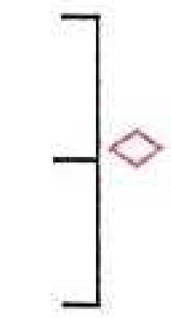
Selected course pointer (W) TO/FROM pointer (W) displays selected course as set by the related MCP course selector
Selected course pointer (W) and line (M) APP CTR, VOR CTR; displays selected course as set by the related MCP course selector. TO/FROM pointer is deisplayed when VOR navigation is being used
TO or FROM annunciation (VOR mode only)
TRACK ORIENTATION
Track indicator (Drift Angle Pointer)
Track Line and Range scale
- shows ground track (based on heading and wind)
- also shows drift angle if in VOR/ILS modes

Trend Vector segments (position) (1 to 3)
- prediction of ground track at the end of 30 secs intervals (ex: 3 segs = 90 secs) Range less than or equal to 10nm = 1 seg; 20nm = 2 segs; greater than 20nm = 3 segs

- based on bank angle and ground speed

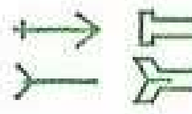
True airspeed
- True North Pointer: Plan mode only; shows orientation to true north
- Vertical Profile Points: T/C = top of climb; S/C = step climb; T/D = top of descent; E/D = end of descent; deceleration segment point has no identifier. All these points are FMC computed

Vertical Deviation scale and pointer

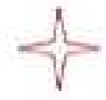


- displays vertical deviation from selected VNAV PATH during descent
- scale represents 400 ft deviation
- magenta pointer is the computed path; center of scale is airplane position
- digital display provided when pointer indicates greater than 400 ft

VOR (C, G), DME/TACAN (C,G), VORTAC (C, G); MAP, MAP CTR, PLN; when the EFIS CP STA map switch is on, appropriate navaids are displayed. All navaids contained in the FMC database and within the MAP area are displayed when the selected range is 5, 10, 20, or 40 mn. Only high altitude navaids are displayed when the selected range is 80, 160, 320, or 640 nm. Navaids not being used are displayed in cyan. Tuned VHF navaids are desplayed in green, regardless of switch selection
- VOR/DME raw data Radials MAP, MAP CTR: if POS Map switch on = bearing line to manually tuned VOR



VOR pointer head and tail (1 & 2)
VOR / ADF selection, Ident / Frequency, VOR DME
Waypoint bearing pointer (magenta) with reference line (- — - — -), shows bearing to active waypoint
Waypoint / ETA / Distance-To-Go
Waypoint symbols: magenta star is "active" waypoint; white stars are "downpath" waypoints. Data in (   ) is for "conditional" waypoints (altitude, vectors, interc)



Weather Radar Returns: magenta is turbulence associated with precipitation

355° / 18

Wind direction speed and arrow
- (if wind >6 kt; blanks if <4 kt) with direction arrow and speed values displayed

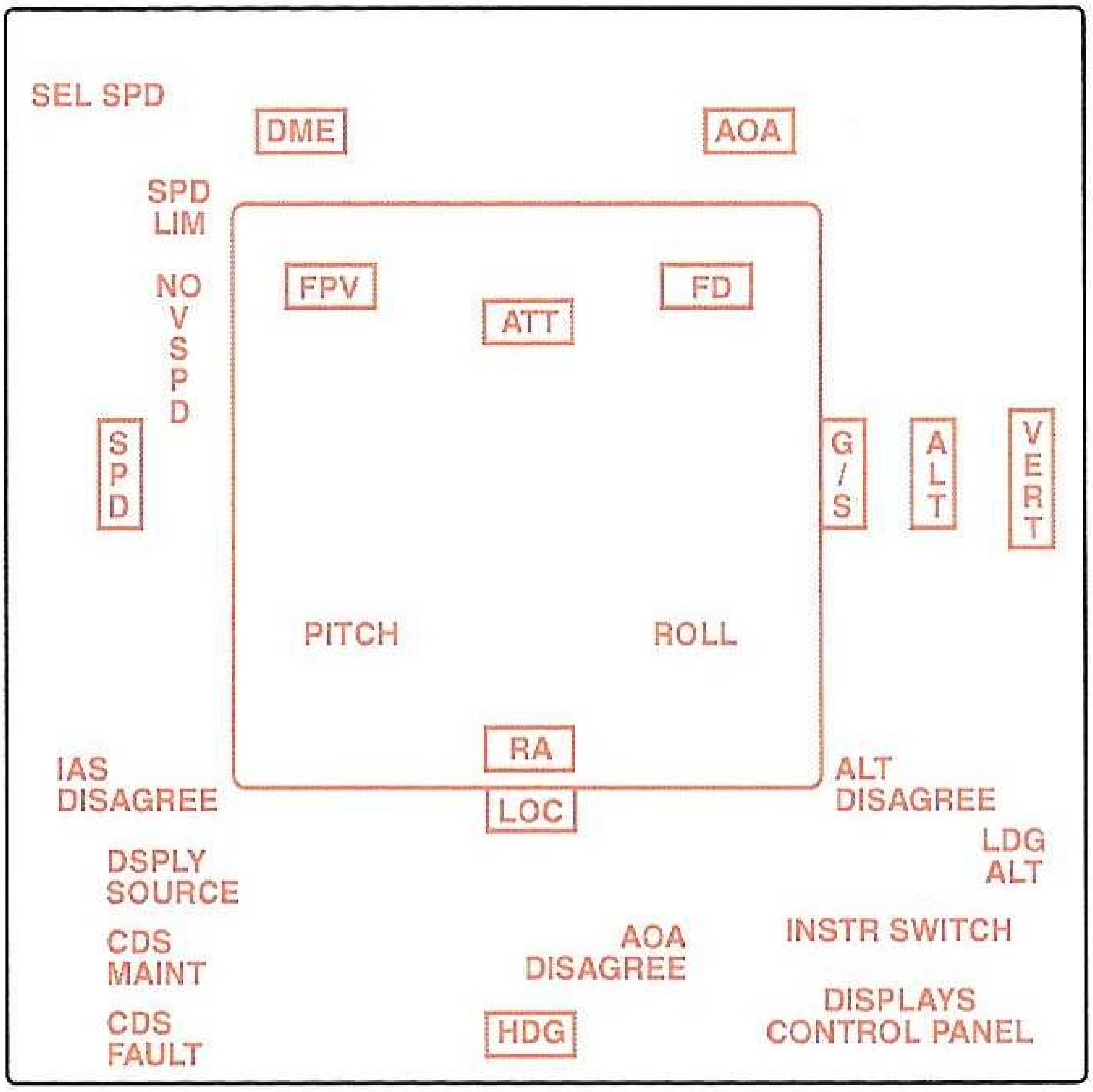
ATC light (NG option)

- located under each Autoflight Annunciator
- part of FANS package
- light illuminates when ATC message is received for pilot action

ATC

PFD FAIL FLAGS

- flags replace the appropriate display to indicate source system failure or lack of computed information
- in alphabetical order:



ALT The barometric altitude or barometric correction has failed: All altimeter symbols are removed except the ALT ALERTannunciation and the barometric setting.

ALT DISAGREE The Captain's and F/O's altitude indications disagree by more than 200 ft for more than 5 sec.

AOA The AOA signal has failed or is invalid when ground speed is greater than 80 knots.

AOA DISAGREE Indicates the left and right AOA values disagree by more than 10° for more than 10 sec.

ATT The attitude display has failed.

CDS FAULT A non-dispatchable CDS fault has occurred. Displayed on the ground only, prior to start of the second engine.

CDS MAINT (white) A non-dispatchable CDS fault has occurred. Displayed on the ground only, prior to start of the second engine.

DISPLAYS CONTROL PANEL With the CONTROL PANEL select switch on the overhead panel in: BOTH ON 1 left (Capt) EFIS control panel has failed NORMAL corresponding EFIS control panel has failed BOTH ON 2 right (FO) EFIS control panel has failed. Altitude information is removed.

DME DME display has failed.

DSPLY SOURCE A single DEU has been selected, either manually or automatically, to drive all 6 DUs.

FD The flight director has failed.

G/S ILS glideslope has failed.

HDG Heading display has failed.

IAS DISAGREE Indicates the Captain's and F/O's airspeed indications disagree by more than 5 knots for 5 sec.

INSTR SWITCH Indicates both the Captain's and First Officer's displays are using the same source of IRU data. Displayed when the IRS switch on the overhead panel is not in the NORMAL position.

LDG ALT Landing altitude input is not available or invalid.

LOC ILS localizer display has failed.

MAP The FMC generated map display has failed.

NO V SPD V1 or VR has not been entered or is invalid.

PITCH The Captain and First Officer's pitch angle displays differ by more than 5°.

RA The radio altitude display has failed.

ROLL The Captain and First Officer's roll displays differ by more than 5°.

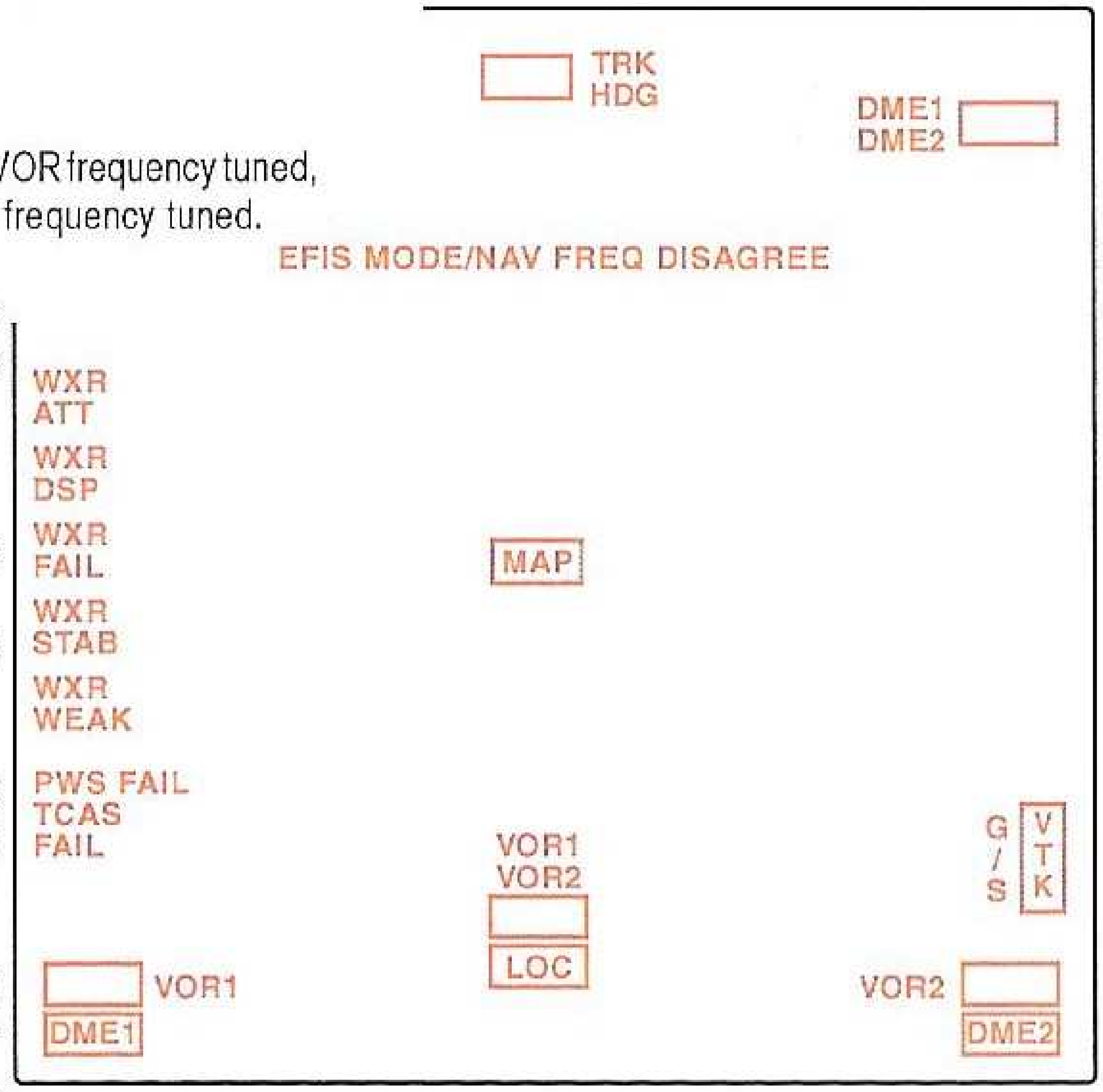
SEL SPD The airspeed cursor is inoperative and removed.

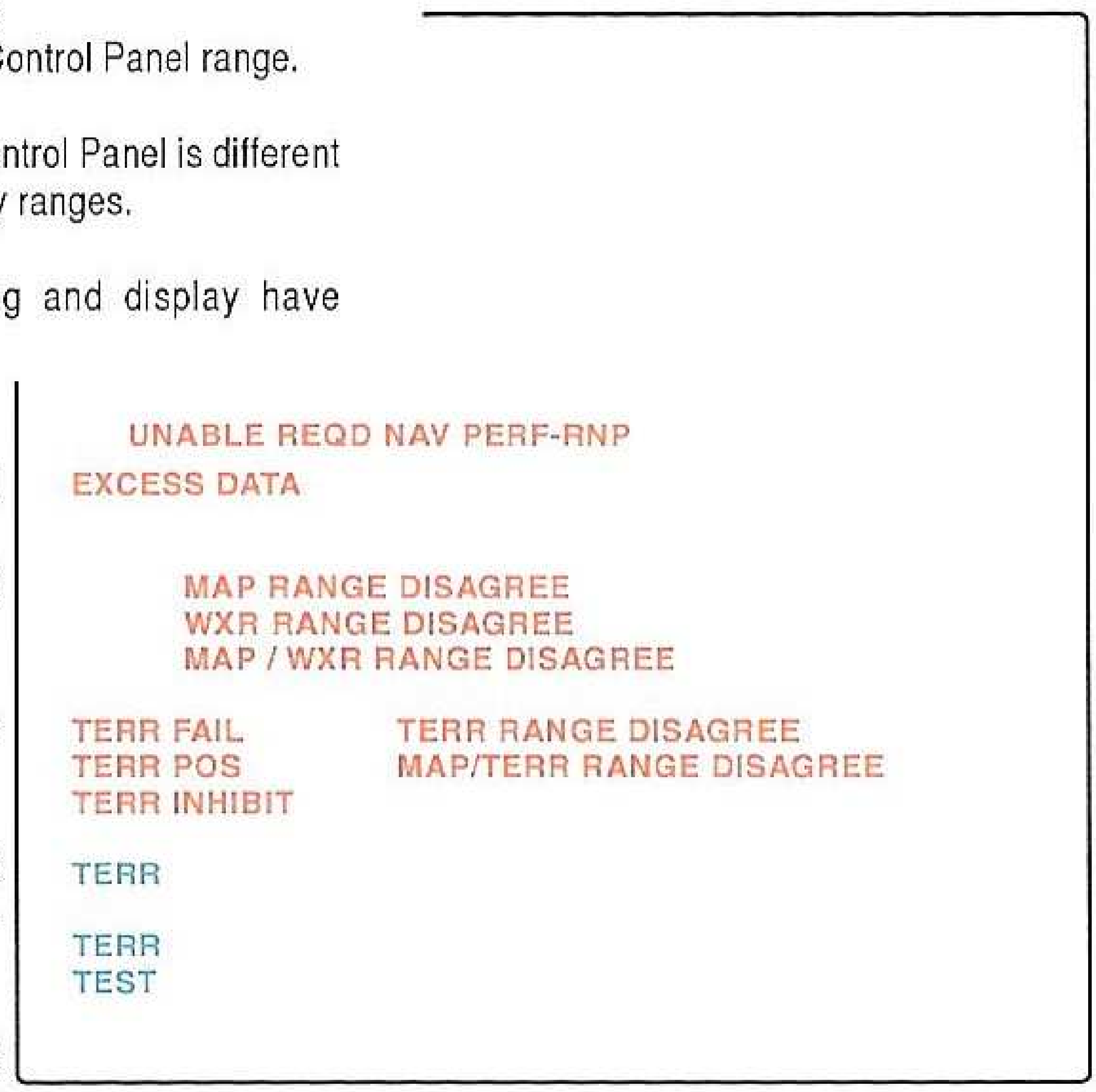
SPD LIM Displays related with stick shaker or maximum operating speed has failed: If the stick shaker warning has failed, the red stick shaker speed arc is removed. If the maximum operating speed has failed, the red and white maximum operating speed arc is removed.

SPD The mach/airspeed indicator is inoperative and all markings are removed.

VERT Vertical speed has failed.

ND SYSTEM FAIL FLAGS





DME 1 or 2 The DME system has failed.

EFIS MODE / NAV FREQ DISAGREE
Indicates APP is selected with a VOR frequency tuned, or VOR is selected with an ILS frequency tuned.

EXCESS DATA
The amount of data sent to the navigation display exceeds the display capability.

G/S ILS glideslope has failed.

HDG Heading display has failed.

LOC ILS localizer display has failed.

MAP The FMC generated map display has failed.

MAP RANGE DISAGREE
Selected range on the EFIS Control Panel is different than the MAP display range.

MAP/ TERR RANGE DISAGREE
Terrain display enabled, Terrain output range disagrees with selected EFIS Control Panel range, and Map display output range disagrees with selected EFIS Control Panel range.

MAP/ WXR RANGE DISAGREE
Selected range on the EFIS Control Panel is different than the MAP and WXR display ranges.

PWS FAIL
Predictive windshear alerting and display have failed.

TCAS FAIL TCAS has failed.

TRK Track data has failed.

TERR Terrain display enabled (manual or automatic display).

TERR FAIL Look-ahead terrain alerting and display have failed.

TERR INHIBIT
GPWS Terrain Inhibit Switch in TERR INHIBIT position.

TERR POS
Look-ahead terrain alerting and display unavailable due to position uncertainty.

TERR RANGE DISAGREE
Terrain display enabled, and Terrain output range disagrees with selected EFIS Control Panel range.

TERR TEST GPWS is operating in self-test mode.

UNABLE REQD NAV PERF-RNP
Displayed in MAP or Center MAP during approach.

VOR 1 or 2 VOR display has failed.

VTK FMC vertical track data is invalid.

WXR ATT Attitude stabilization for antenna has been lost.

WXR DSP Display unit cooling has been lost or an overheat condition has occurred. Radar display is blanked.

WXR FAIL Weather radar has failed and no data is displayed.

WXR RANGE DISAGREE
Selected range on the EFIS Control Panel is different than the WXR display range.

WXR STAB Antenna stabilization is OFF.

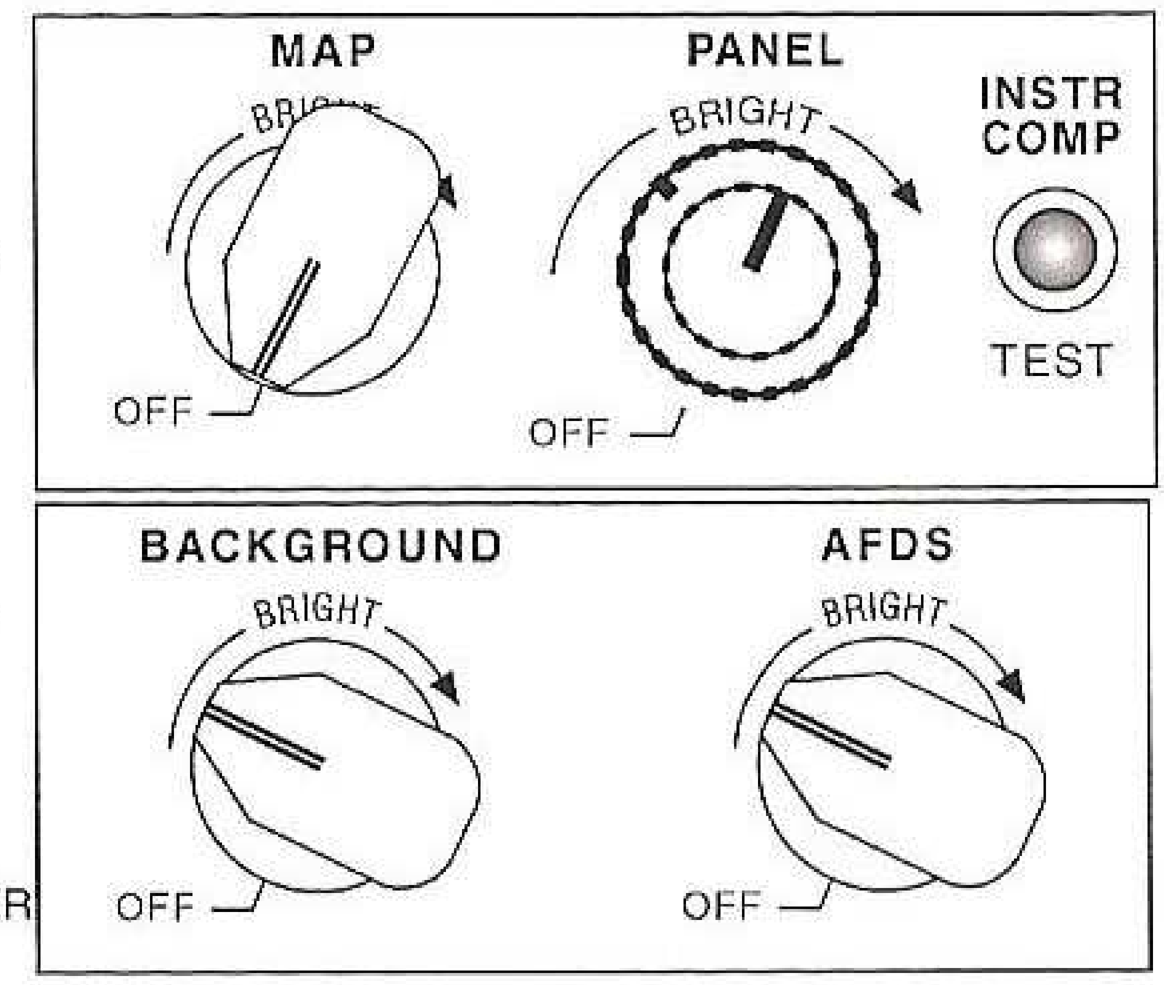
WXR WEAK Weather radar calibration fault.

WINDSHIELD / FOOT AIR CONTROLS

WINDSHIELD
- applies conditioned air to the No. 1 windows for anti-fogging
- if you lose window heat, use this windshield heat control

FOOT-AIR
- applies conditioned air to the pilot's leg positions

COCKPIT LIGHTS



MAP light
- rotate to control overhead map lights Lights, Cockpit; (on EFIS, located on side-wall)

PANEL lights
- rotate to control instrumentation lighting
  - Capt controls "center" panel also
- outer knob controls lights; inner knob controls HSI indicator lights

BACKGROUND lights - rotate to control incandescent lights for Capt, center, and FO
- if lose normal AC Transfer Bus #2 (TRANSFER BUS OFF light) the instrument florescent floods go to AC standby bus at fixed lower intensity

AFDS Flood light
- controls brightness of lighting directed at AFDS panel

Also have various other CB, PANEL, and FLOOD light controls to rotate

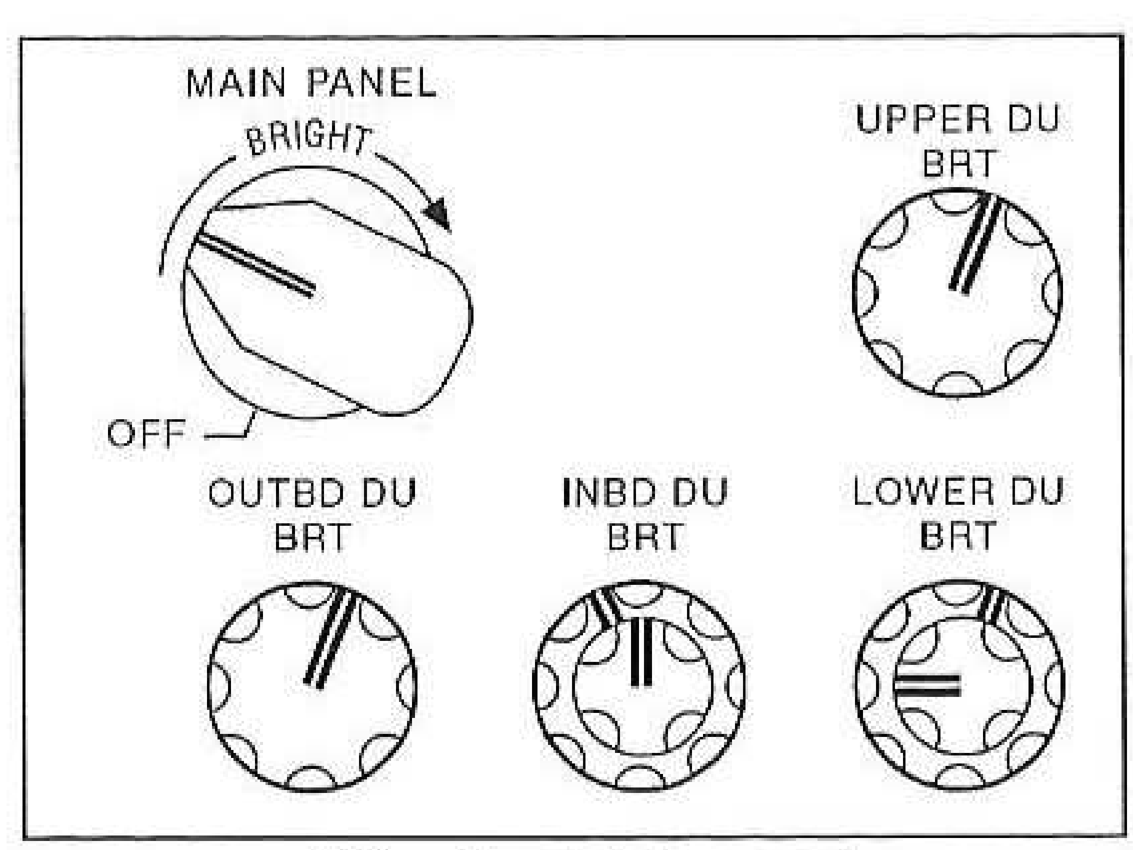
BATTERY BUS ONLY: if lose all AC power, you have these lights:

Standby compass, Dome lights, Background instrument flood lights, Selected system information and warning lights

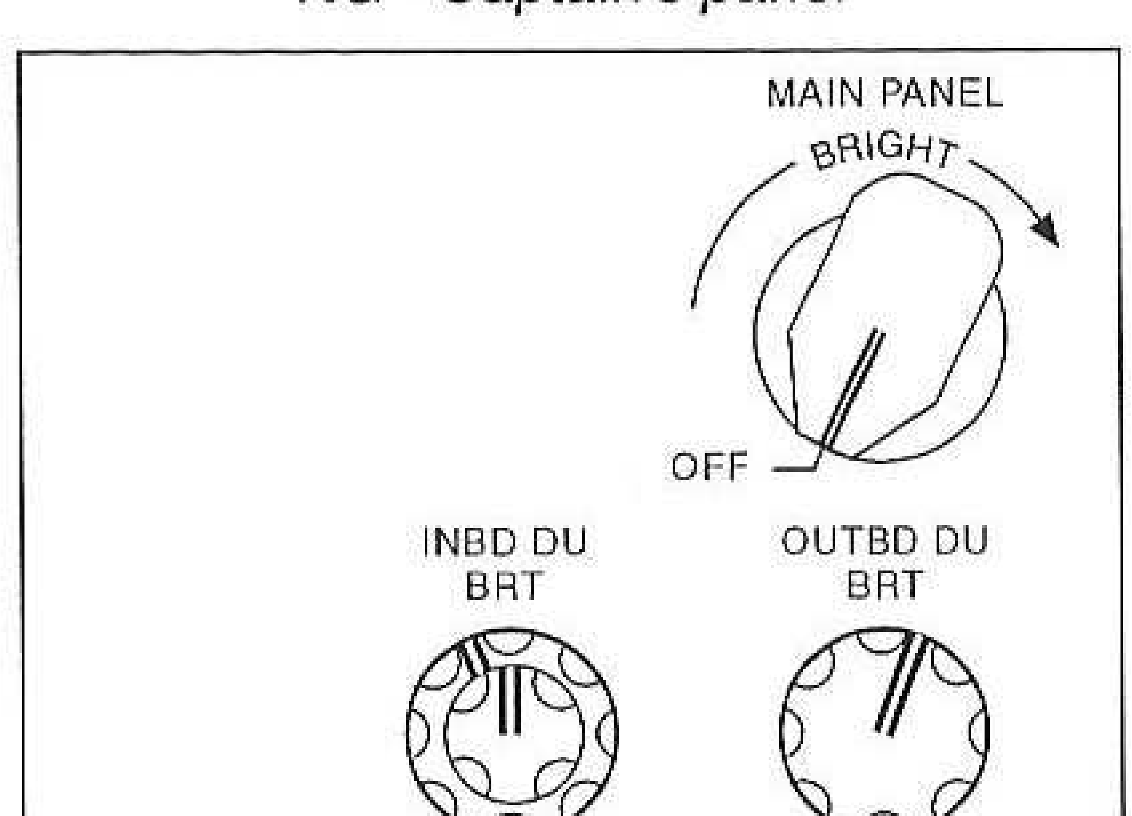
FORWARD ENTRY LIGHTS
- just outside of cockpit, will dim when cockpit door is opened (if an engine is running)

BRIGHTNESS CONTROL PANELS (NG)

- BRIGHT control knob is a variable transformer
  - the knob turns to adjust the voltage available to the fixed transformers
- two panels, one located below the captain's displays and one located below the first officer's displays
- manually sets adjustment of the LCDs
- the controls for the inboard LCDs and the lower center LCD are dual controls
  - the larger knob controls the overall brightnes of the LCD
  - the small knob controls the radar relative brightness when the radar is on

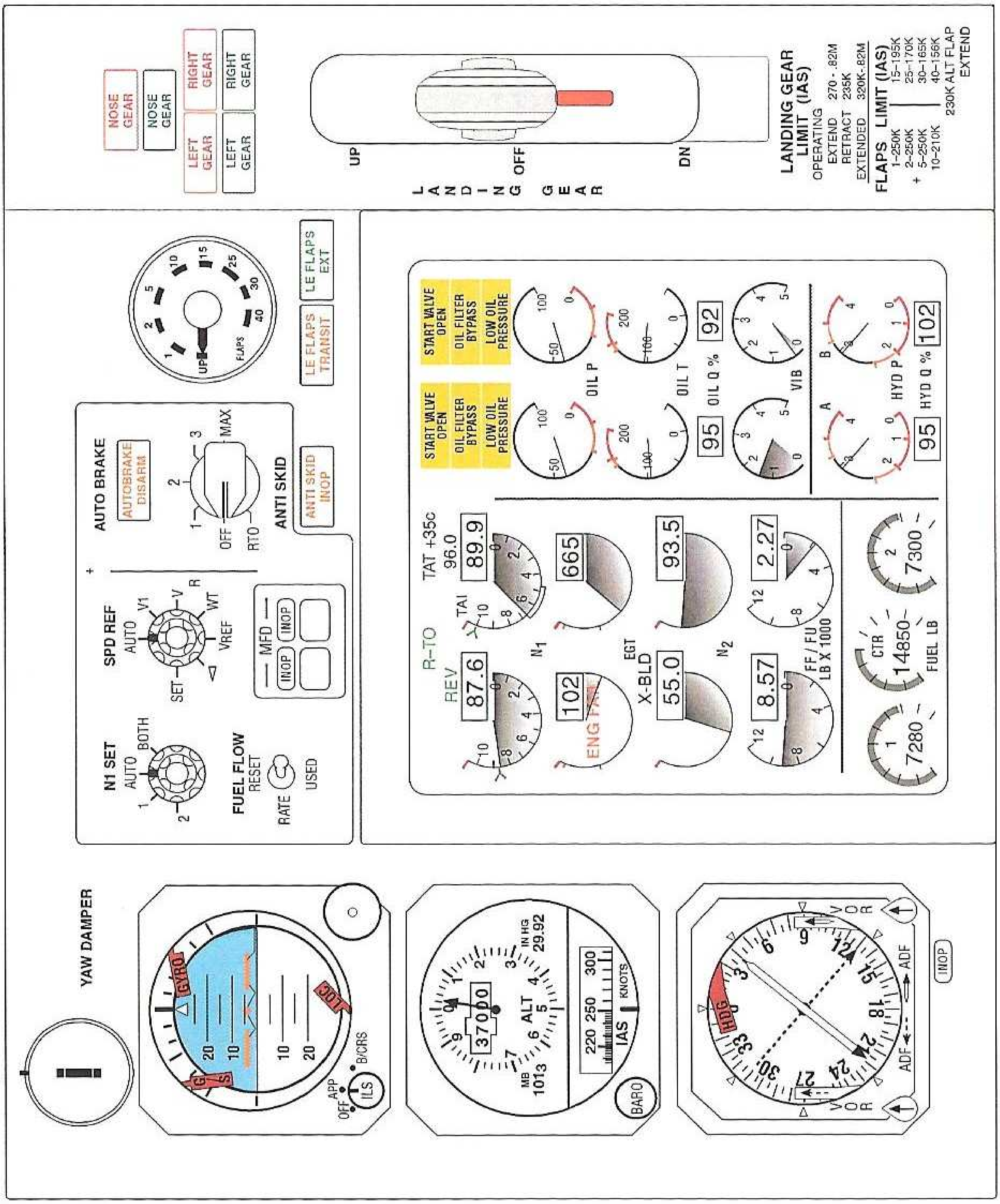


NG - Captain's panel

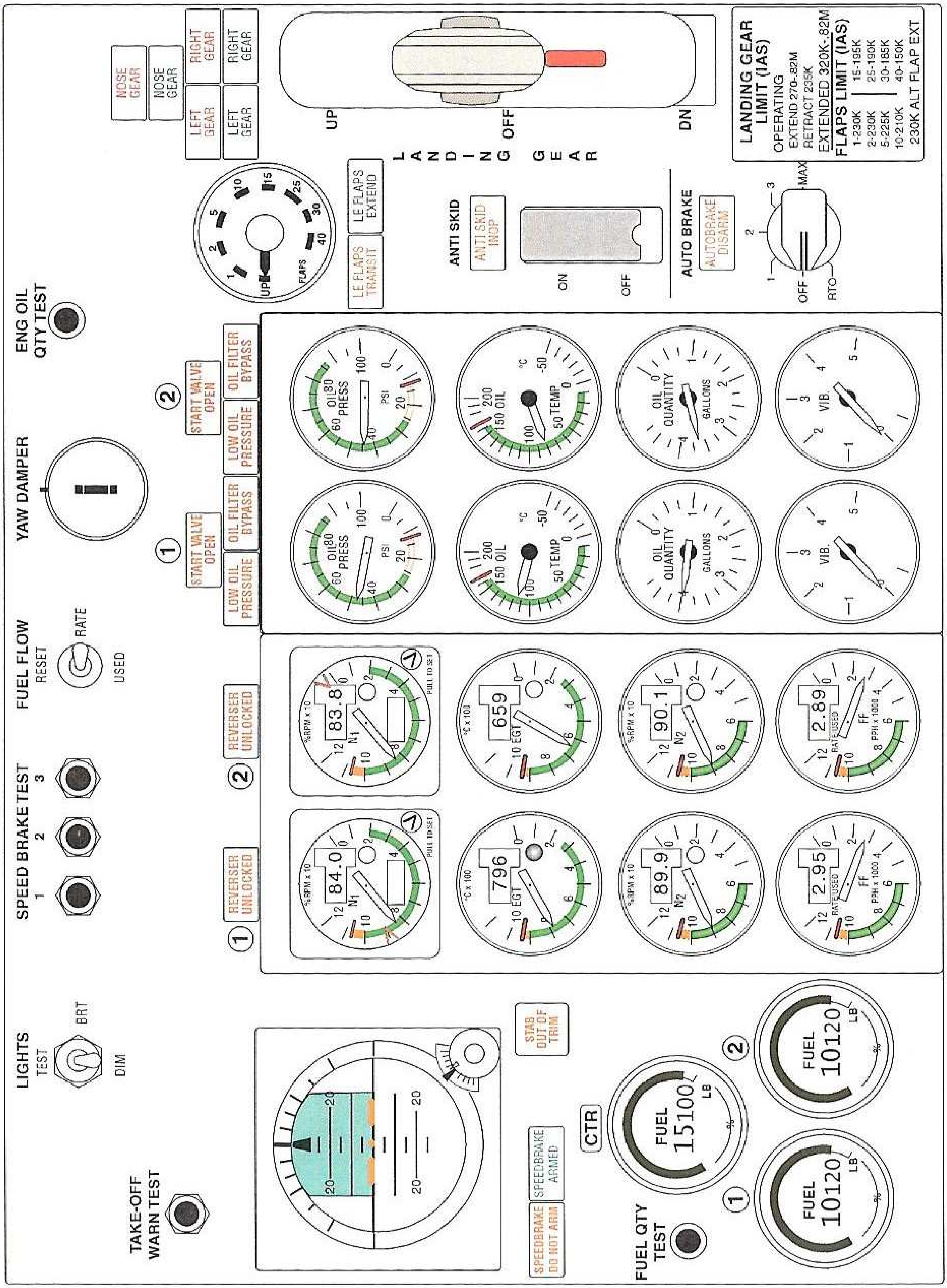


NG - FO's panel

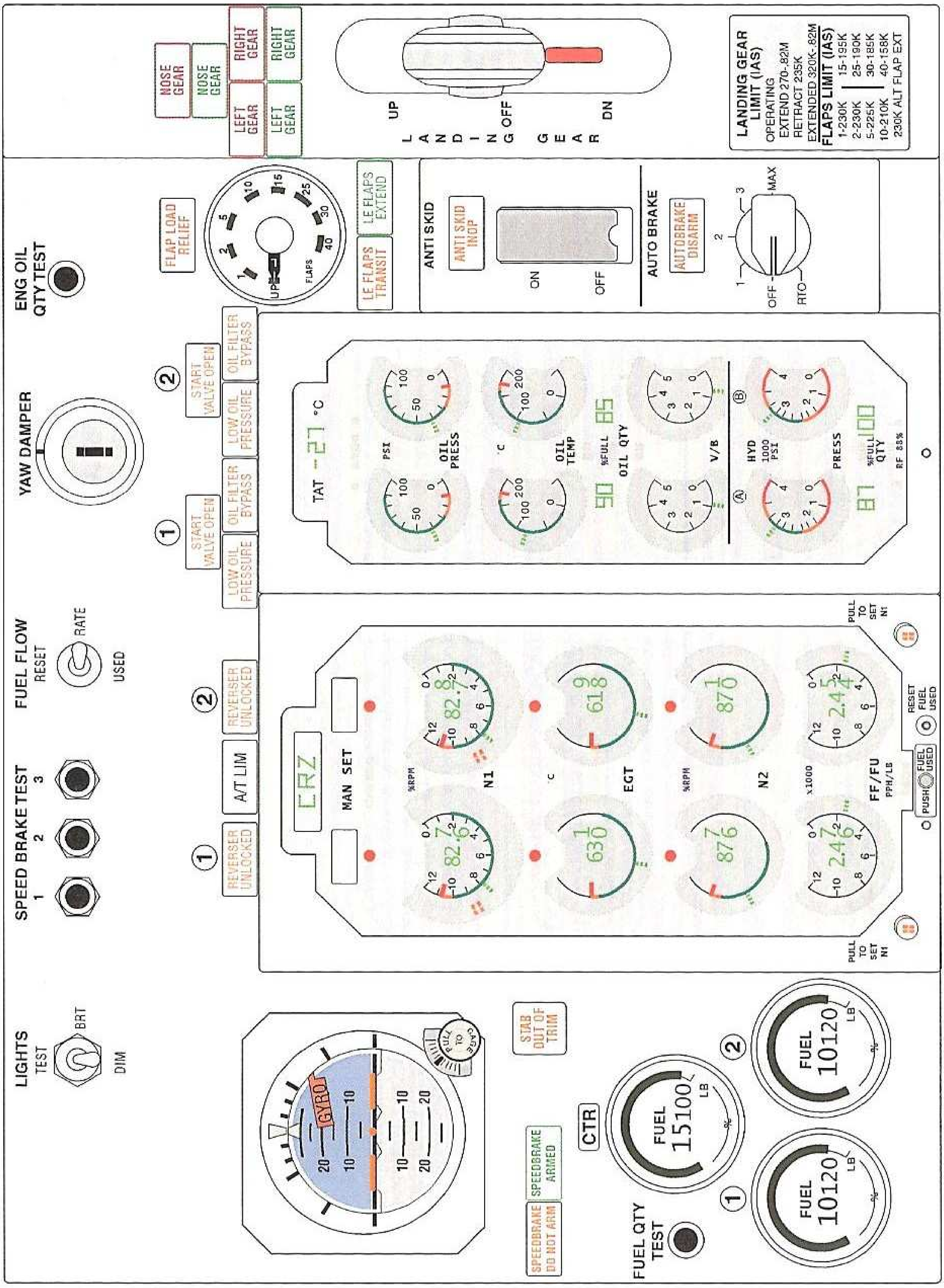
CENTER PANEL - (NG EFIS Option)



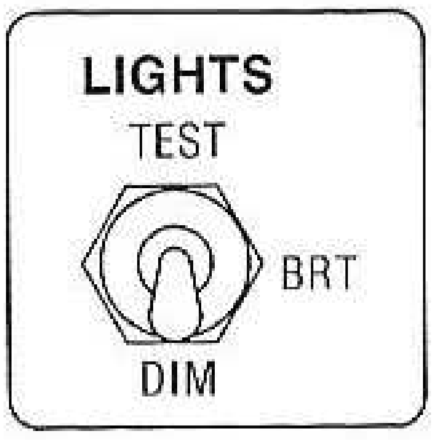
CENTER PANEL - (3-4-5 Round Dial)



CENTER PANEL - (3-4-5 EIS)



LIGHTS TEST SWITCH



TEST
- illuminates all system-associated lights on the forward and aft overhead panels, and some lights on the Captain and FO instrument panels
- may / may not illuminate the WHEEL WELL fire warning light

BRT / DIM
- controls light intensity

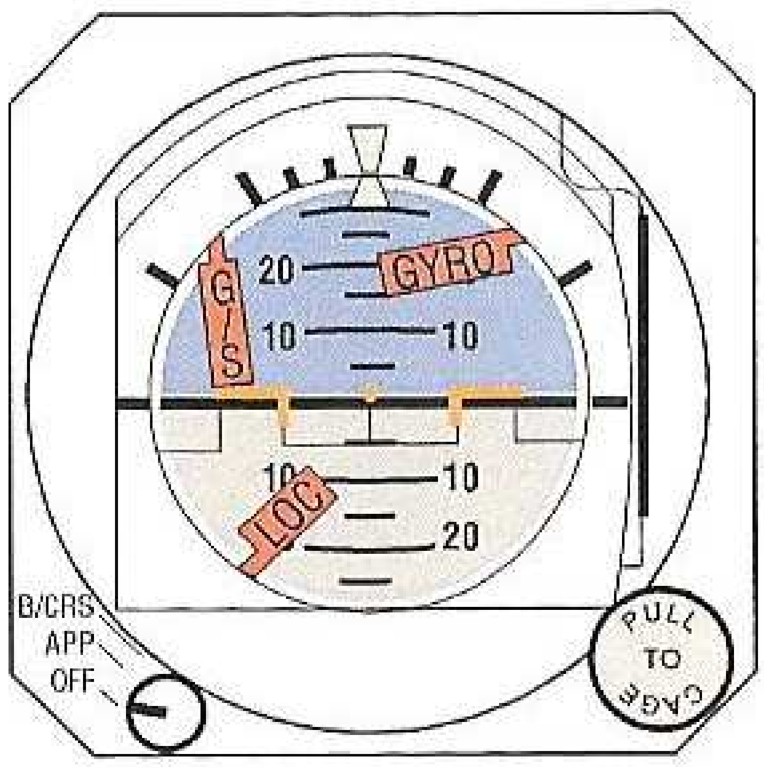
Note: Placing the Lights Test switch in the TEST position will result in a master caution recall and any stored fault will cause the associated light to remain illuminated when the switch is released to BRT/DIM

TAKEOFF WARNING SWITCH (option)
- depress to activate test
- installed in parallel with the Takeoff Configuration Warning system
- depressing this switch will activate the takeoff warning horn if any of the flight control surfaces or their associated proximity switches are not in the proper positon for takeoff

SPEED BRAKE TEST switches (1, 2, 3)
- maintenance test only
- actuating the switches will test the indicator light control circuit and the actuator circuit
- on EFIS series aircraft these are not installed

STANDBY INSTRUMENTS

STANDBY HORIZON INDICATOR



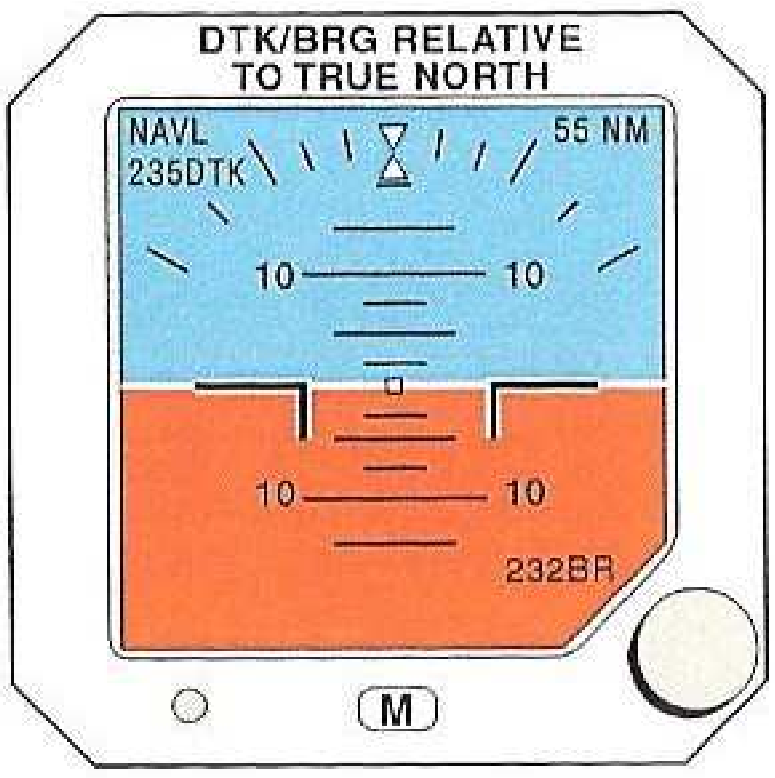
- power feed from battery bus
- backup for IRS
- reaches operational speed within 3 minutes after power is applied (normal rate of erection is 3°/sec)
- after power has been removed teh gyro takes approximately 9 minutes to come to rest

BANK ANGLE SCALE
- freedom in roll is 360°

PITCH ANGLE SCALE
- in 5° increments
- freedom in pitch is approximately 90°

WARNING FLAGS (3)

GYRO = loss of power, LOC or GS = failure of LOC or G/S



GYRO CAGING CONTROL KNOB
- pulling momentarily aligns horizon line with airplane symbol and provides for fast erection of gyro (let gyro spin for 30 sec then pull cage knob)
- airplane should be level during this procedure

PITCH TRIM SCALE (non-EFIS)
- provides a reference for adjusting the symbolic airplane pitch representation
- marked in 1° increments

APPROACH MODE SELECTOR (EFIS, NG only)

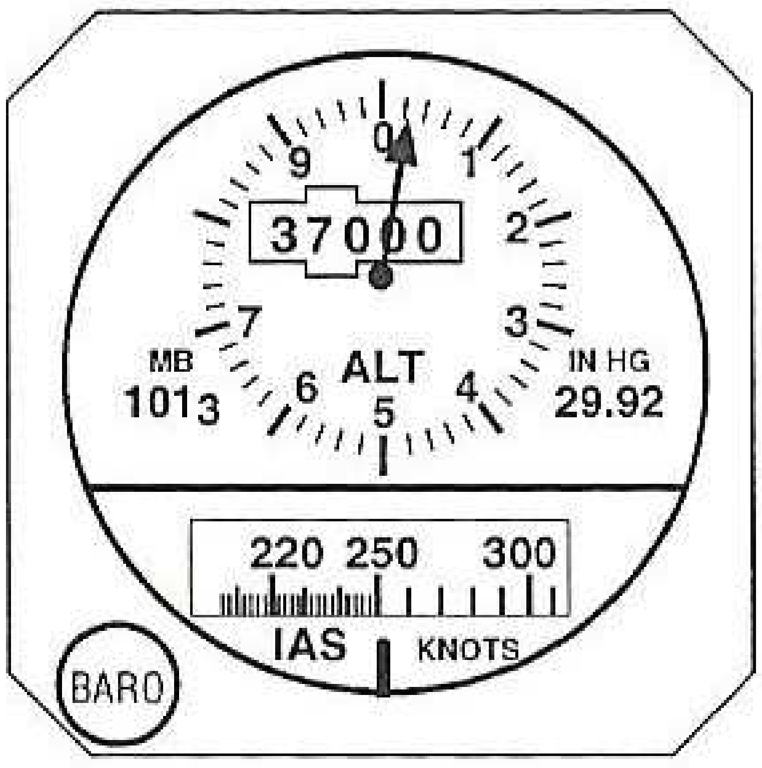
OFF
- glideslope and localizer pointers and failure flags retract out of view

APP
- glideslope and localizer pointers in view
- ILS signals provided by #1 ILS receiver

B/CRS
- reverse sensing for localizer pointer during back course approaches
- glideslope pointer and flag not displayed

(3-4-5) Note: If the standby ADI has an ILS-B/CRS selector, the Captain's EFIS displays may not be on the AC stby bus and would be blank with loss of all generators

STANDBY AIRSPEED / ALTIMETER INDICATOR



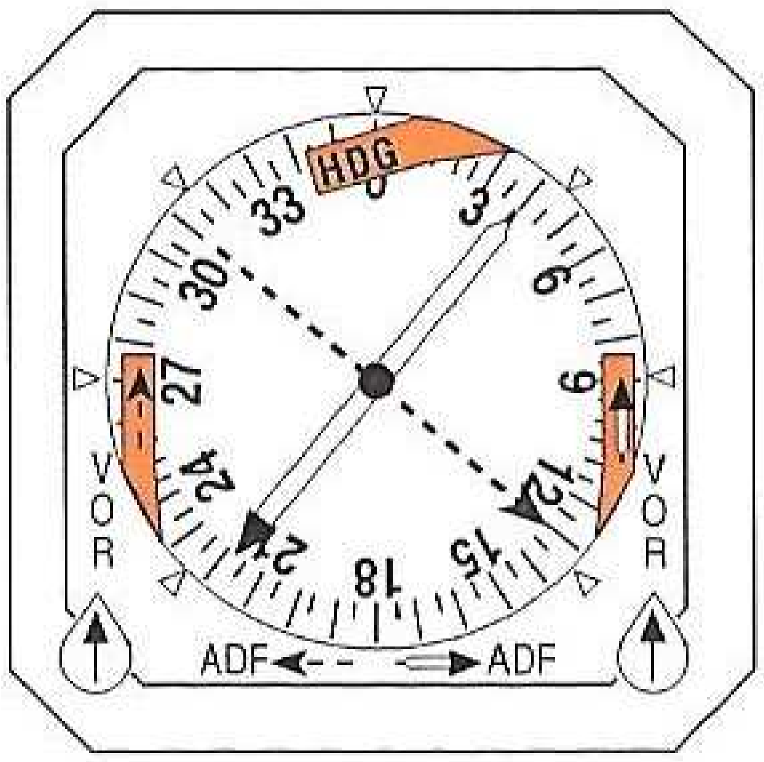
- a vibrator is on the instrument frame to reduce friction errors in the mechanical linkage and to improve indicator response

STANDBY ALTIMETER
- pneumatic operation
- receives static pressure from alternate static ports
- Digital Counter
  - indicates thousand foot increments of current altitude
  - green flag appears in the left window when altitude is below 10,000'
  - a striped flag appears in the left window when altitude below zero is displayed
- Altitude pointer
  - indicates hundred foot increments of current altitude
- Barometric Setting Control adjusts the barometric correction in both setting windows (MB and IN HG)
- no failure flags; must cross-check other instruments

STANDBY AIRSPEED DRUM
- pneumatic operation
- receives ram pressure from aux pitot probe and static pressure from alternate static ports
- indicates airspeed in knots

(300 non EFIS) uses ADC #1 for pitot information
(3-5 EFIS) uses the #2 Aux pitot
(NG) uses the Aux pitot

STANDBY RMI



HEADING warning flag
- compass signal from IRU/ADIRU is lost

Bearing pointers
- narrow pointer uses signals from #1 VHF NAV or #1 ADF (if installed)
- narrow pointer uses signals from #2 VHF NAV or #2 ADF (if installed)

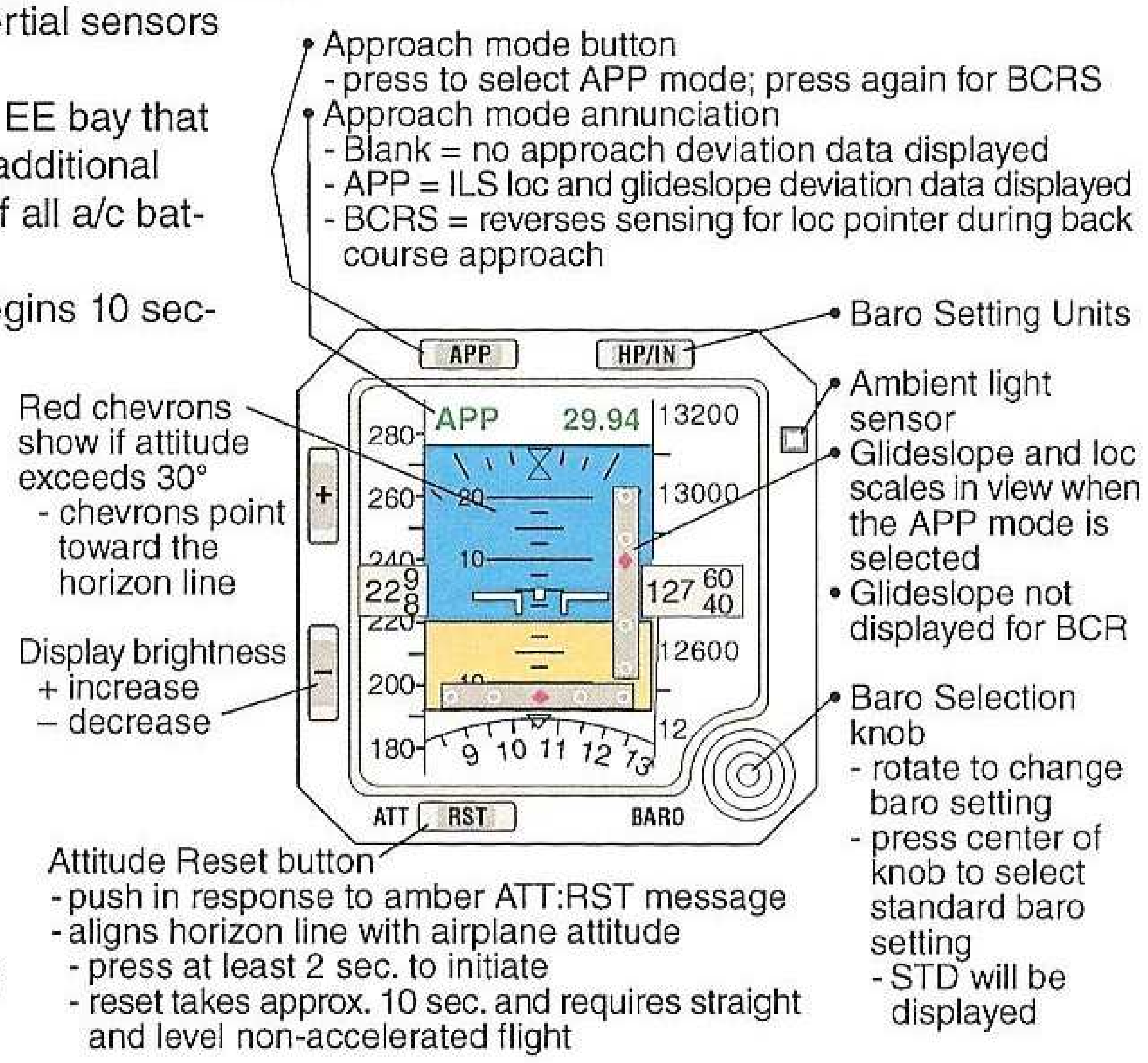
Bearing pointer warning flags 1 and 2
- VOR mode
  - RMI power failure - VHF NAV signal unreliable
- ADF mode
  - RMI power failure - ADF signal unreliable

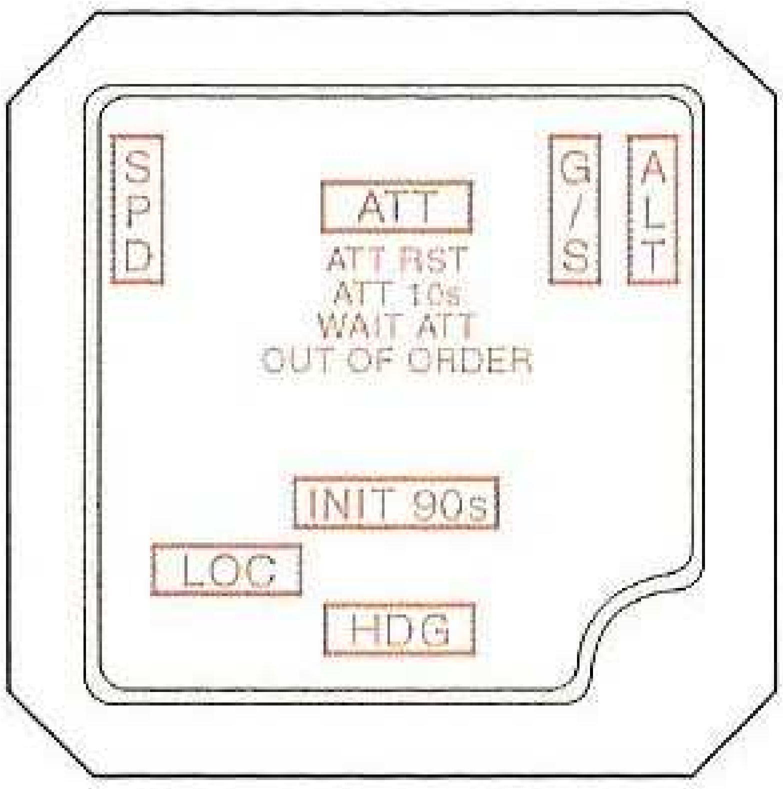
VOR/ADF bearing pointer switches (rabbit ears)
- rotate to select VOR or ADF for the bearing pointers

Standby Horizon Notes:
- power from battery bus (if lose generators, should last at least 30 mins on battery)
- quick reference to tell if Battery Bus is not powered:
  - ask yourself: "Does standby attitude have flag, or is N1 & EGT inop?"
- on EFIS series airplanes, you will also have full ILS command bars with back course capability. Switchable from OFF, ILS, or B/CRS

INTEGRATED STBY FLIGHT DISPLAY (ISFD) (option)

- displays attitude, airspeed, altitude, ILS (#1 nav), and heading
- connected to aux pitot and alternate static
- attitude uses its own inertial sensors
- powered by battery bus
- also separate battery in EE bay that will power the ISFD an additional 150 minutes after loss of all a/c battery power
- 90 second alignment begins 10 seconds after BAT switch is placed to ON
  - do not move a/c during alignment or alignment will be interrupted
- ATT messages
  ATT:RST = attitude must be reset using the attitude reset switch
  ATT 10s = 10 sec initialization in progress
  WAIT ATT = temporary self correcting loss of attitude
  INIT 90s = 90 second initialization in progress
  OUT OF ORDER = total ISFD system failure
  SPD = airspeed has failed
  LOC = ILS localizer has failed
  ATT = attitude has failed
  G/S = ILS glideslope has failed
  HDG = heading has failed





FUEL GAUGES (3-4-5)

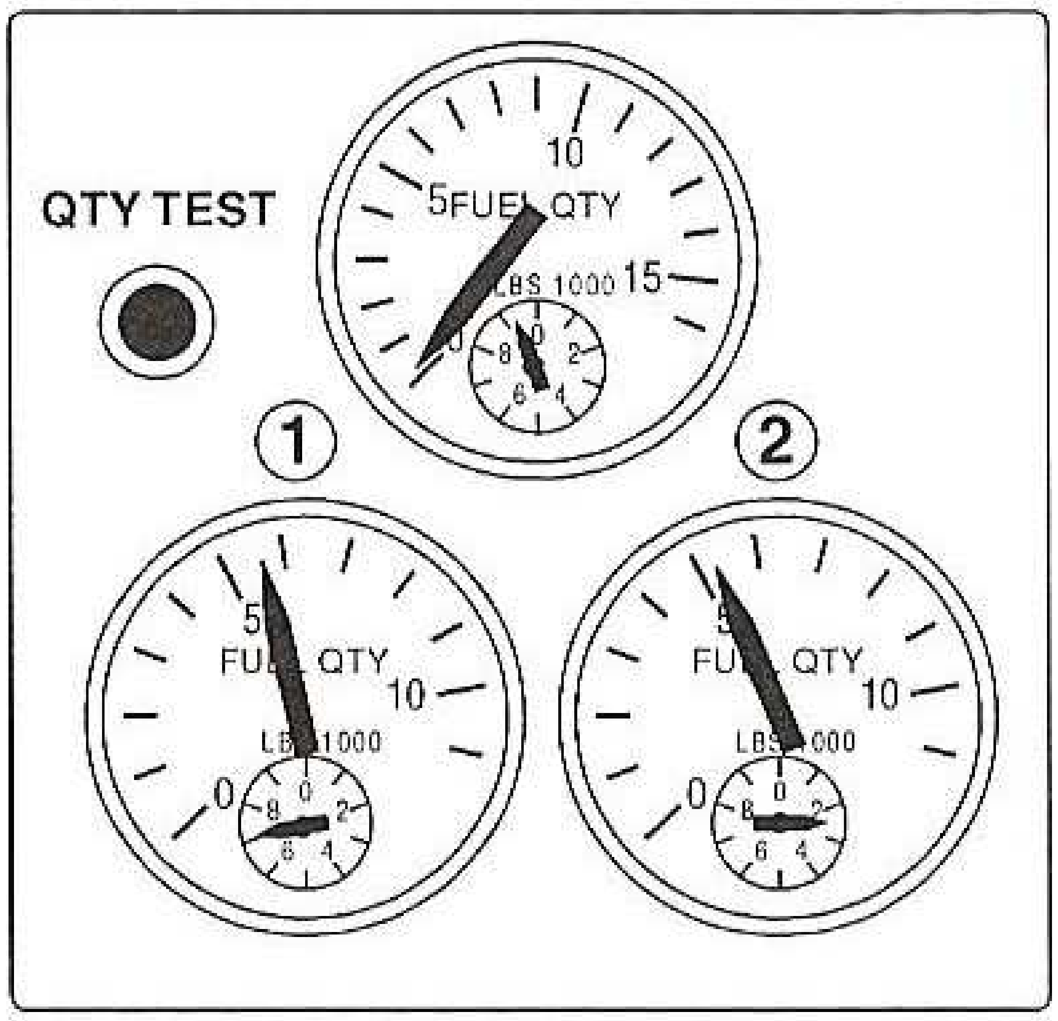
FUEL QUANTITY TEST switch (3-4-5)

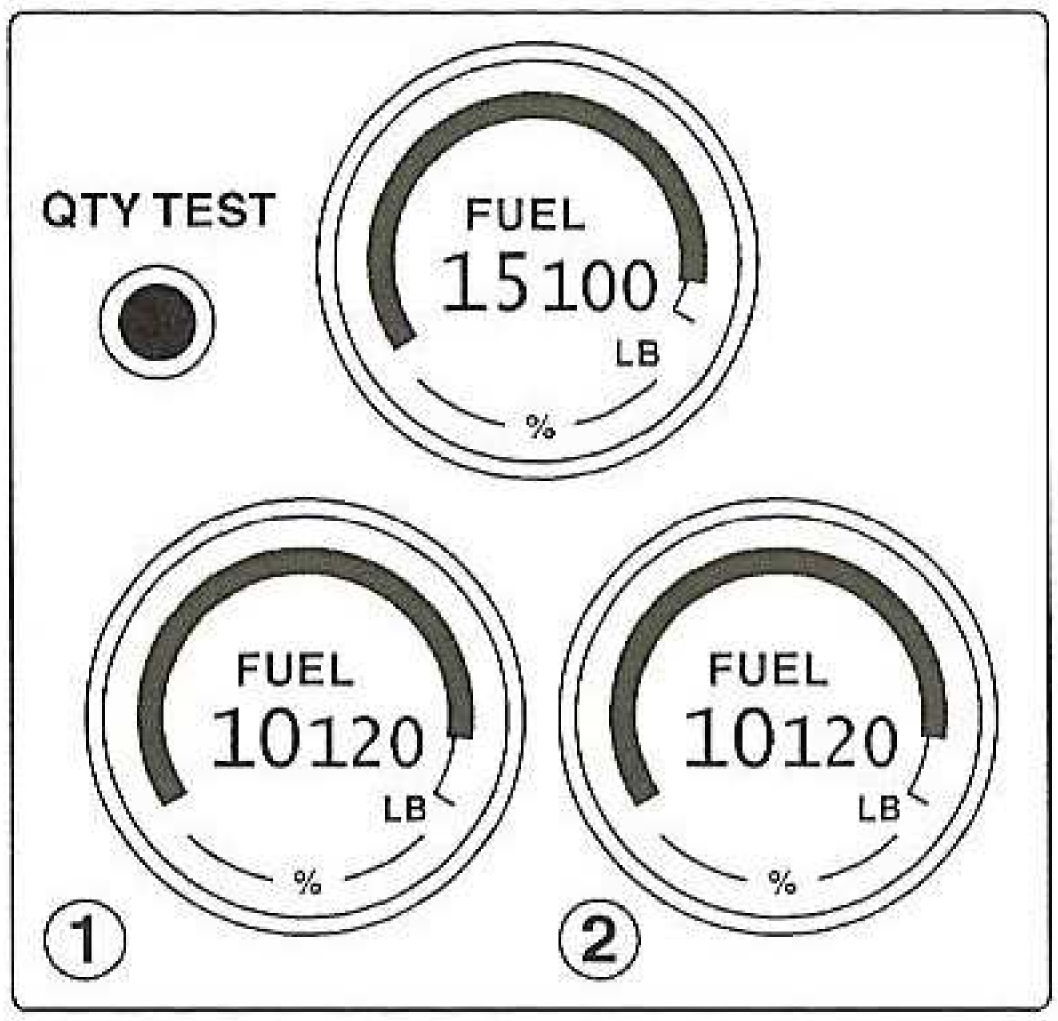
PRESS initiates a test which requires a maximum of 100 seconds to complete

- ERR code for 2 secs; "8s" for 2 secs; max capacity for 2 secs; actual fuel

FUEL QUANTITY INDICATORS (3-4-5)

- three indicators in cockpit and three at the fueling station
  - Standby AC bus for cockpit gauges
  - 28 VDC hot battery bus for fueling panel
- lb or kg option
- digital readout plus analog arc representing overall fuel quantity
- accuracy is ±2.5% of full scale reading
- cockpit gauges get quantity directly from their respective tank units
- fuel summatiion unit
  - located on the FOs aux panel
  - takes the three cockpit fuel gauge quantities, adds them together, and sends it to the FMC where it is converted to a display of total remaining fuel





FUEL GAUGE ERROR CODES (3-4-5)

- ERR appears in the gauge, above the fuel numbers, when an error code comes up
- error codes may be read during the "test" (codes 1 through 10)
- to clear error codes, press the TEST button while the error code is displayed during the test
  - do not clear error codes unless instructed by maintenance
- hard error indicated by an ERR symbol and the absence of the analog quantity arc around the circumference of the gauge. Instead of indicating a quantity in lbs, it shows a fuel quantity of 0 (zero) lbs. Any quantity indicator displaying a hard error indication is unusable. Enter the ERR code in the logbook. Do not attempt to clear
- soft error indication is characterized by the ERR symbol but the indicator will continue to present the analog arc and the fuel quantity in lbs. This is because whenever a soft error is displayed, the fuel quantity is still valid within an accuracy of ± 3%. Enter a soft error code in the logbook for maintenance action

Research has turned up 2 tables:

ERR Code	FQI Reading	Probable Cause
0	Zero	Missing or disconnected tank unit
1	Normal	Tank contamination
2	Zero	Bad HI-Z lead
3 *1	Normal	Bad compensator unit wiring
4 *2	Zero	Bad tank unit wiring
5	Normal	Bad compensator unit
6	Zero	Bad tank unit
7	Normal	Contamination/water in compensator
8	Zero	Bad fuel quantity indicator
9	Normal or zero	- Improperly calibrated indicator
	Blank	Bad fuel quantity indicator

*1 Positioning the P15 test gage switch in TEST GAGES position log error code 3 into the memory of the fuel quantity indicators.
*2 If you push the FUEL QTY TEST switch on the P1-3 panel (in the cockpit) this makes an entry of error code 4 into the fuel quantity indicators.

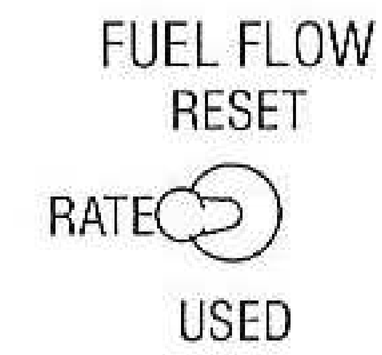
ERR Code	FQI Reading	Probable Cause
1	Normal	Open or short
2	Zero	Short in compensator
3	Normal	Excessive compensator unit leakage
4	Zero	Open circuit
5	Zero	Short in tank unit
6	Normal	Excessive tank unit leakage
7	*1	Calibration unit failure
8	Blank	Error in DCTU data
9	*1	Indicator memory failure
10	Zero	Open or short

*1 If failure occurs during flight indicator reading will be normal with err shown.
If failure occurs when power is applied the FQI will read zero with err shown.

(L/OP) Ballast Fuel

- fuel may be loaded into center tank and declared ballast fuel provided actual ZFW plus ballast does not exceed max ZFW, center tank fuel pump switches are operative, and ballast fuel is not used for burn requirements

FUEL FLOW SWITCH



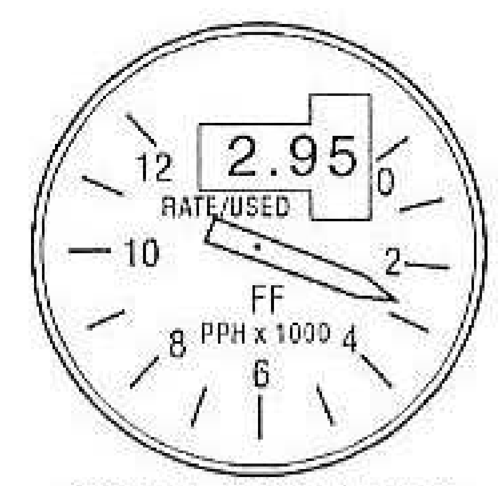
FUEL FLOW / FUEL USED READOUT

(3-4-5)

RATE - the digital displays on both Fuel Flow Indicators shows rate of fuel consumption (lbs/hr or kg/hr)

USED displays fuel used per engine since last reset

RESET decreases readout to zero



300 / 400 / 500

(NG)

RATE displays fuel flow to engine (lbs/hr or kg/hr)

USED
- displays fuel used per engine since last reset
- after 10 seconds, display automatically reverts to fuel flow

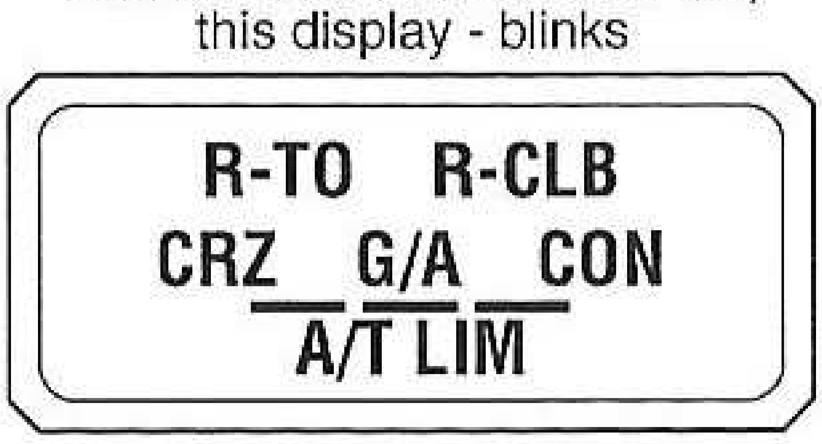
RESET
- resets fuel used to zero
- displays fuel used for 1 second, decreases to zero, then displays fuel flow

- Note: failure of any N1, EGT, N2 or Fuel Flow indicator or transmitter results in the respective digital display blanking and the pointer moving to zero

THRUST MODE ANNUNCIATOR (3-4-5)

- on (3-4-5) EFIS airplanes only, above N1 gages
- shows lights to annunciate the A/T N1 LIMIT modes
  - TO (full power takeoff) - CRZ
  - R-TO (reduced takeoff) - G/A
  - CLB - CON
- if FMC is not computing thrust limit, – – – and A/T LIM is displayed. Autothrottle limit calculations are invalid or either engine's N1 is less than 18%

LIGHTS TEST switch in TEST, this display - blinks



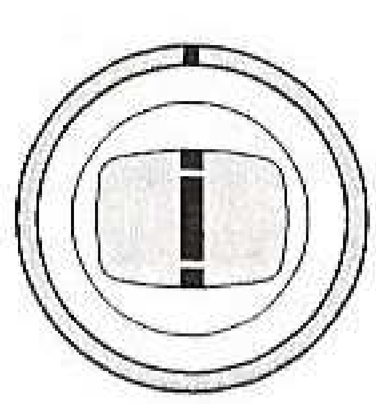
THRUST MODE DISPLAY (NG)

- located on CDS above N1 gauges and normally calculated by FMC
- (green) active N1 limit reference for A/T and manual thrust control
- with N1 SET control in AUTO, active N1 limit is displayed by reference N1 bugs

TO (full power takeoff)	D-TO (assumed temp red takeoff)	CLB (climb)
R-TO (reduced takeoff)	D-TO 1 (derate1 & asum temp takeoff)	R-CLB (reduced climb)
TO 1 (derate takeoff 1)	D-TO 2 (derate2 & asum temp takeoff)	CLB 1 (derate climb 1)
TO-2 (derate takeoff 2)	TO-B (takeoff thrust bump)	CLB 2 (derate climb 2)
CRZ (cruise)	CON (max continuous)	Q-CLB (quiet climb)
– – – FMC is not computing thrust limit		GA (go around)

- (white) A/T LIM is displayed. FMC is not providing the A/T system with N1 limit values. A/T is using degraded N1 thrust limit from the respective EEC

YAW DAMPER INDICATOR


YAW DAMPER

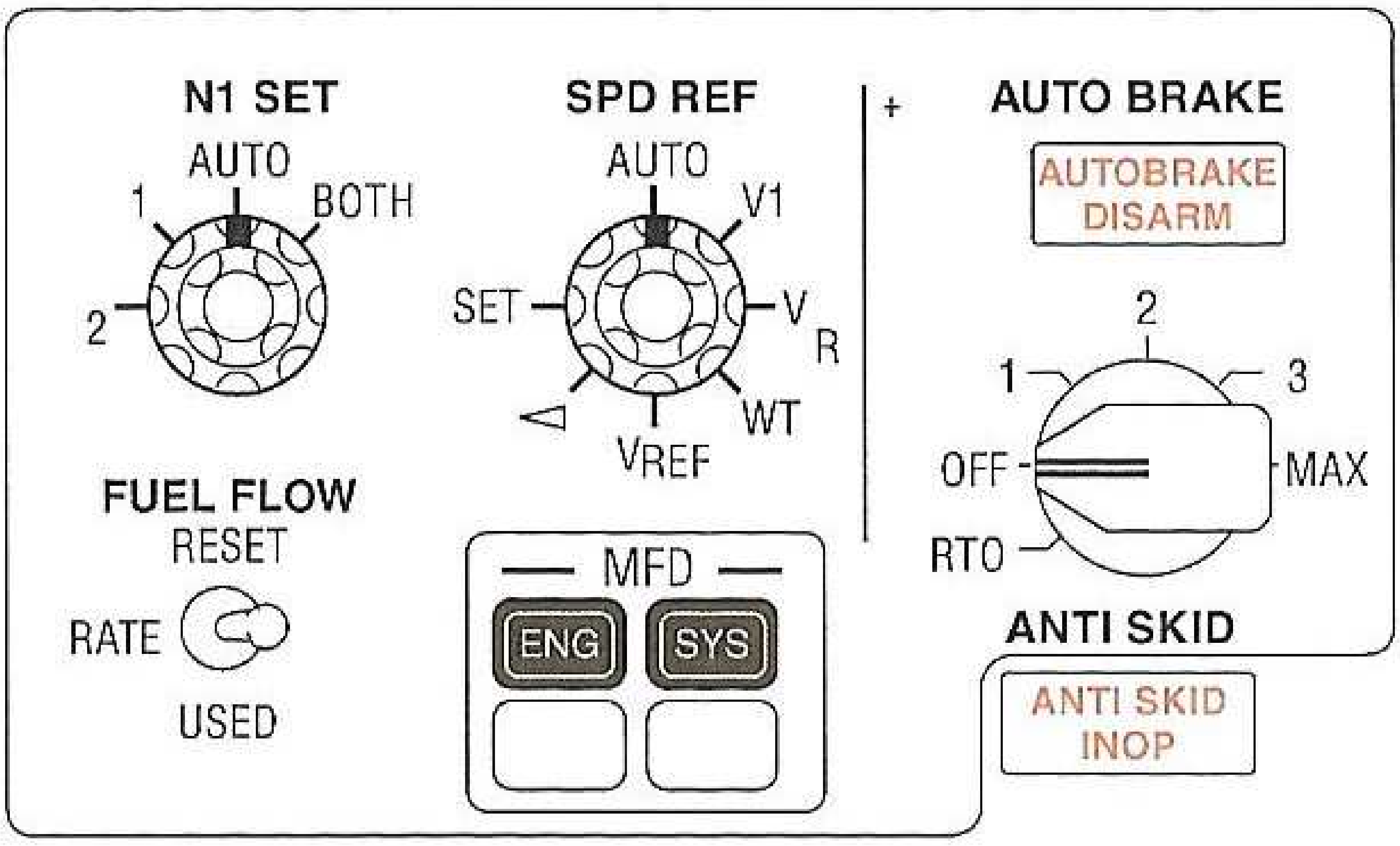
- indicates yaw damper movement of rudder (not rudder pedal inputs)
- inoperative when yaw damper switch is OFF
- right turn equals a left deflection; left turn equals right deflection (check on taxi)

(NG) only main yaw damper inputs are shown on the indicator (#1 SMYD)
- not standby yaw damper

OIL QUANTITY TEST BUTTON (3-4-5)

- oil quantity indicators move toward zero when pressed

ENGINE DISPLAY CONTROL PANEL



N1 SET (Outer knob)
- AUTO
  - both reference N1 bugs set by FMC based on N1 LIMIT page and TAKEOFF REF page
  - displays reference N1 bugs at active N1 limit for A/T
  - displays above N1 digital display box
- BOTH
  - both reference N1 bugs and readouts manually set by turning N1 SET inner knob
  - has no effect on A/T operation
  - excellent tool for use during takeoff requiring "cutback" power that must be manually set
- 1 or 2
  - respective N1 reference bug and readout manually set by turning N1 SET inner knob
  - has no effect on A/T operation

N1 SET (Inner knob - spring loaded to center)
- rotate to position reference N1 bug(s) and readouts when N1 SET outer knob is set to BOTH, 1, or 2
  - rotating inner knob will set green N1 reference bug(s)

SPD REF selector (Outer knob)
- sets the reference airspeed bugs on the Mach/airspeed indicator or speed tape
- would be used if both FMCs had failed
- AUTO
  - reference airspeeds and gross weight are provided automatically through the FMC
  - any manually set bugs are blanked
- V1 used to manually set decision speed on the ground
  - in flight, displays V1 INVALID ENTRY
- VR used to manually set rotation speed on the ground
  - in flight, displays VR INVALID ENTRY
- WT allows manual entry of gross weight
  - on ground - sets (green) UP bug
- VREF used to manually set the landing reference speed in flight
  - automatically set Vref +15 bug
  - on the ground, displays VREF INVALID ENTRY
- ◁ extra bug (5th) may be set manually to the desired value
- SET removes the text above the Mach/airspeed indicator

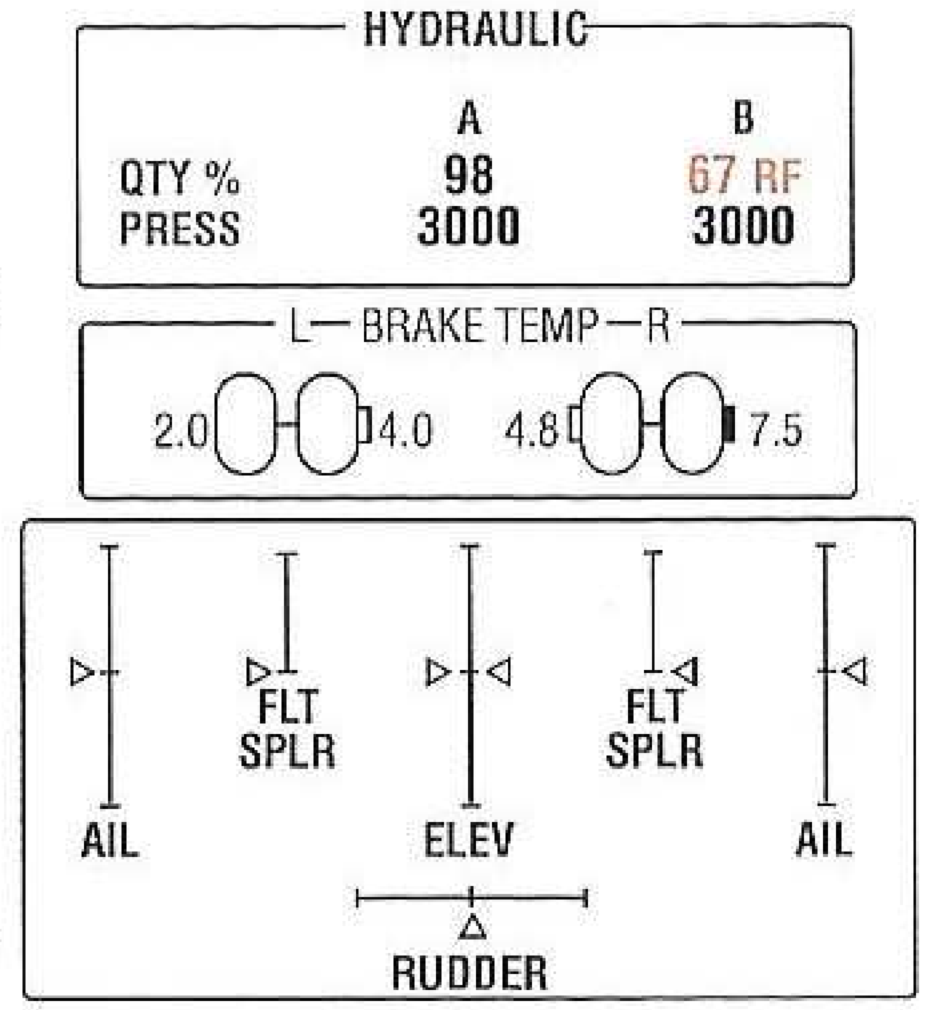
SPD REF selector (Inner knob)
- manually sets the appropriate reference airspeed or gross weight
- the digital display appears above the Mach/airspeed indicator or speed tape

NO VSPD flag
- displayed if decision speed bug fails or if you do not enter the values into the FMC

MULTIFUNCTION DISPLAY switches (MFD)

ENG

- single push displays hydraulic indications on lower DU, or if the lower DU is not available, on the inboard DU, based on position of the display select panel selector
- (optional displays) brake temp and flight control surface position indications
  - normal brake temps 0-4.9 (white)
  - high brake temps 5.0-9.9 (amber)
    - brake symbols blank < 2.5
    - brake symbols white = hottest brake on each truck within range of 2.5 - 4.9
    - brake symbols solid amber = overheat of 5.0 - 9.9 (clears when less than 3.5)
- second push blanks lower DU



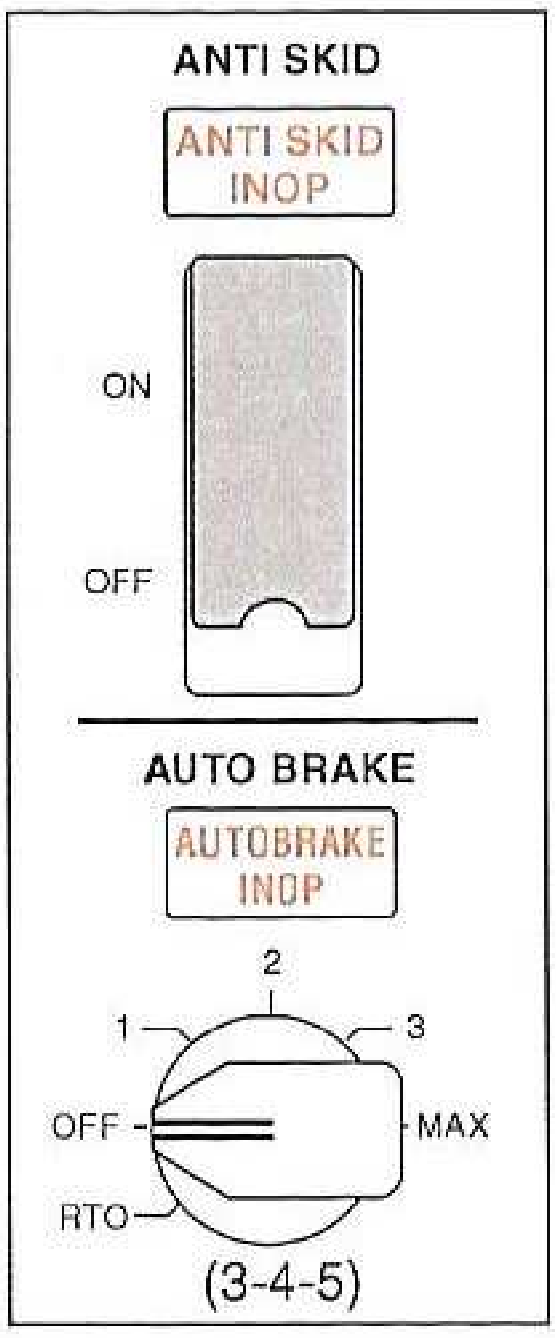
SYS

- single push displays hydraulic pressure and quantity on lower DU
- second push blanks lower DU

ANTISKID

ANTISKID INOP light

- illuminated
  - when a system fault is detected by antiskid monitoring system, or
  - disagreement between parking brake lever and the parking brake shutoff valve
- armed on the ground and inflight (3-4-5) if A/S switch is on
- (3-4-5) turning the antiskid switch off will also turn on this light
- if antiskid is inop autobrake system must be turned OFF and speed brakes must be extended manually as wheel spinup signal comes from antiskid system



ANTISKID CONTROL switch (3-4-5)

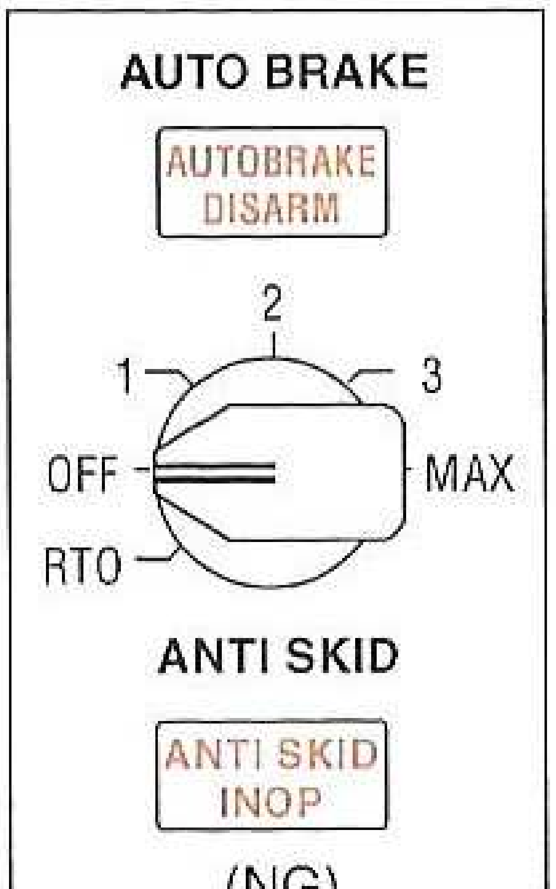
ON - guarded position

OFF - turns off antiskid system and illuminates ANTISKID INOP light

AUTO BRAKE

AUTO BRAKE DISARM light (amber)

- illuminated
  - momentarily during self-test when RTO is selected on ground
  - a malfunction exists in the automatic braking system or,
  - disarmed system by manual braking during RTO or landing, or
  - disarmed system by moving speed brake lever from up position to down detent during RTO or landing, or
  - autobrakes selected off, autobrake shuttle valve solenoid sees pressure greater than 1000 psi
  - (3-4-5) ANTISKID turned off and takeoff is rejected between 60 and 90 kts
- if landing is made with RTO selected, no autobraking action occurs and light illuminates after touchdown
- extinguished
  - autobrake logic is satisfied, autobrakes armed
  - autobrakes selected off



(NG)
- if the thrust lever(s) are advanced during RTO or after touchdown, (3 sec delay is incorporated after landing)

- do not takeoff with light on
- Note: when selecting RTO, the DISARM light will illuminate for about 2 secs to indicate self test initiation. After 2 secs the light will extinguish

AUTO BRAKE SELECT switch
- used to select RTO or the desired deceleration rate of auto braking after landing
- landing mode selection equals total deceleration (thrust reverse plus braking)
- landing mode available in air / RTO available on ground

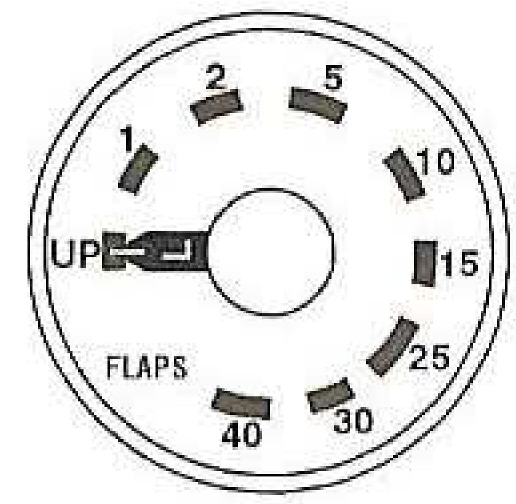
(NG)
- landing settings may be selected after touchdown prior to 60 kts

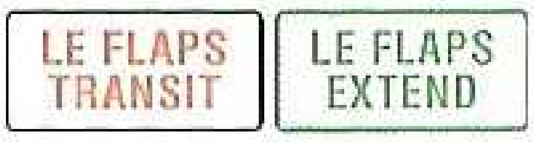
NG: A windshear during a heavy-weight Flaps 30 landing can cause the flaps to blow up, generating a GPWS Mode 4 warning (flaps not in landing configuration). Include this in your brief, and your intentions.

AUTOBRAKE SETTINGS

Autobrake settings	psi available	Scheduled rate of deceleration
1	1250	4 ft / sec
2	1500	5 ft / sec
3	2000	7.2 ft / sec
max *	3000	12 ft / sec below/14 ft / sec above 80 kts
RTO	3000	decel rate not controlled
* switch must be pulled out to select max * equivalent to slightly less than full manual braking		

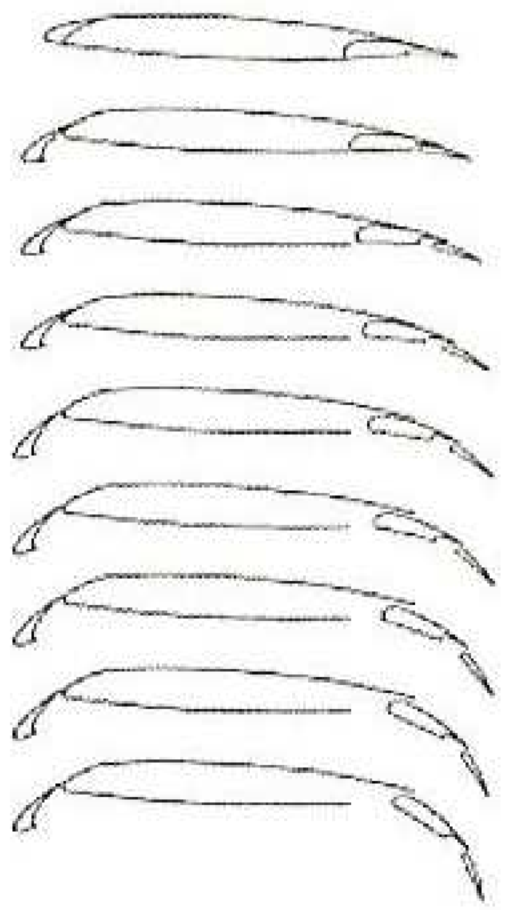
FLAP INDICATOR





- indicates position of left and right TE flaps
- provides TE flaps asymmetry protection and (NG) skew protection
  - a comparator switch will close the flap bypass valve if the flap position needles become split
- normal AC power
  - if power is lost, indicator will "freeze," no asymmetry protection
  - making a selection with the flap lever sends a measured voltage to the gauge
    - if you select 1 and the gauge goes to 5, you've had a voltage spike and probably a tripped CB

(NG)
- if the FSEU senses an asymmetry or skew condition a needle split will be indicated on the flap position indicator



FLAP LOAD RELIEF SYSTEM
- a TE flap load relief function protects the flaps from excessive air loads
- this function is operative at different positions for the Classic, the NG, and -800SFP
- the flap position indicator displays the flap retraction and re-extension
- Classic
  - if the flaps are set at 40 and the speed exceeds 158–162 kts, flaps will retract to 30
    - they re-extend when speed is reduced to 153 to 157 kts
- NG
  - if the flaps are set at 40 and the airspeed exceeds 163 kts, the flaps retract to 30
    - they re-extend when speed is reduced below 158 kts
  - if the flaps are set at 30 and the airspeed exceeds 176 kts, the flaps will retract to 25
    - they re-extend when speed is reduced below 171 kts
  - in addition to the NG above, the Short Field Performance (SFP) package adds these:
    - if the flaps are set at 25 and the airspeed exceeds 191 kts, the flaps retract to 15
    - if the flaps are set to 15 and the airspeed exceeds 201 kts, the flaps retract to 10
    - if the flaps are set to 10 and the airspeed exceeds 211 kts, the flaps retract to 5

- NG
  - when the flaps are set at 30, the FSEU will retract the TE flaps to 25 if the airspeed exceeds approx. 176 kts
    - they re-extend when speed is reduced to approx. 171 kts
  - when the flaps are set at 40, the FSEU will retract the TE flaps to 30 if the airspeed exceeds approx. 163 kts
  - they re-extend when speed is reduced to approx. 158 kts

LE FLAP LIGHTS

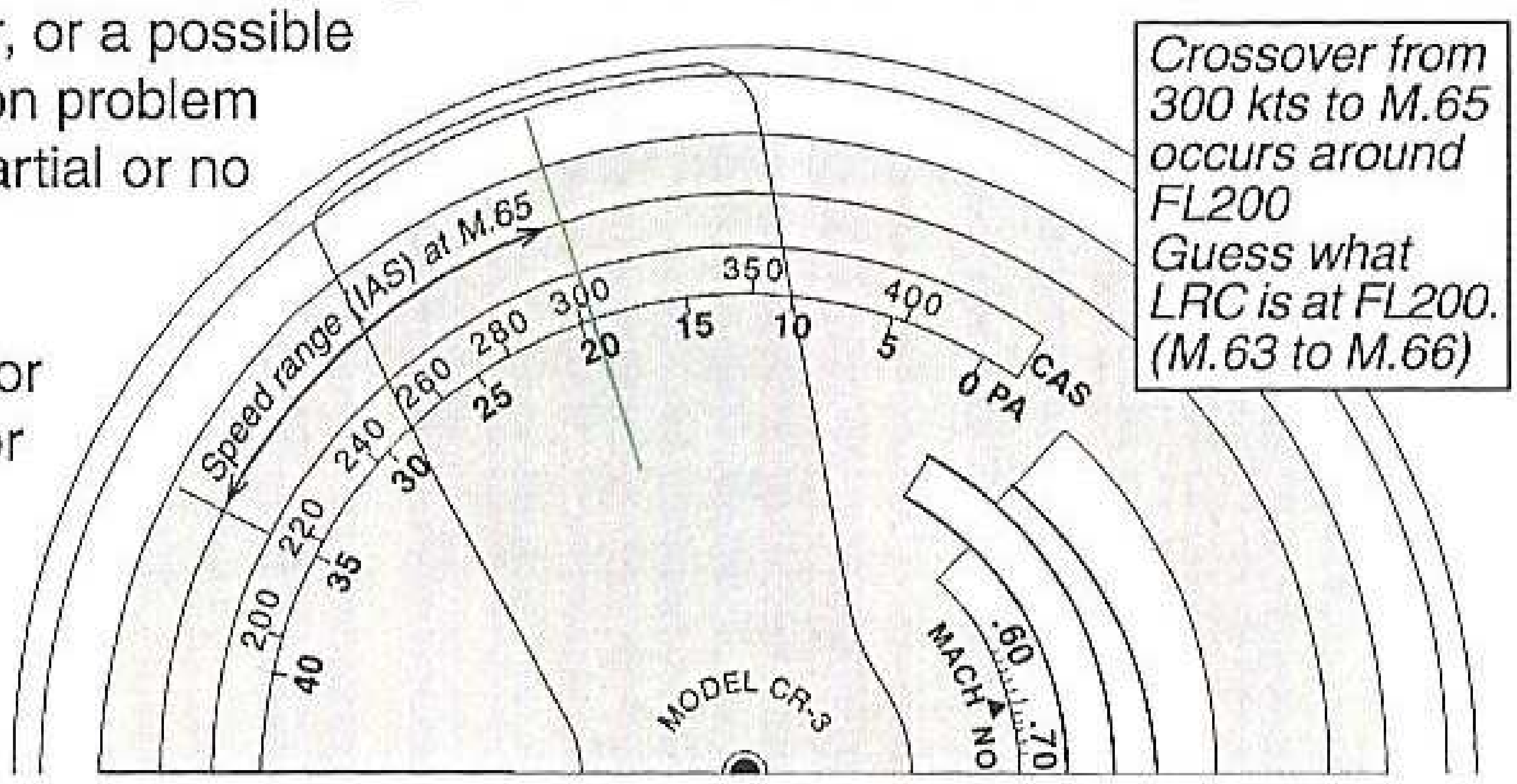
- green and amber leading edge position indicating lights on the center panel indicate the collective position of the LEDs
- no light illuminated indicates that the flap or slat is retracted
- if any flap or slat does not reach the selected position, the LE FLAPS EXT light will not come on (green) and the LE FLAP TRANSIT light will remain illuminated (amber)

LE FLAPS EXT light (green)

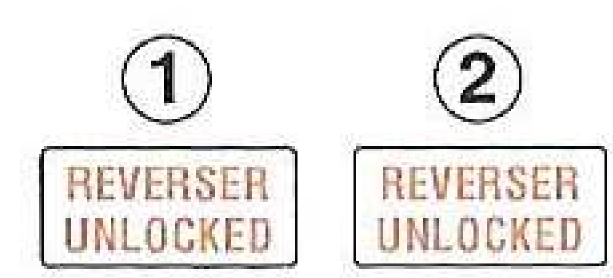
- illuminated when all of the LE flaps and slats are in an extend or full extend position
- LE devices agree with selected trailing edge flaps setting

LE FLAPS TRANSIT light (amber)

- illuminated indicates one or more leading edge device is not extended or retracted when commanded by the flap lever, or a possible leading edge device indication problem
  - indicates asymmetrical, partial or no leading edge devices
- or (NG) a LE uncommanded motion (UCM) has occurred or a LE skew condition exists for slats 2-7 only
- light is inhibited during auto-slat operation
- if only one LE transit light is on, limit maximum airspeed to 300 knots (280 knots for turbulent air penetration) or .65 MACH, whichever is lower.
- if more than one LE transit light is illuminated, do not exceed 230 kt



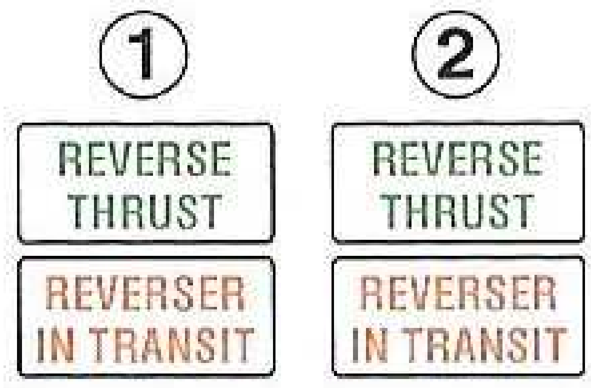
REVERSER UNLOCKED LIGHTS (amber) (forward panel) **(3-4-5)**
(QRH) REVERSER UNLOCKED (inflight)



- illuminates when either reverser sleeve is not in the stowed and locked position or the light is giving a false indication
- only multiple failures could allow the engine to go into reverse thrust
  - such failures may preclude returning the engine to forward thrust
- unstowed reverser sleeves produce buffet and increase drag
- movement of the reverser sleeves to the reverse thrust position mechanically retards the throttle to idle and the interlock limits movement of the throttle as long as the engine is in reverse thrust

THROTTLE...CHECK
  - do not actuate reverse thrust lever
  - if the throttle is unrestricted and no buffet or yaw exists, operate the engine normally
  - if the throttle has not moved toward IDLE and movement of the lever is unrestricted, the engine is in forward thrust
  - if the thrust lever is restricted or buffet or yaw exists, shut down the engine

REVERSE THRUST LIGHTS (green) (3-4-5 option)

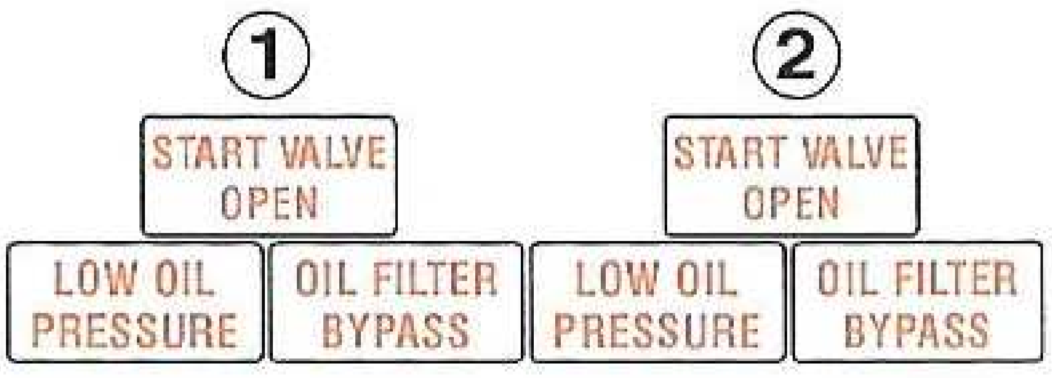


- forward panel
- illuminates when both thrust reverser sleeves have reached the fully deployed position and and the reverse thrust lever is in the reverse thrust position

REVERSER IN TRANSIT LIGHTS (amber) (3-4-5 option)

- forward panel
- illuminates when either thrust reverser sleeve is not stowed
- extinguishes when the green REVERSE THRUST light illuminates (both sleeves are fully extended) and the reverse thrust lever is in the reverse thrust position
- extinguises when both sleeves are fully retracted and the reverse thrust lever is fully forward and down

START VALVE OPEN LIGHTS (amber)



- illuminated indicates the start valve is open
  - valve is pneumatically operated
  - spring closed if no pneumatic pressure

(QRH) Start Valve Open Light On or
(QRH) Start Valve Fails to Close

- If the starter does not cutout or if the START VALVE OPEN light illuminates during ground or flight ops, accomplish the following:

ENGINE START SWITCH ....OFF
- If no starter cutout or start valve open light remains illuminated:

  ISOLATION VALVE SWITCH ....CLOSE

  PACK (AFFECTED SIDE)..OFF
  - ensures remaining pack switches to high flow if in-flight

ENGINE BLEED SWITCH (AFFECTED ENGINE) ....OFF

APU BLEED SWITCH (IF STARTING #1)..OFF

Isolates bleed air to prevent starter disintegration and possible aircraft damage

- If during ground ops:

  GROUND AIR SOURCE (IF IN USE) .... DISCONNECT

  Insure air source is removed prior to next step

  START LEVER (AFFECTED ENGINE).. CUTOFF

OIL WARNING LIGHTS / ALERT

OIL FILTER BYPASS (amber)

- illuminated indicates an impending bypass of the scavenge (main) oil filter
  - oil comes from scavenge oil pumps (reference fold-out schematics)

(QRH) Oil Filter Bypass

THRUST LEVER ....RETARD
- if not in a critical phase of flight, slowly retard the thrust lever until the OIL FILTER BYPASS alert/light extinguishes or the thrust lever is closed
- operate the engine at reduced thrust to keep the light extinguished

LOW OIL PRESSURE (amber)

- illuminated indicates that oil pressure is at or below the red line
- illuminates at 13 psi
- low oil pressure is also indicated by oil pressure in the amber band with takeoff thrust set

ENGINE INDICATORS

N1 RPM IND.

- two indicators, a pointer and digital
- indicates low speed rotor in percent of RPM
- used as primary thrust indication
- N1 indicator is on Battery Bus (for Battery Start)

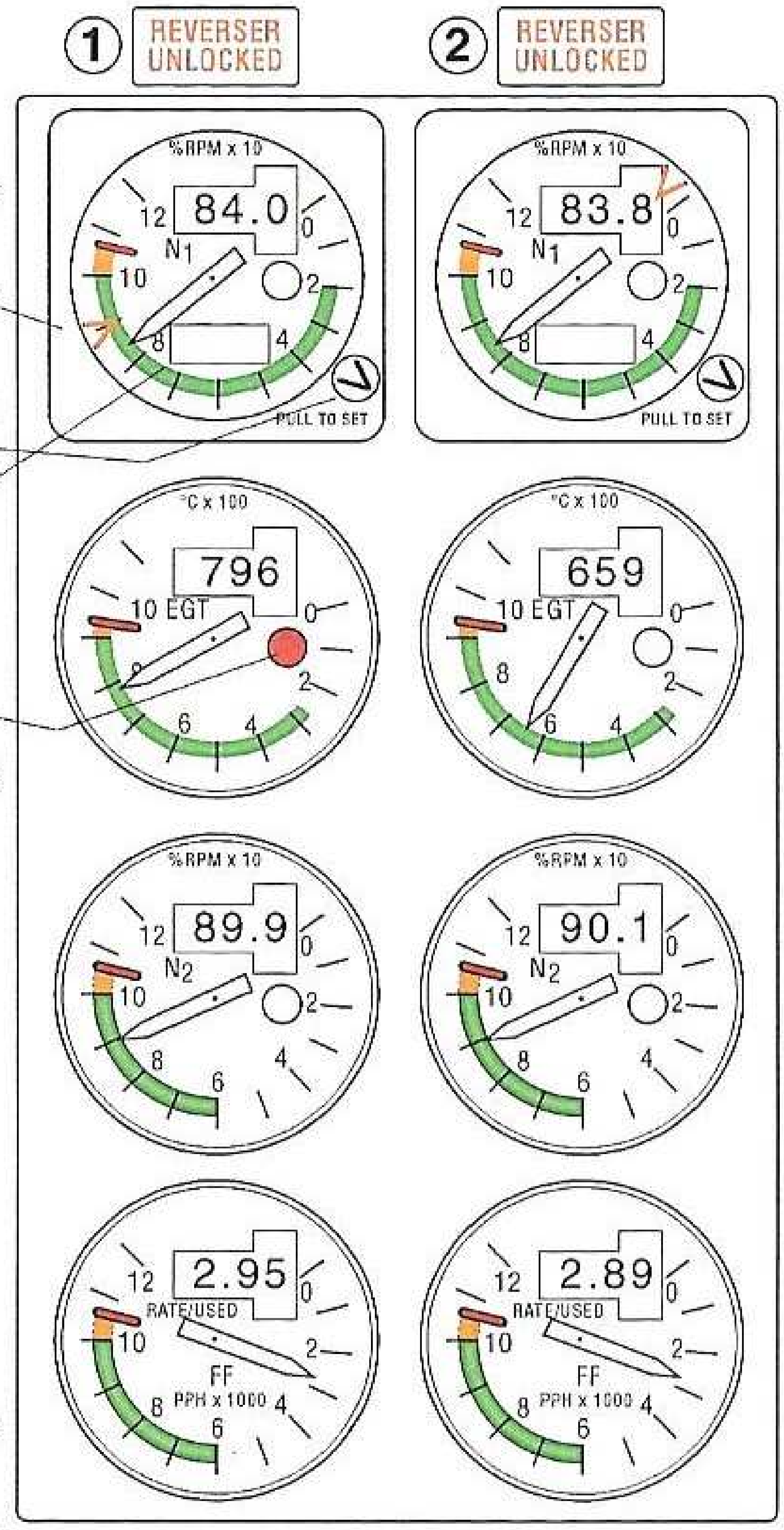
(L/OP) Powerplant, Max N1

(3-4-5) Max N1 is 106%

(MEL) N1 Tachometer - ATA 77

- Digital indicators may be inop, except for EIS/CDS equipped airplanes, provided autothrottle is used for takeoff thrust setting (needle must be operable)

- the N1 reference bug is set by input signal from the FMC if the knob is pushed in
- it can be set manually – pull the knob out
- the desired N1 RPM will also display in the lower digital display
- red warning ligths remain illuminated until the engine parameter is reduced below the limit
- right hand displays readings at FL310 at M.80



EXHAUST GAS TEMPERATURE (EGT)

- indicates turbine exhaust gas temperature in C°
- the cursor moves to the corresponding position on the outer scale
- EGT indicator is on Battery Bus (Battery Start)
- measured at second stage low pressure turbine nozzles

(EIS) if flashing, indicates abnormal start advisory system has sensed conditions which may lead to an abnormal start

- red warning light illuminates if EGT limit has been reached or exceeded and remains illuminated until EGT is reduced below the limit

EGT LIMITATIONS
Start 725°
Takeoff* 930°
Max Cont 895°
* 5 minutes
10 min. allowed in event of loss of thrust on one engine during takeoff

(MEL) EGT Indicator - ATA 77

- digital counter may be inop except for EIS / CDS equipped a/c

N2 RPM INDICATOR

- indicates high speed rotor in % of RPM

(EIS) red warning light illuminates if N2 limit has been reached or exceeded and remains illuminated until N2 is reduced below the limit

(L/OP) Powerplant, Max N2

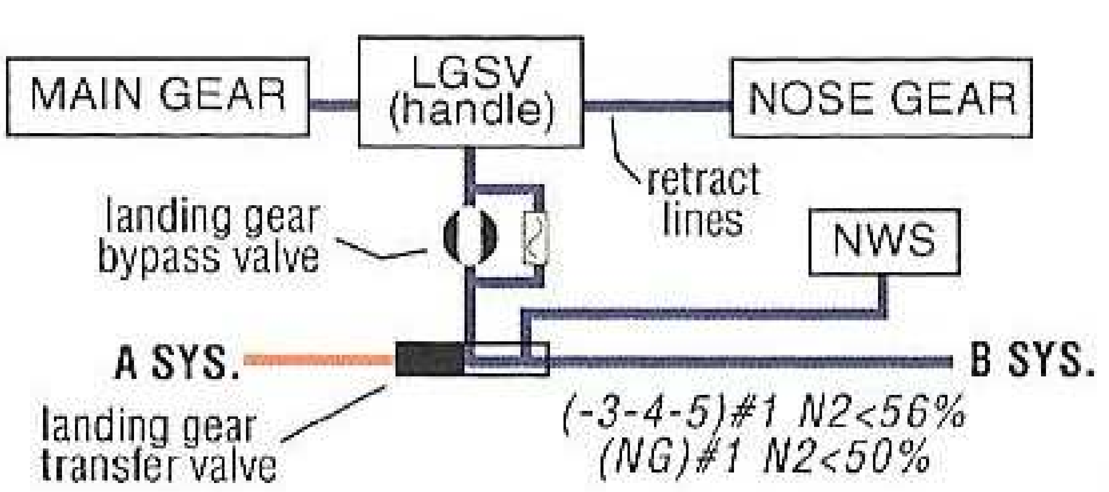
Max N2 is 105%

(MEL) N2 Tachometer - ATA 77

- (3-4-5) One may be inop provided engine #1 tach generator operates normally and alternate start procedure is used. Digital counters may be inop except for EIS/CDS airplanes (needle must be operable)

N2 Tach Generator

- (3-4-5) N2 tach generator for #1 engine must operate normally for dispatch because it provides a signal to the landing gear transfer valve to identify when #1 engine has lost power

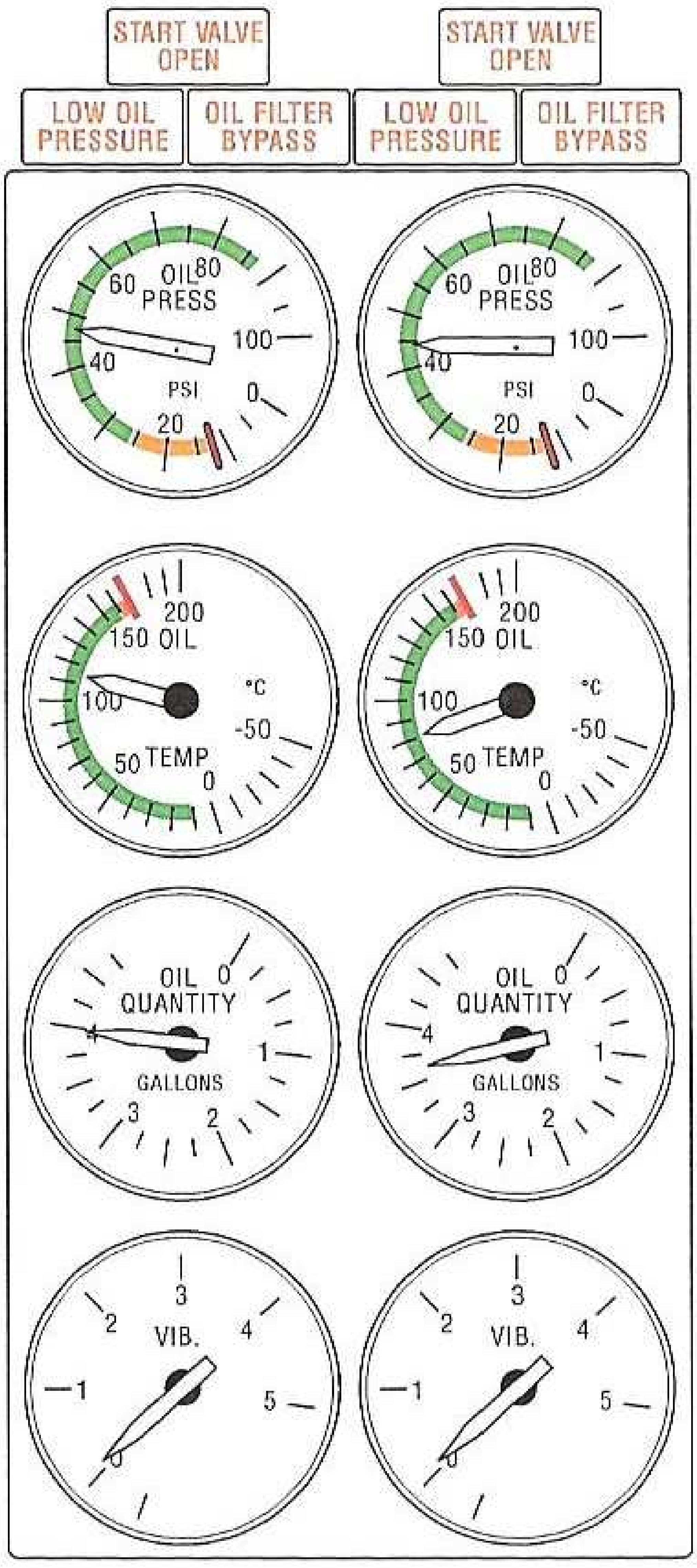


- Verification that the N2 tach generator is operating normally (when the N2 tach indicator is inop) can be done by observing that the engine start switch automatically moves to OFF during the engine start
- Alternate Start Procedure: Start the engine with the operating N2 first, noting time to attain 25% N2 and N1 rpm at that time. Then note the N1 rpm at starter cutout. Start the other engine using these times. If tach gen is inop manually move start sw. off

Engine Indicator System Notes:

- The engine tachometer system measures the speed of the low speed (N1) rotor and high speed (N2) rotor
- N1 speed is a means of monitoring engine power output, engine condition, and N1 rotor integrity overspeed
  - The N1 speed sensor is a pulse counter that senses N1 rotor speed and provides signals to the N1 tach indicator and PMC
- N2 rotor speed is a means of controlling engine starting and monitoring engine condition and N2 rotor integrity and overspeed
  - The N2 speed sensor is an ac gen, whose frequency is directly proportional to rotor speed, that provides signals to the N2 tach indicator and electrical power for PMC

OIL INDICATORS (3-4-5)



OIL PRESSURE INDICATOR

- indicates engine oil pressure in psi
- can operate in the yellow band (low thrust settings) except at takeoff thrust
- during cold weather operations pressure may rise above the green band during engine starting and warm-up
- oil pressure is unregulated and is primarily a function of N2 speed
  - this is the reason for the large green band

(L/OP) Powerplant, Oil Pressure

- minimum 13 psi; must be in green for takeoff

(L/OP) Powerplant, Cold Starts

- if temp below -31°F, idle for 2 mins, if no oil pressure, shutdown engine, attempt another start in 10-15 mins

OIL TEMPERATURE INDICATOR

- indicates engine oil temperature in C°
- sensed after it has passed through the scavenge pump and scavenge filter

(3-4-5) oil temp probe prior to fuel / oil heat exchanger

(L/OP) Powerplant, Oil Temps

(3-4-5) if temperature exceeds the yellow band for 15 minutes or is above red radial, shut the engine down

OIL QUANTITY INDICATOR

(3-4-5) indicates engine oil quantity in gallons

(3-4-5) EIS indicates engine oil quantity in percent

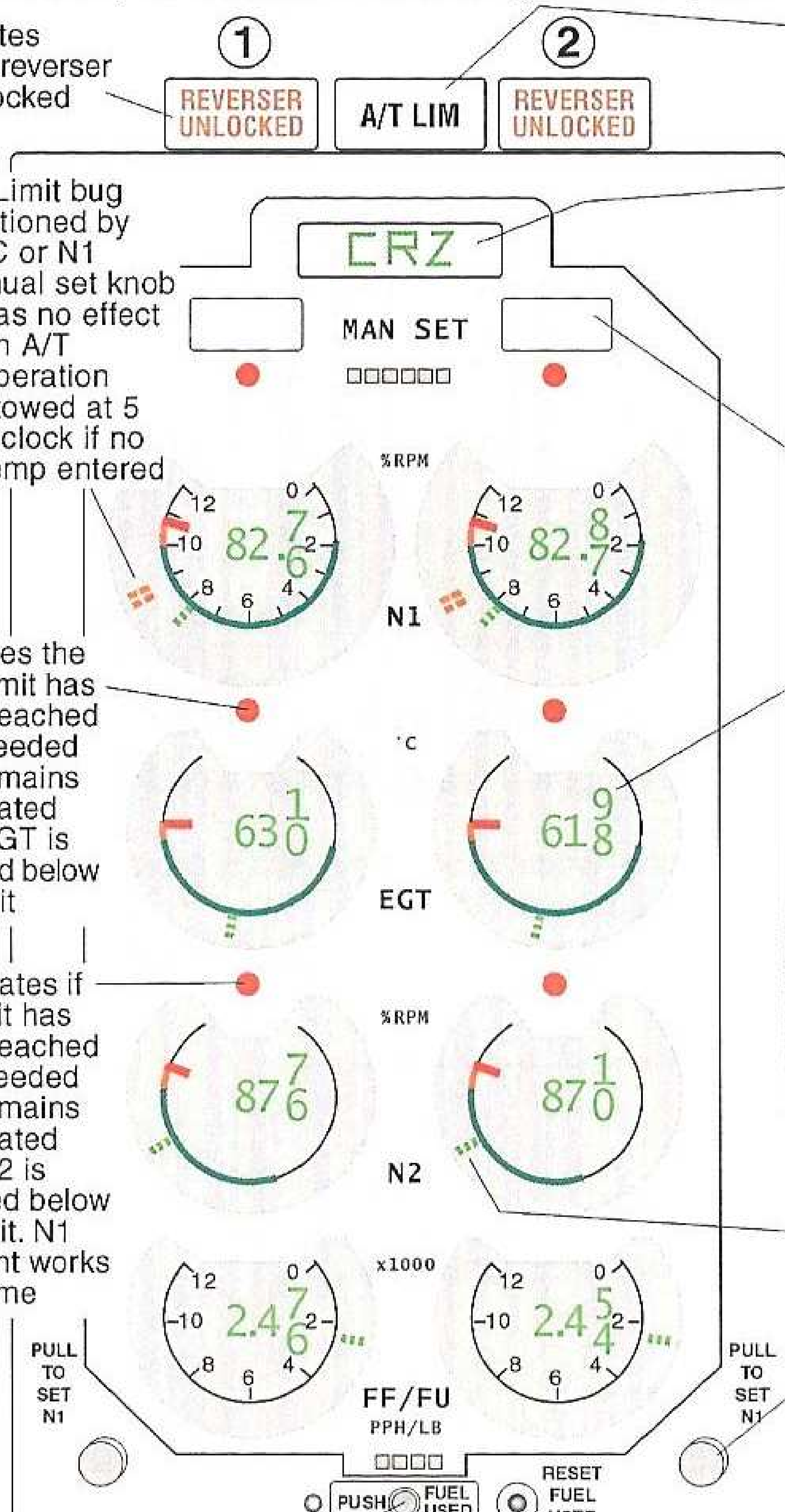
(L/OP) Powerplant, Oil Quantity

- minimum prior to engine start (check specific carrier)
  (3-4-5) 3 gal
  (3-4-5) EIS 75%
  (NG) EFIS 60% / PFD ND 12 qts

ENGINE INDICATING SYSTEM (EIS)

PRIMARY EIS DISPLAY

- the EIS is composed of two independent, solid state integrated displays: the left is the Primary Display and the right is the Secondary Display
- the display panel visually indicates to the flight crew any open circuit failures of the N1, N2, EGT and FF engine sensors, by slewing the pointer and counter displays to zero, holding the setting for 2 seconds, then setting the counter display to dashes and blanking the pointer display
- a maintenance module inside the display monitors the N1, N2 and EGT of both engine channels. On detection of an exceedance in one or more of the parameters, the EIS Primary Display unit stores the actual parameter values of N1, N2, EGT and Fuel Flow for that engine in a battery-backed RAM. This information is also stored during an abnormal engine start condition. Information stored in battery-backed RAM may be retrieved and erased by an external command signal while power is applied to the unit



Indicates thrust reverser is unlocked

- N1 Limit bug positioned by FMC or N1 manual set knob
  - has no effect on A/T operation
  - stowed at 5 o'clock if no temp entered

Indicates the EGT limit has been reached or exceeded and remains illuminated until EGT is reduced below the limit

Illuminates if N2 limit has been reached or exceeded and remains illuminated until N2 is reduced below the limit. N1 red light works the same

- When the FUEL USED push-button is pressed, the display shows the fuel used value for a period of 10 seconds then switches back to Fuel Flow

- Resets FUEL USED
- Button is recessed

- White A/T LIM if A/T computer is calculating a singel fixed N1 limit when FMC calculations become invalid or if either engine N1 is less than 18%

- Thrust Mode Annunciator
  - Displays active N1 limit reference mode

TO (full power takeoff)	CRZ
R-TO (reduced takeoff)	G/A
CLB	CON
R-CLB	

--- FMC is not computing thrust limit

- If the FMC input fails, the N1 bug freezes and dashes show in the MAN SET N1 limit display
  - blank when manual set knob is pushed in

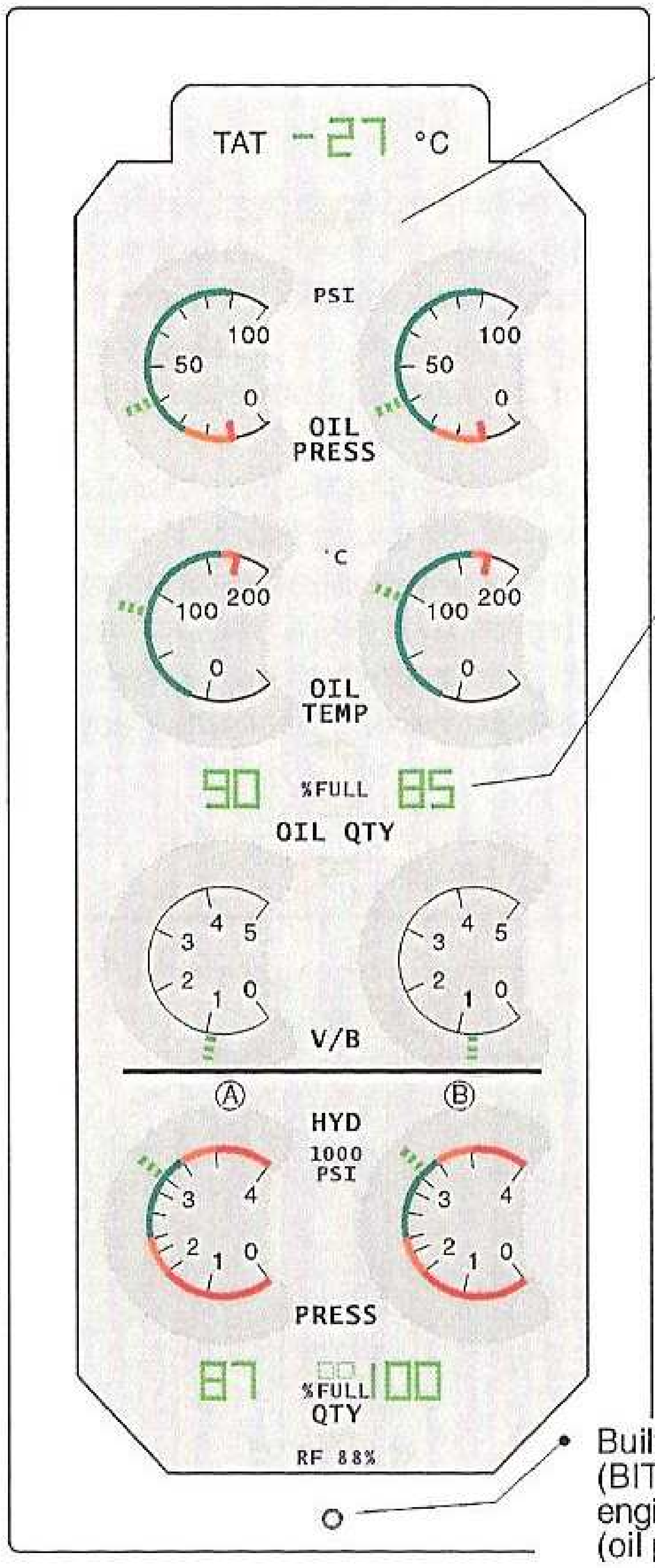
Abnormal Start Advisory System (ASAS)

- The Primary Display will detect a hung start, hot start, start stall, or idle rollback
- The EGT indication will flash at 2 flashes per second if the N2 acceleration is less than 50 rpm/sec, the EGT is more than 725°C, or a corrected EGT limit curve is exceeded
- A false warning can occur if the N2 momentarily decreases after starter cutout and the EGT is not more than 725°C
- If the N2 acceleration stops or is very slow, or if the EGT quickly goes to, or goes past 725°C, shut down the engine
- The flashing EGT indication can be reset by pushing the RESET FUEL USED button

- LED pointer

- Pull out and rotate knob to set N1 limit manually; this disables the FMC generated input signal, removes the N1 bug drive failure indication (if present), causes the MAN SET numeric counter to illuminate, and allows the limit N1 to be set
- Clockwise rotation of the knob moves the N1 bug clockwise in unison with changing changing numeric values on the MAN SET counter to show increasing limit N1

SECONDARY EIS DISPLAY



- Light sensors
- Engine OIL PRESS, OIL TEMP, VIB and HYD PRESS values are displayed by LED pointer moving on the dial face.
- TAT, engine OIL QTY and hydraulic QTY are displayed by a numeric digital counter.
- The engine oil quantity signal is displayed in terms of % FULL.
- The OIL QTY indicator also displays the fault code if a BITE test fails when initiated from a recessed BITE button.
- Failure of an input signal to the secondary EIS panel will cause an affected pointer to blank or an affected digital counter to display dashes
- An internal failure will cause either type of display to blank
- Built-In-Test-Equipment (BITE) is inhibited if either engine N1 exceeds 10% rpm (oil press > 13 psi)

- The Secondary Display will provide failure indication of the affected parameter in the same manner as the EIS Primary Display.
- the total air temperature (TAT) signal is from the digital air data computer (DADC). The TAT indicator will show dashes if no computed data (NCD) is being received from the DADC. The inflight TAT indication is comprised of outside air temperature (OAT) plus all of the ram rise. On the ground, the TAT indication is approximately OAT if pitot heat is OFF
- the OIL PRESS signal is derived from an engine oil transmitter. The value is displayed by an LED pointer moving on the dial. The display panel sends the engine oil pressure signal to the digital flight data acquisition unit (DFDAU).
- engine oil temperature signal is from a resistive temperature bulb. The OIL TEMP indicator displays the value in °C by an LED pointer moving on a dial.
- engine oil quantity signal is from the engine-mounted oil quantity transmitter.
- the engine vibration indicator displays the engine vibration level on a circular dial with an LED pointer.
- the hydraulic oil pressure signal is from the hydraulic system A and B pressure transmitter and is displayed by a LED pointer on a circular dial.
- the hydraulic oil quantity signal is from the reservoir-mounted transmitter. The HYD QTY indicator displays the hydraulic oil quantity in terms of % FULL.

Parameter Range

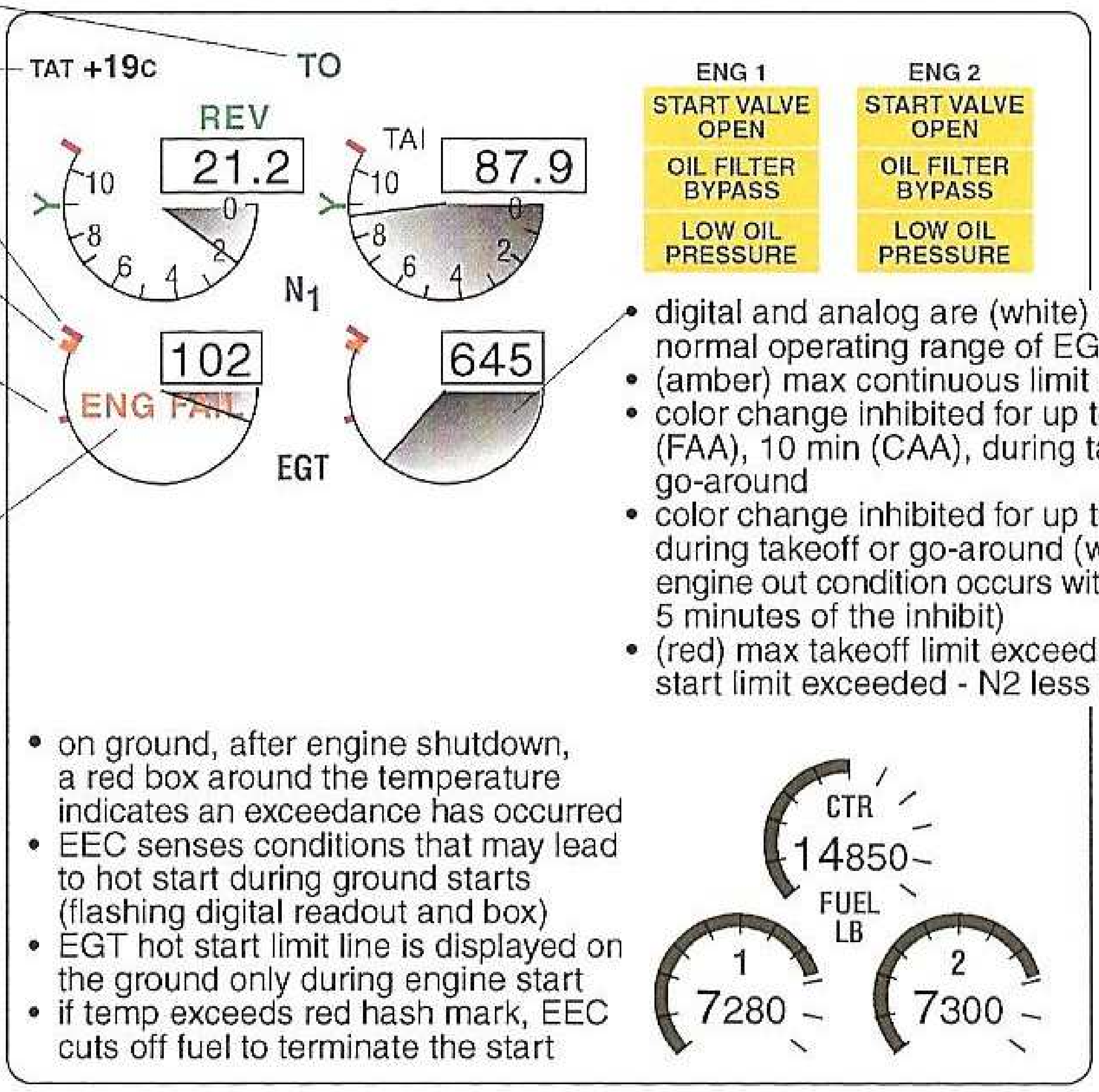
Total air temperature	-60 to 99°C
Engine oil pressure	0 to 100 psi
Engine oil temperature	-50 to 200°C
Engine oil quantity	0 to 100% of Full
Engine vibration	0 to 5 Scalar Units (Nondimensional)
Hydraulic oil pressure	0 to 4,000 psi
Hydraulic oil quantity	0 to 100% of Full

ENGINE VIBRATION INDICATORS

- indicates engine vibration level at the #1 bearing (fan) or rear frame (turbine) sections of the engine
- OFF INDEX MARK (blue) - indicator goes to this mark if the system is inoperative
- vibration measured at #1 bearing and turbine exhaust case

PRIMARY ENGINE DISPLAY (PFD/ND option)

- (green) active N1 limit
- (cyan) label (white) temp TAT °C
- red line displays max takeoff EGT
- (amber) lower end of band displays max continuous EGT
- (red) start limit
  - displays after start switch to GRD and disappears after roll-back and <50%
- (amber) engine operating below sustainable idle (<50% N2) and engine start lever in IDLE
  - remains until engine recovers, or start lever is moved to cutoff, or engine fire handle is pulled



- digital and analog are (white) indicating normal operating range of EGT in C°
- (amber) max continuous limit exceeded
- color change inhibited for up to 5 min (FAA), 10 min (CAA), during takeoff or go-around
- color change inhibited for up to 10 min during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit)
- (red) max takeoff limit exceeded or max start limit exceeded - N2 less than 50%

- on ground, after engine shutdown, a red box around the temperature indicates an exceedance has occurred
- EEC senses conditions that may lead to hot start during ground starts (flashing digital readout and box)
- EGT hot start limit line is displayed on the ground only during engine start
- if temp exceeds red hash mark, EEC cuts off fuel to terminate the start

THERMAL ANTI-ICE INDICATOR

- TAI indicator located on CDS above N1 indicators
- (green) cowl anti-ice valve(s) open
- (amber) cowl anti-ice valve is not in the position indicated by the associated engine anti-ice switch

THRUST REVERSER INDICATOR

- REV alert digital display on the uppper DU just above the N1 indicators
  - one for each thrust reverser
  - (amber) thrust reverser has moved from the stowed position
    - one or both sleeves of a T/R are between 10 and 90 % of travel to the deploy position
  - (green) thrust reverser is deployed
    - both sleeves are more than 90% of travel to deploy position

(QRH) REVERSER UNLOCKED (inflight)

- illuminates when either of the two reverser sleeve is not in the stowed and locked position or the light is giving a false indication
- only multiple failures could allow the engine to go into reverse thrust
  - such failures may preclude returning the engine to forward thrust
  - unstowed reverser sleeves produce buffet and increase drag
- movement of the reverser sleeves to the reverse thrust position mechanically retards the throttle to idle and the interlock limits movement of the throttle as long as the engine is in reverse thrust

THRUST LEVER...ADVANCE

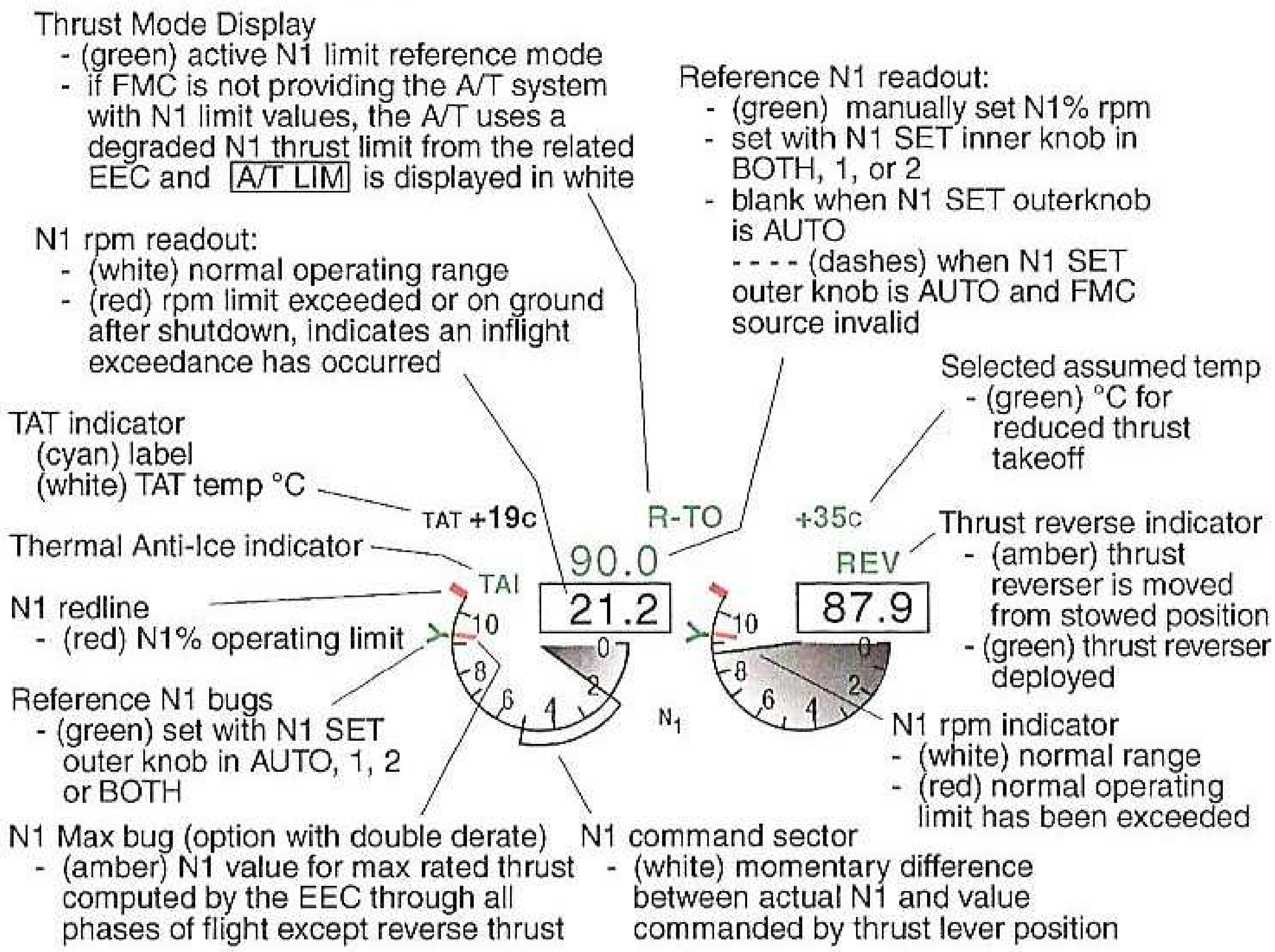
- do not actuate reverse thrust lever
- if the throttle is unrestricted and no buffet or yaw exists, operate the engine normally
- the EEC inhibits power above idle if the related reverser sleeve has moved from the stowed positon
- if the throttle has not moved toward IDLE and movement of the lever is unrestricted, the engine is in forward thrust
- if the thrust lever is restricted or buffet or yaw exists, shut down the engine

N1 RPM INDICATOR

- two indicators, a pointer and digital
- indicates normal low speed rotor in percent of RPM
- used as primary thrust indication
- N1 indicator is on Battery Bus (for Battery Start)

(L/OP) Powerplant, Max N1

- Max N1 is 104% (5,380 rpm)



EXHAUST GAS TEMPERATURE (EGT) INDICATOR

- the cursor moves to the corresponding position on the outer scale
- measured at second stage low pressure turbine nozzles

START VALVE OPEN ALERT

START VALVE OPEN (amber)

- illuminated steady indicates the start valve is open
  - valve is pneumatically operated
  - will close due to a spring installed
- blinking
  - uncommanded opening of start valve

ENG 1	ENG 2
START VALVE OPEN	START VALVE OPEN
OIL FILTER BYPASS	OIL FILTER BYPASS
LOW OIL PRESSURE	LOW OIL PRESSURE

(QRH) Start Valve Open Light On or (QRH) Start Valve Fails to Close

- If the starter does not cutout or if the START VALVE OPEN light illuminates during ground or flight ops, accomplish the following:
  - Engine Start Switch .... OFF
- If no starter cutout or start valve open light remains illuminated:
  - Isolation Valve Switch .... CLOSE
  - Engine Bleed Switch (affected engine) .... OFF
  - APU Bleed Switch .... OFF
    - Isolates bleed air to prevent starter disintegration and possible aircraft damage
- If during ground ops:
  - Ground Air Source .... Disconnect
    - Insure air source is removed prior to next step
  - Start Lever .... CUTOFF

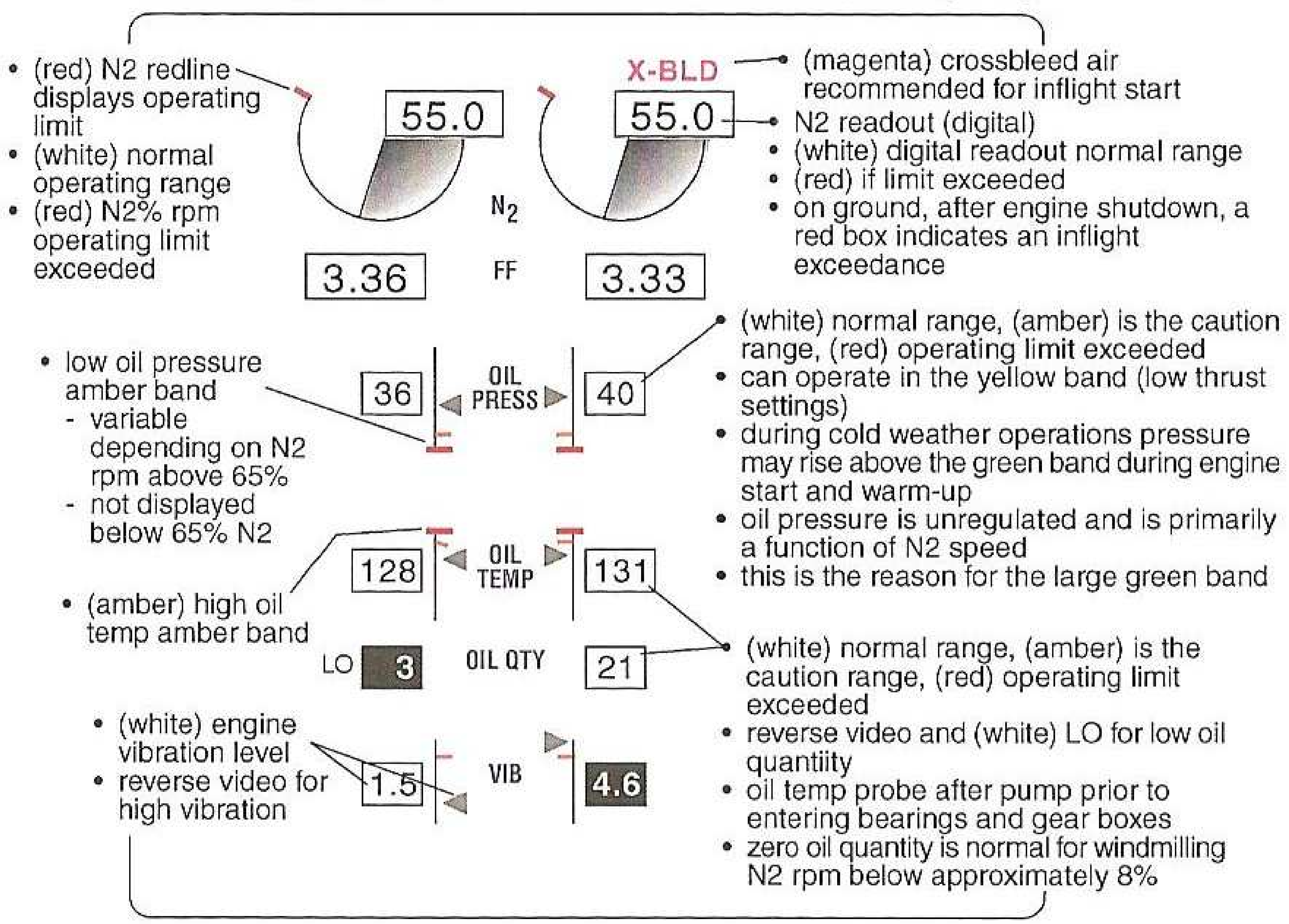
ENG 1	ENG 2
START VALVE OPEN	START VALVE OPEN
OIL FILTER BYPASS	OIL FILTER BYPASS
LOW OIL PRESSURE	LOW OIL PRESSURE

OIL FILTER BYPASS (amber)
- illuminated indicates an impending bypass of the scavenge (main) oil filter
  - oil comes from scavenge oil pumps
  - blinks with an impending bypass
  - see Note below

LOW OIL PRESSURE (amber)
- illuminated indicates that oil pressure is at or below the red radial
  - 13 psi
  - see Note below

Note
- alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine
- all three boxes blink for 10 sec then alert remains on steady and solid amber boxes removed
- blinking is inhibited
  - during takeoff from 80 kts to 400 ft RA, or 30 sec after reaching 80 kts, whichever occurs first
  - during landing below 200 ft RA until 30 sec after touchdown
  - during periods when blinking is inhibited, alerts illuminate steady

SECONDARY ENGINE DISPLAY (PFD/ND option)
- displayed when:
- CDS initially powered up
- when selected by the Multi-Function Display (MFD)
- in flight when an engine start lever moved to CUTOFF
- in flight when an engine fails
- when a secondary engine parameter exceeds normal operating range



N2 RPM INDICATOR
- indicates high speed rotor in % of RPM

(L/OP) Powerplant, Max N2
Max N2 is 105% (15,183 rpm)

X-BLD START (Crossbleed start indicator)
- displayed when airspeed is lower than that for a windmilling start

DU Failures
- if the upper DU fails, the primary engine display shows on the lower DU
  - if an exceedance occurs while the primary engine display is on the lower DU, the compact engine display shows
- if the lower DU fails, the upper DU continues to show the primary engine display
  - if an exceedance occur, the compact engine display shows on the upper DU
- if either upper or lower DU fails, you can switch between the compact display and the primary engine display by a push of the ENG button on the engine display control panel

OIL INDICATORS (NG)

OIL PRESSURE INDICATOR
- indicates engine oil pressure in psi

(L/OP) Powerplant, Oil Pressure
- minimum 13 psi; must be in green for takeoff

(L/OP) Powerplant, Cold Starts
- if temp below -31°F, idle for 2 mins, if no oil pressure, shutdown engine, attempt another start in 10-15 mins
- does not function until starter is engaged
- blinks with a low oil pressure conditon

OIL QUANTITY GAUGE

(6-7-8-9)	(3-4-5)
Max = 5.8 gal / 23.3 qt	
100% = 5.3 gal / 21.1 qt	4 = 4 gal
75% = 4.0 gal	3 = 3 gal
50% = 2.7 gal	2 = 2 gal
25% = 1.3 gal	1 = 1 gal
LO = < 4 qt	

(EFIS option) on Primary Engine Display and in gal
(PFD ND option) on Secondary Engine Display and in qts.
Average oil consumption of all 737s is .1 USgal per hour

OIL TEMPERATURE INDICATOR
- indicates engine oil temperature in C°

(L/OP) Powerplant, Oil Temps
- if temperature exceeds the yellow band for 45 minutes or is above red radial, shut the engine down

OIL QUANTITY INDICATOR
- when servicing, added oil flows through the scavenge filter and both heat exchangers before reaching IDG.
  Do not overservice

(L/OP) Powerplant, Oil Quantity
- minimum prior to engine start (check specific carrier)
- EFIS 60% / PFD ND 12 qts maintenance base, 10 qts non maintenance

ENGINE VIBRATION INDICATORS
- indicates engine vibration level at the #1 bearing (fan) or rear frame (turbine) sections of the engine
- OFF INDEX MARK (blue) - indicator goes to this mark if the system is inoperative
- vibration measured at #1 bearing and turbine exhaust case

(QRH) Powerplant, Excessive Vibration

- vibration levels in excess of 4 units accompanied by perceivable airframe vibrations require crew action.
- if not in icing conditions and flight conditions permitting, reduce throttle to maintain AVM below 4.0 units

UPPER ENGINE DISPLAY (EFIS OPTION)

- N1 rpm digital readout
- (white) normal operating range
- (red) operating limit exceeded
- (red) on ground, after engine shutdown, indicates an inflight exceedance has occurred

N1 limit reference is the active N1 limit for autothrottle and manual thrust control

SEL assumed temp for reduced thrust takeoff from FMC

- Reference N1 readouts are manually set
- Set with N1 SET knob when N1 SET is in BOTH, 1, or 2
- Blank when N1 SET is AUTO position
- – – – – when N1 SET in AUTO and FMC source invalid

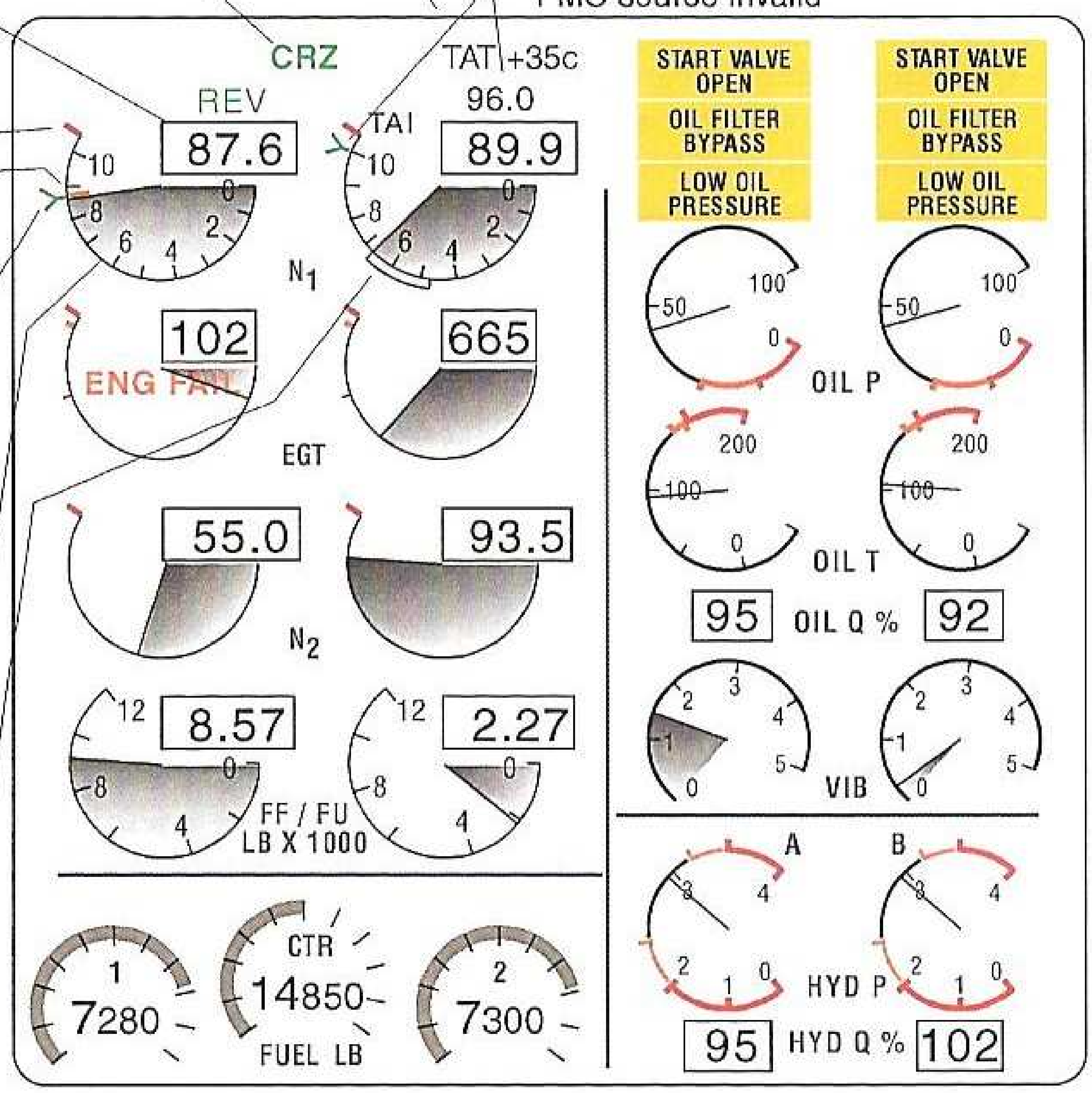
- (red) N1 redline displays operating limit

- (amber) N1 Max bug
- N1 value for full rated thrust
- computed by the EEC through all phases of flight
- upper limit for A/T ops
- not displayed when reverse thrust is selected

- (green) reference N1 bugs with N1 SET outer knob in auto, 1, 2, or both

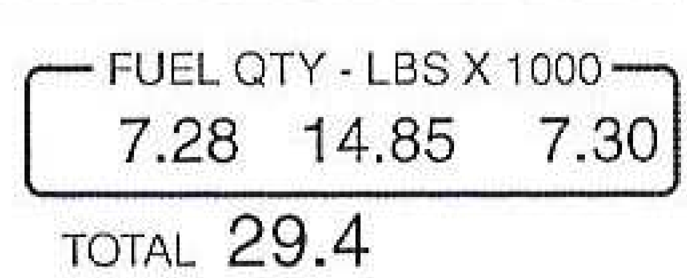
- digital and analog indications are (white) in normal ops in % rpm, (red) operating limit exceeded

- (white) N1 command sectors display momentary difference between actual N1 and value comanded by thrust lever position



FUEL QUANTITY INDICATORS

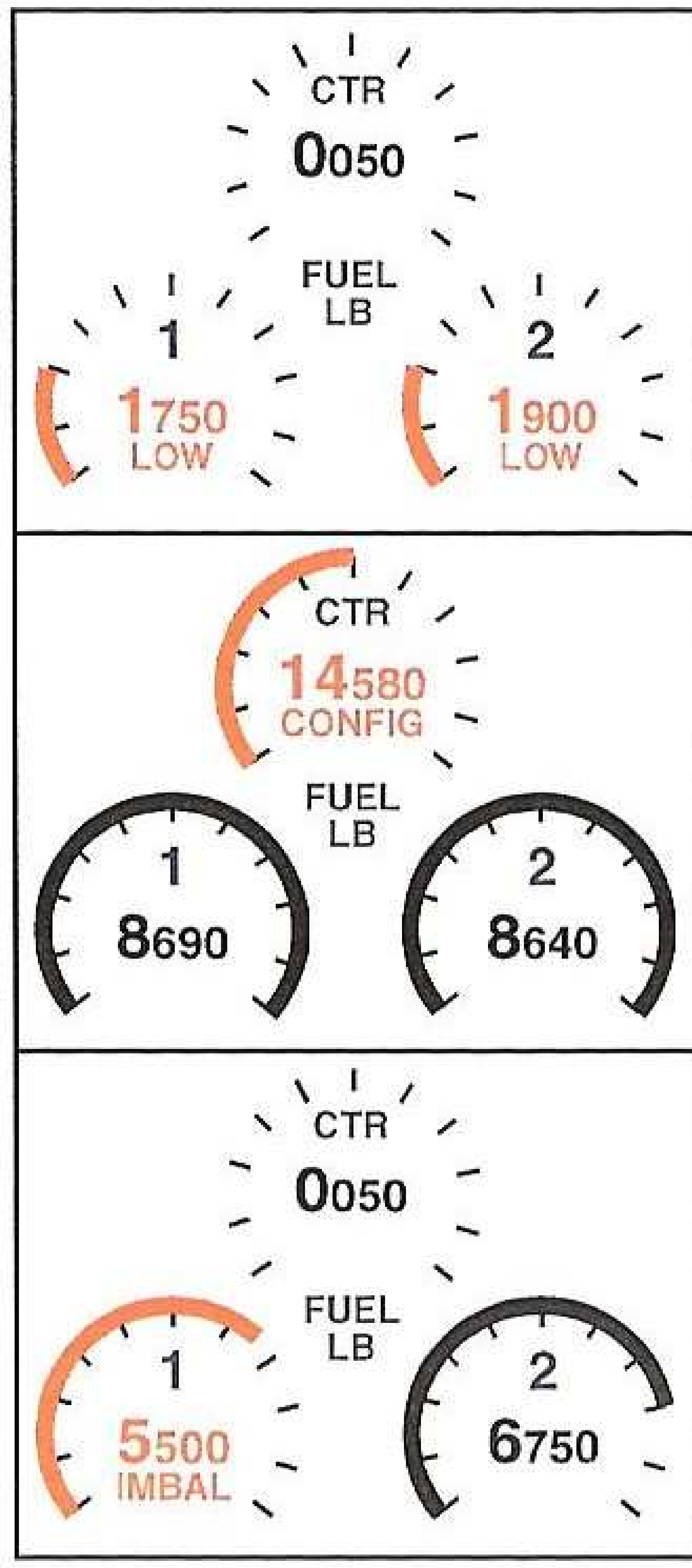
- 3 indicators in cockpit and 3 at the fuel station
- Fuel Quantity Indicators indicates usable fuel in related tank
- Total Fuel Quantity Indicators indicates total useable fuel
- accuracy is ±2.5% of full scale reading
- the Fuel Quantity Processor Unit (FQPU):
  - calculates fuel weight in each tank, monitors the fuel system for faults, calculates the total fuel weight, stores faults in non-volatile memory, sends fuel weight to the CDS, sends fault data to the CDUs, sends fuel weight to the fueling panel (P15), and sends fuel weight to the FMC
- the FQPU connects to two isolated 28v dc power sources at a time. The FQPU operates when either or both of the sources have power
- the FQPU can receive power from any of these three sources
  - 28v dc battery
  - 28v dc bus 1, or
  - 28v dc hot battery bus



(L/OP) Ballast Fuel

- fuel may be loaded into center tank and declared ballast fuel provided actual ZFW plus ballast does not exceed max ZFW, center tank fuel pump switches are operative, and ballast fuel is not used for burn requirements

FUEL ALERT INDICATION DESCRIPTIONS



FUEL LOW indication (amber)
- fuel quantity less than 2000 lbs (907 kgs) in related main tank
- fuel quantity arc and digits on tank(s) with low fuel quantity turn amber
- displayed until quantity is increased to 2500 lbs (1134 kgs) or more

FUEL CONFIG indication (amber)
- center tank quantity greater than 1600 lbs (726 kgs), both center tank pumps are producing low or no pressure and either engine is running
  - (modified / new a/c) both center tank switches are OFF
- fuel quantity arc and digits on center tank turn amber
- when illuminated, the indications will remain amber until center tank quantity is less than 800 lbs (363 kg), one center tank pump is producing high pressure or both engines are not running

FUEL IMBAL indication (amber)
- main tanks differ by more than 1000 lbs (453 kgs)
- IMBAL displays below main tank with lowest fuel quantity
- fuel quantity arc and digits on main tank with lowest fuel quantity turn amber
- inhibited when the airplane is on the ground
- inhibited by fuel LOW indication when both indications exist
- amber display until imbalance is reduced to 200 lbs (90 kgs) or less

(QRH) Low Fuel
- you are "min fuel" with less than 2000 lbs in either main tank
- open crossfeed, turn all pumps on, maintain minimum pitch attitude

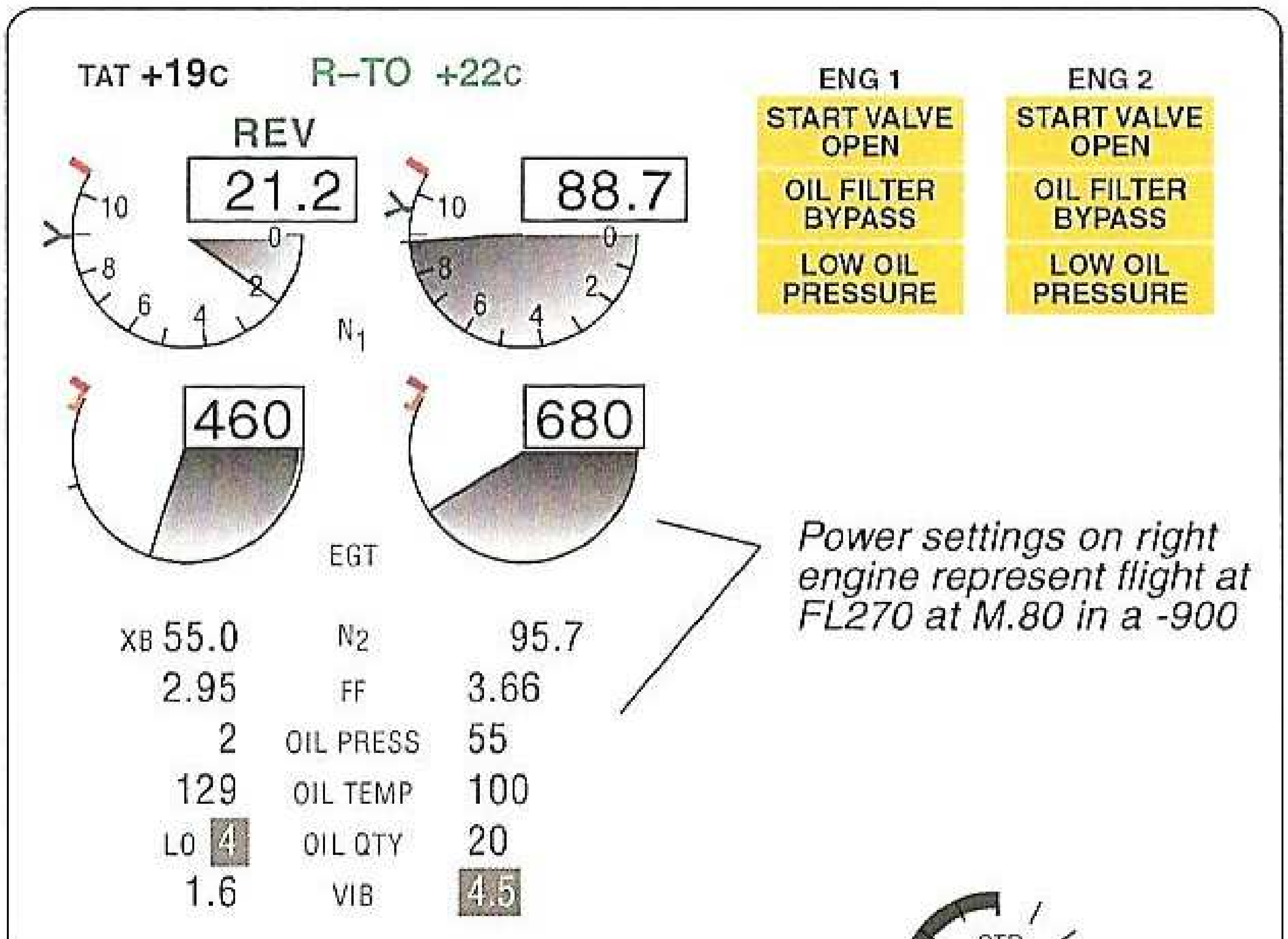
(MEL) Fuel Quantity Gauge - ATA 28
- one may be inop provided all boost pumps for the associated tank and fuel flow meter operates normally, center tank indicator operates normally and crew periodically computes fuel remaining
- measureing stick reading is taken after each refueling to verify quantity or tank is emptied and serviced with a known quantity
- FSU does not have to be disconnected because FQIS will send a "no valid data" signal to the FMC when a fuel quantity system error is detected

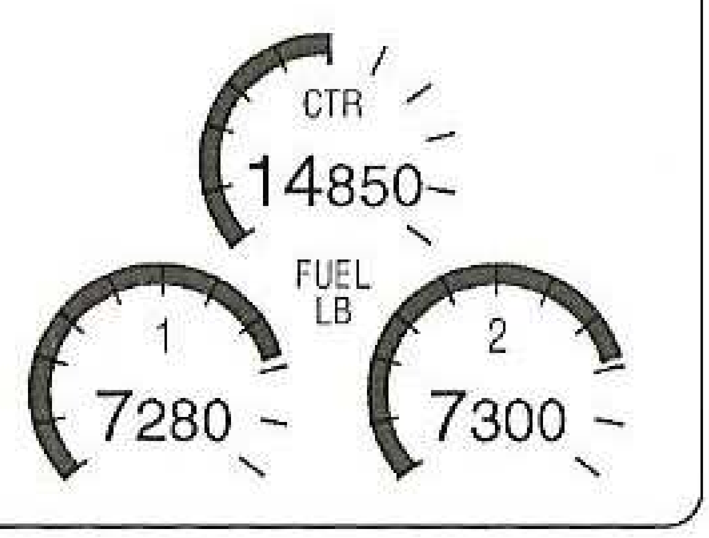
(L/OP) Fuel, Lateral Balance
- lateral fuel imbalance between tanks 1 and 2 must be scheduled to be zero
- random fuel imbalance must not exceed 1000 lbs (453 kg)

(L/OP) Fuel, Loading and Balance
- main tanks must be full if center has more than 1000 lbs (453 kg)
  - if less than 1000 lbs, then wing tank fuel may be loaded if balance is considered
- use center to depletion followed by wing tanks
- use aux fuel and center fuel equally until aux is depleted
- use only Jet A and A1 fuels

COMPACT ENGINE DISPLAY (PFD / ND OPTION)

- the following changes occur to the secondary engine display in the compact engine display
  - N2 rpm
    - changes from round dial display to a digital display
    - digital display is framed by a red box after engine shutdown on the ground if an inflight exceedance occurred
  - oil pressure and oil temperature indications
    - displayed in digital format
    - digital display amber or red if limits are exceeded
  - vibration (VIB) indicator
    - displayed in digital format





TAT INDICATOR

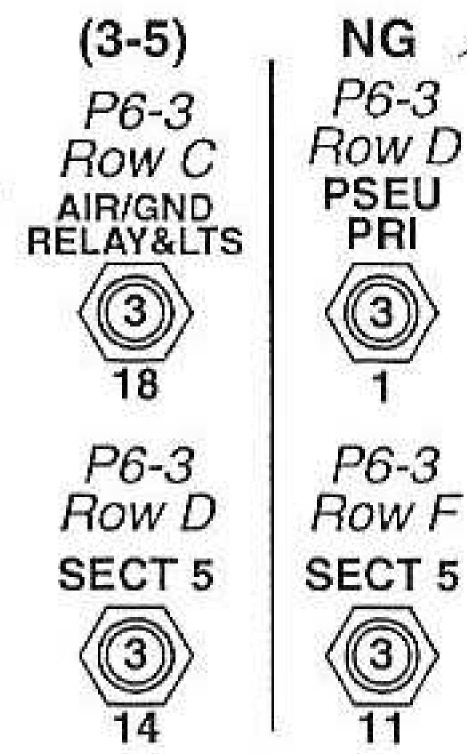
- from the left ADIRU
- shows on the top of the engine display
- if the left ADIRU is invalid, the right ADIRU value is shown
- TAT goes out of view when the data from both ADIRUs is invalid

LANDING GEAR INDICATOR LIGHTS

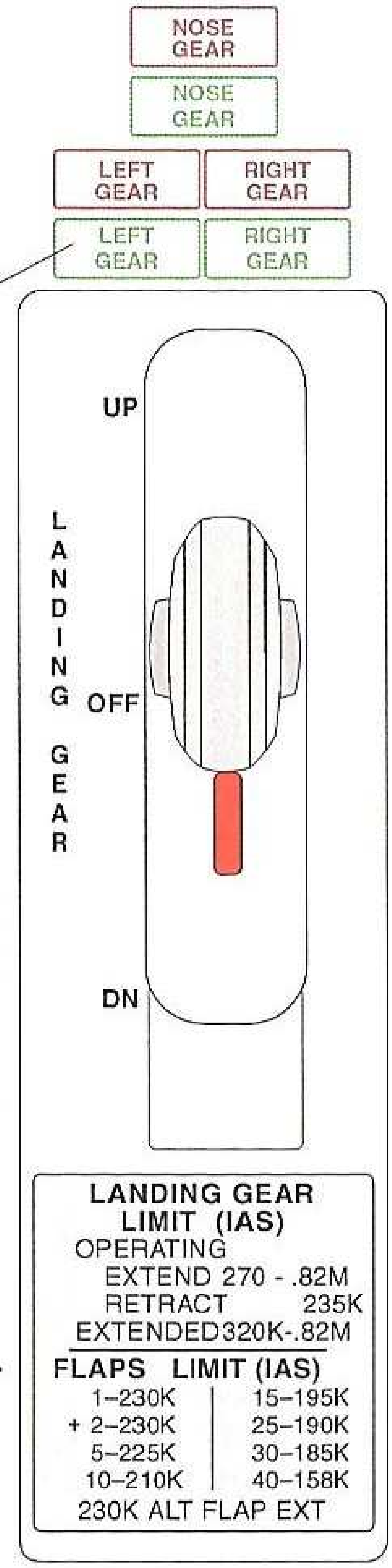
RED
- will remain on while the gear are in transit until the gear position agrees with the control lever position (gear up and locked)
- with all landing gear up and locked, all warning lights will be off with gear lever UP or OFF
- illuminated = gear not down and locked warning
  - either or both thrust levers retarded to idle

(NG) RA must be less than 800 ft

GREEN
- respective gear down and locked
- to check light ops, check these CBs in
  - (NG) do not cycle PSEU CBs in-flight



(NG)
- redundant but independent set of landing gear indicator circuits and lights on overhead
- gear is down and locked as long as one green landing gear indicator light for each gear is illuminiated (center or overhead panel)
- landing gear warning horn is deactivated when all three are down and locked



LANDING GEAR CONTROL LEVER ASSEMBLY (NG)

- has four control lever position switches
  - two down position switches
    - when you put the landing gear lever in the down position, the down position switches move to the closed position. This sends signals to the landing gear position indication and warning system. The position indication system uses these signals to operate the red landing gear position lights.
  - two up position switches
    - when you put the landing gear lever in the up position, the up position switches move to the closed position. This sends signals to the antiskid system. The antiskid system uses these signals to inhibit antiskid operation during gear retract braking so that the system will not sense a skid and release brake pressure

LANDING GEAR LEVER

UP / DN
- handle, via a cable, operates landing gear selector valve to retract or extend the gear
- lever lock prevents movement up when airplane is on ground
- in flight, sensors from nose gear or right main activate a solenoid to unlock the landing gear lever
- leave in up position for 10 sec after all red gear llights have extinguished to ensure positive uplock of the gear

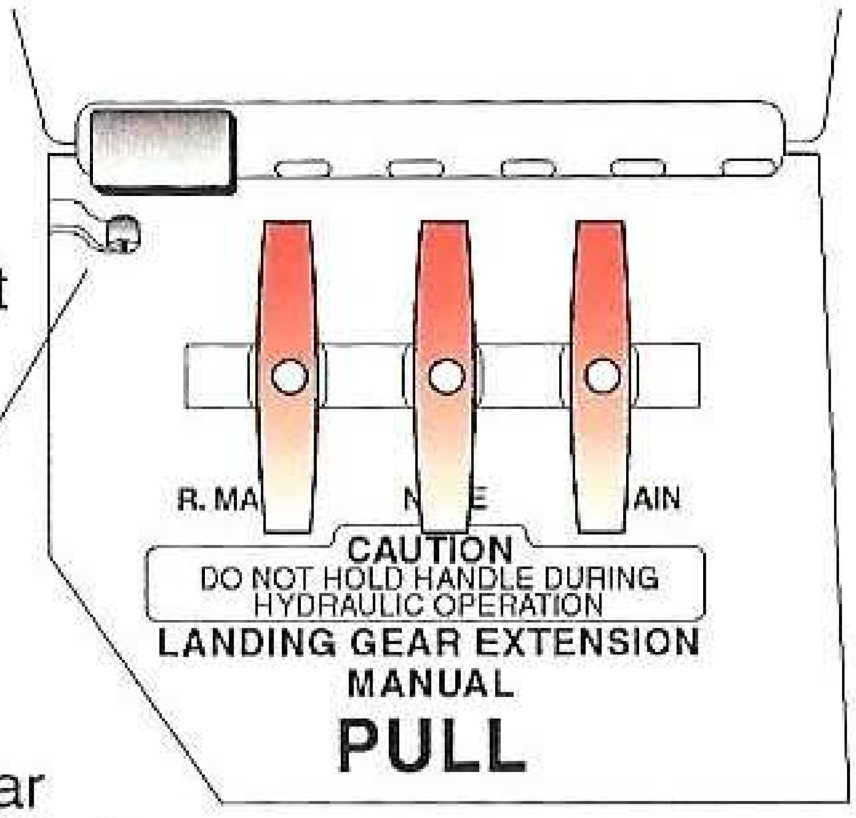
OFF pressure port is blocked and both the up and down lines flow directly to return

(NG) slightly smaller handle to allow better viewing of displays

OVERRIDE TRIGGER

- in the air, allows gear to be raised, bypassing lever lock
- when the right main gear shock strut is compressed by airplane weight on the gear, a circuit opens to de-energize the landing gear safety relay. When de-energized, the relay opens contacts, cutting off power to the lock solenoid. The lever lock then moves into the locked position.

- when the shock strut extends, the proximity switch closes and the reverse sequence of operations energizes the lock solenoid to release the lock. The lock solenoid remains energized when gear is retracted and electrical power is on the airplane.
- the override trigger permits the lever to bypass the lock if a malfunction of the system causes the lock to engage.



MANUAL GEAR EXTENSION HANDLES

- cables go to the uplocks (release mechanism of the nose gear and the extension linkages of the right and left main landing gear)
- the landing gears extend by airloads and own weight

(3-4-5) landing gear lever must be in the OFF position

(NG)

  - when door is opened, access door position switch sends signal to ldg gear selector valve bypass valve; up pressure is ported to system return and landing gear retraction is disabled until door is closed (prevents hyd lock so gear will free fall)
  - don't close this door if you are doing the procedure for the *gear handle stuck up*
  - manual gear extension is possible with landing gear lever in any position
  - with access door closed gear can be retracted by placing gear lever down, then up
  - do NOT hold handles in any extended position during hydraulic operation

MAIN GEAR VIEWER (in passenger cabin) (3-4-5)

- opposite 3rd window aft of overwing exit, 1 foot left of aircraft center
  - before leaving the cockpit, turn the Wheel Well light ON and use the PA
  - pull up on carpet identified by a metal button to look through the viewer
  - two mirrors, angled to look at alignment marks on each upper and lower side strut
- indication that the main landing gear is down and mechanically locked is provided by observing the alignment of red stripes

NOSE GEAR VIEWER (in cockpit) (3-4-5)

- cover plate for viewer is located on the floor just inside the cockpit door
  - turn the Wheel Well light ON
- indication that the nose gear is down and mechanically locked is provided by observing that the two red arrows on the down lock strut are touching point-to-point
- (3-4-5) nose gear light must be operative

(L/OpSpec) Landing Gear, Speeds

- extend 270 kt or .82M - retract 235 kt - extended 320 kt or .82M
- do not apply brakes until after touchdown

(QRH) Landing Gear Lever Will Not Move Up After Takeoff

- the landing gear lever cannot be placed to the UP position in the normal manner due to either a failure of the landing gear lever latch solenoid or a failure of the air/ground system

LANDING GEAR LEVER ....DOWN

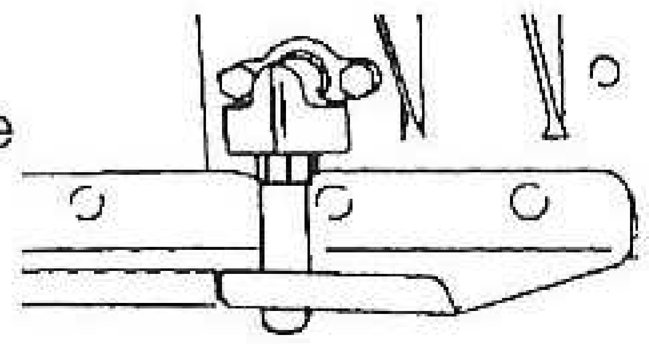
- takeoff configuration warning horn sounds when flaps are fully retracted
  - indicates a failure of the air/ground system or ground spoiler bypass valve
  - pull LANDING GEAR AIR / GND RELAY & LIGHTS C/B (C/B PANEL P6-3, C18)
  - do not operate speedbrakes in flight
  - reset CBs after gear extension to confirm gear down indication, then pull again

OR

- takeoff configuration warning horn remains silent after flaps are fully retracted
  - indicates a failure of the landing gear lever latch solenoid
  - pull landing gear override trigger and place landing gear lever UP, then OFF

Landing Gear System Notes

1. hydraulic sys A normally supplies pressure for landing gear extension and retraction
   - with loss of engine 1, gear is retracted by B system through Landing Gear Transfer Unit
2. Nose gear
   - operated by hydraulic system A through NLG downlock hydraulic line
     - pedal steering deactivated when wheel strut extends
   - doors connect to the shock strut and move mechanically when the nose landing gear extends or retracts; no cockpit indications of door position
   - a drag strut holds the nose gear in the extended or retracted position
     - the drag strut has an upper and lower part
     - a lock mechanism moves to an over-center position to lock the drag strut in both up and down positions
     - two bungee springs keep the lock links in this position
     - the lock actuator unlocks and locks the gear during extension and retraction
   - snubber stops nose gear rotation after retraction
   - for minimum radius 180° turn stop a/c completely. Hold tiller to the max angle, release brakes, add thrust on outboard engine, turning at less than 10 kts
   - if turning more than 78° you must disconnect the torsion links (support the lower link)
     - red stripe on the outside of nose landing gear door shows when wheels are at 78°
     - if turning more than 90° you must disconnect the taxi light wire bundle
3. Main gear
   - no pressure needed to keep the gear down after it's locked
     - downlock springs hold the downlock mechanism in an over-center locked position when the main landing gear moves to the down and locked position
     - the downlock actuator locks and unlocks the downlock mechanism during main landing gear extension and retraction
   - when gear is raised, alternate brakes stop main gear rotation before they go into the wheel well (alternate antiskid is inhibited)
   - held up by mechanical uplock hook (no hydraulics needed)
   - (NG) a frangible (breakable) fitting removes up hydraulic pressure from the main gear actuator if a damaged, spinning tire with loose tread moves into the main gear well



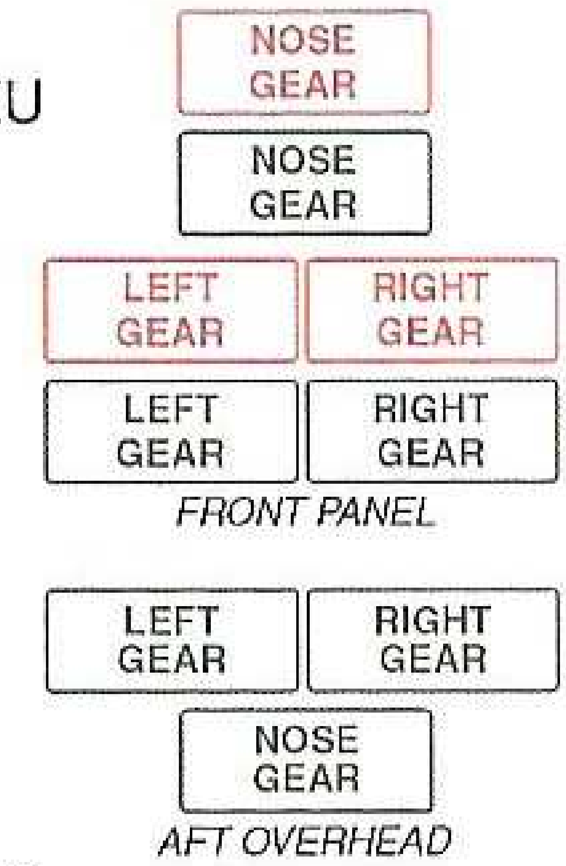
     - the retraction of that gear stops, and it free falls back to the down position, preventing damage to components in the wheel well
     - 3-4 liters of hydraulic fluid will be lost overboard until a volume fuse closes
     - fitting is located on the aft outboard ring of each wheel well
     - the affected gear cannot be retacted until the fitting is replaced
     - this feature added at JAA request, not for certification since retract (alternate) brake system would have to fail before a spinning gear entered the main gear well
4. air/ground system

   (3-5) receives logic from a teleflex cable on the right main gear and sensors on the nose gear
     - 3 different and separate air/ground logic systems are used: nose gear ground sensing, main gear air sensing and main gear ground sensing.

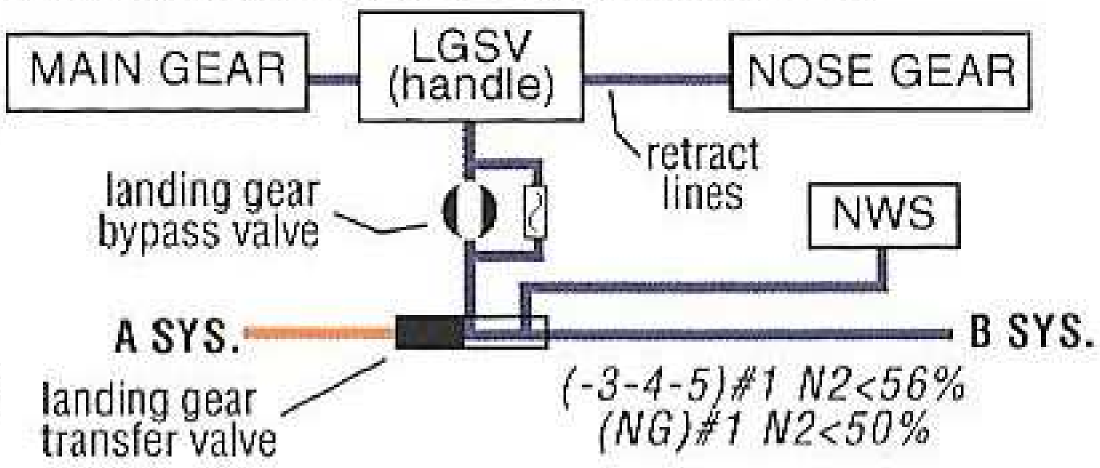
   (NG) two air/ground systems monitor the compression of the landing gear shock struts.
     - two compressed sensors are on each landing gear. One sensor sends inputs to air/ground system 1 and the other sensor sends inputs to air/ground system 2

   Following items related to air/ground system:

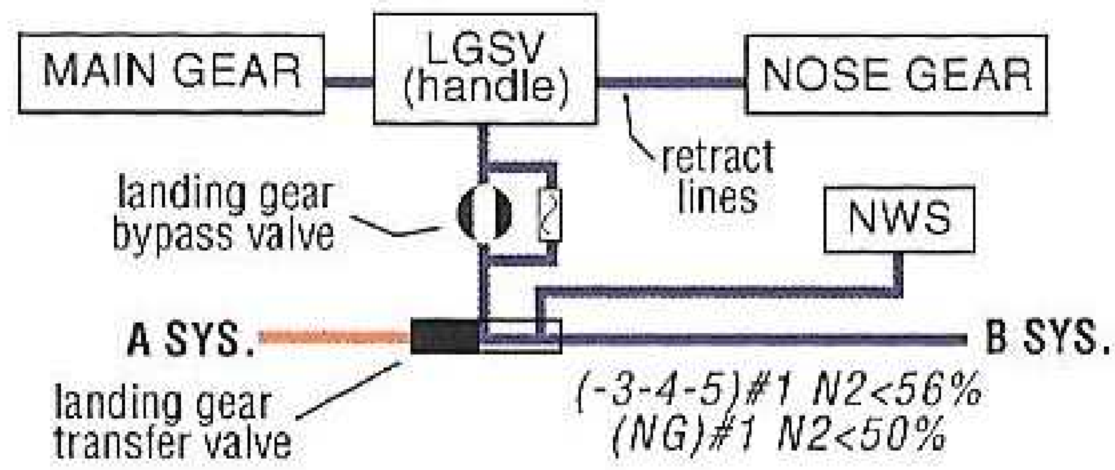
   ACARS, anti skid, APU fire horn, auto brakes, auto slat system, auto throttle, engine idle control, flight recorder, FMC (no GPS input), landing gear lever lock, landing gear transfer unit, pack valves, pressurization, ram air, speed brake lever actuator, stall warning, standby hydraulic pump, takeoff warning, thrust reverser, TOGA switch, voice recorder, wing anti-ice



5. gear position sensors (NG)
   - System 1 (primary) and System 2 (auxiliary) lights controlled by PSEU
     - System 1 operates the primary position green light
       - System 1 sends landing gear down and locked signals to the flight data aquisition unit (FDAU)
     - System 2 operates the auxiliary position green light
   - nose gear has
       - two gear down sensors (Sys 1 and Sys 2)
       - two gear up/downlock sensors (Sys 1 and Sys 2)
   - main gear (left and right) has
     - two gear uplock sensors (Sys 1 and Sys 2)
     - two gear downlock sensors (Sys 1 and Sys 2)
     - the landing gear position green lights come on when targets move near the down sensors and near the lock sensors
   - green safe indications with landing gear lever in DN position
     - nose gear
       - green NOSE GEAR light on front panel illuminates when the primary up/down lock sensor indicates gear is locked and the primary down sensor indicates gear is down
       - green NOSE GEAR light on aft overhead panel illuminates when the auxiliary up/down lock sensor indicates gear is locked and the auxiliary down sensor indicates gear is down
     - main gear (left and right)
       - green LEFT/RIGHT GEAR lights on front panel illuminate when the respective primary downlock sensor indicates gear is down and locked
       - green LEFT/RIGHT GEAR lights on aft overhead panel illuminate when the respective auxiliary downlock sensor indicates gear is down and locked
   - red unsafe indications with landing gear lever in DN position
     - nose gear
       - red NOSE GEAR light on front panel illuminates if either primary and/or auxiliary up/down lock sensors indicate gear is not locked or either primary and/or auxiliary down sensors indicate gear is not down
     - main gear (left and right)
       - red LEFT/RIGHT GEAR lights on front panel illuminate when either the primary and/or auxiliary downlock sensors indicate respective gear is not down and locked
6. landing gear transfer valve



   - the landing gear transfer valve lets the landing gear be raised by the B hydraulic system
   - opens when
     - airplane is on the ground and
     - nose wheel steering is switched to Alternate position
       - B qty must be normal
   - opens when
     - airplane is in the air (sensor on right main gear strut) and
     - (NG) #1 engine N2 < 50%
       (3-4-5) #1 engine N2 < 56% and
       - from the tach generator on the engine, not the tach indicator in the cockpit
     - gear handle in up position, and
     - either main gear not up and locked
   - after takeoff, if #1 engine fails, the landing gear transfer valve moves to the alternate position, which changes the gear extension and retraction supply from A to B to automatically raise the gear
     - improves 2nd segment climb capability (obstacle clearance requirements)
     - if the LGTV didn't work, the A system electric pump would raise the gear but at a much slowerrate since electric pump only puts out about 6 gpm (3-4-5), 5.7 gpm (NG), vs approximately 22 gpm (3-4-5), 36 gpm (NG) for engine pump (2ng segment)



- LGTV does not work with hydraulic system failure, only with engine failure
  - with hydraulic system failure you still have both engines operating and can meet 2nd segment climb requirements
- shuttle valve shifts and ports B system pressure and fluid to LGTU
- once the gear is retracted, the landing gear transfer valve shifts back to system A
- approximately .8 gal of fluid actually transfers. There is more fluid in the landing gear actuators with the gear retracted. When the gear free falls for landing, fluid from the actuators is ported to the A system return line, transferring a small amount of B fluid to the A system. If a missed approach is performed, the LGTU will again raise the gear. If this is done several times, such as in the simulator, the A system reservoir will eventually overflow and B system will need servicing

7. manual gear extension
   - If A system is lost, the landing gear can be dropped manually through use of the manual gear extension handles located in the floor aft of the right side center console
     - pulling these levers release the gear uplocks and allows the gear to free fall with the assistance of air load
8. towing airplane
   - when towing airplane, depressurize the hydraulic system A
     (3-4-5) if steering lockout pin is installed the A system hydraulics does not have to be off
       - red line on nose gear doors indicates max turn point when under tow
     (NG) tow lever to TOW position depressurizes the nose wheel steering system
       - you do not have to depressurize hydraulic system A
       - downlock pins are installed to prevent an outside force from unlocking the gear
9. tires
   - mains are 28 bias ply rating, nose gear tires are 12 bias ply rating
     - tires are inflated with nitrogen

Brake System Notes:

1. 3 sources: Normal, Alternate, and Brake accumulator
2. Normal brakes (antiskid available for all 4 individual wheels)
   - Hydraulic system B; main landing gear brakes only ("B for brakes")
3. Alternate brakes (antiskid available for each set of wheels)
   - when system B pressure is low, a valve opens to put system A pressure to alternate brake metering valves; no action required of crew to do this
   - autobrakes not available when alternate brakes in use
   - (3-4-5) automatic braking of main gear wheels upon gear retraction is done through hydraulic system gear up pressure. The pressure is routed to the A ports of each of the two alternate brake metering valves. The pressure drives the slide to meter reduced pressure from hydraulic system A through the alternate antiskid units to halt the wheels before they enter the wheel well.
     - during gear retraction the alternate antiskid circuitry is disabled by the landing gear lever up switch so that the system will not sense a skid and release brake pressure
4. Brake accumulator
   - system B supplies pressure (3000 psi); accumulator (gas) precharge is 1000 psi
     - with accumulator brakes you will have antiskid protection
   - if you lose system B, brake accumulator pressure is isolated from the normal brake system by accumulator isolation valve
   - if A and B systems fail, brake accumulator pressure moves the accumulator isolation valve to send pressure to the normal brake system (8 full brake applications)
     - you will have some braking as long as the brake pressure reads more than 1000 psi
   - if brake pressure indicates zero psi, you have lost your N_2 precharge. If system A or B is operating, you will still have brakes. If you then lose A and B, you have no brakes

5. Auto brake
   - uses system B hyd - Normal brakes (autobrakes inop if no B hydraulics)
   - monitors wheel deceleration and controls metered pressure at wheel spinup and idle throttles to maintain what the pilot selected until the airplane comes to a full stop
   - senses deceleration rate and modulates brake pressure accordingly - the proper applicaton of reverse thrust will result in reduced braking for large portion of rollout
   - override autobrake system by - prioritized (AUTOBRAKE DISARM light comes on)
     - stowing speed brake lever (put nose gear down first or you may get a tail strike)
     - manual brake application of more than 750 psi on either normal brake meter valve
     - advancing one or both throttles
     - autobrake selector switch to off, (DISARM light out - power removed from system)
   - if ANTI-SKID INOP light comes on, autobrake is disarmed
6. RTO
   - on ground, self test: wheel spin less than 60k, antiskid on, throttles at idle, select RTO
     - armed: speed greater than 90k, throttles advanced
     - activated: speed greater than 90k, throttles retarded
       - 3000 psi routed to all 4 brakes until airplane is stopped or de-activated by pilot
   - if you reject between 60 and 90, autobrakes do not come on
     (3-5) disarm light comes on, (NG) disarm light does not come on
   - RTO disarmed after takeoff (rt main gear) but switch must be manually turned off
   - if RTO still armed for landing, it disarms
     (3-5) about 2 minutes after landing the AUTOBRAKE DISARM light comes on
     (NG) about 2 seconds after landing the AUTOBRAKE DISARM light comes on
   - during RTO, when at least 1 thrust reverser lever is moved, the speedbrake refused takeoff switch closes and the auto speedbrake actuator extends fully, moving all spoilers up
7. Antiskid
   - offers these functions: skid control, locked wheel protection, touchdown protection, hydroplane protection, and gear retract braking inhibit.
     - skid control controls each wheel deceleration during normal braking (4 vlvs), and both wheels on each main landing gear during alternate braking (2 valvs)
       - if a wheel slows down too quickly, the skid control releases brake pressure until the wheel speed increases.
     - locked wheel protection compares the wheel speeds of the two outbd or the two inbd pair of wheels
       - if the slower wheel speed decreases to less than 30% of the faster wheel speed, the locked wheel protection releases brake pressure from the slower wheel
     - touchdown protection prevents brake operation from wheels 2 and 4 only prior to wheel spin-up
     - hydroplane protection compares wheel speed data to ADIRU ground speed data. When the wheel speed decreases to 50 knots less than ground speed, the hydroplane protection releases pressure to wheels 1 and 3 only
     - gear retract inhibit prevents the alternate antiskid system from operation during normal landing gear retraction to permit gear retract braking to stop the wheels
8. brake wear indicators
   - brake wear indicators should extend beyond the brake flange with brakes set

AIR/GROUND SYSTEM LOGIC TABLE

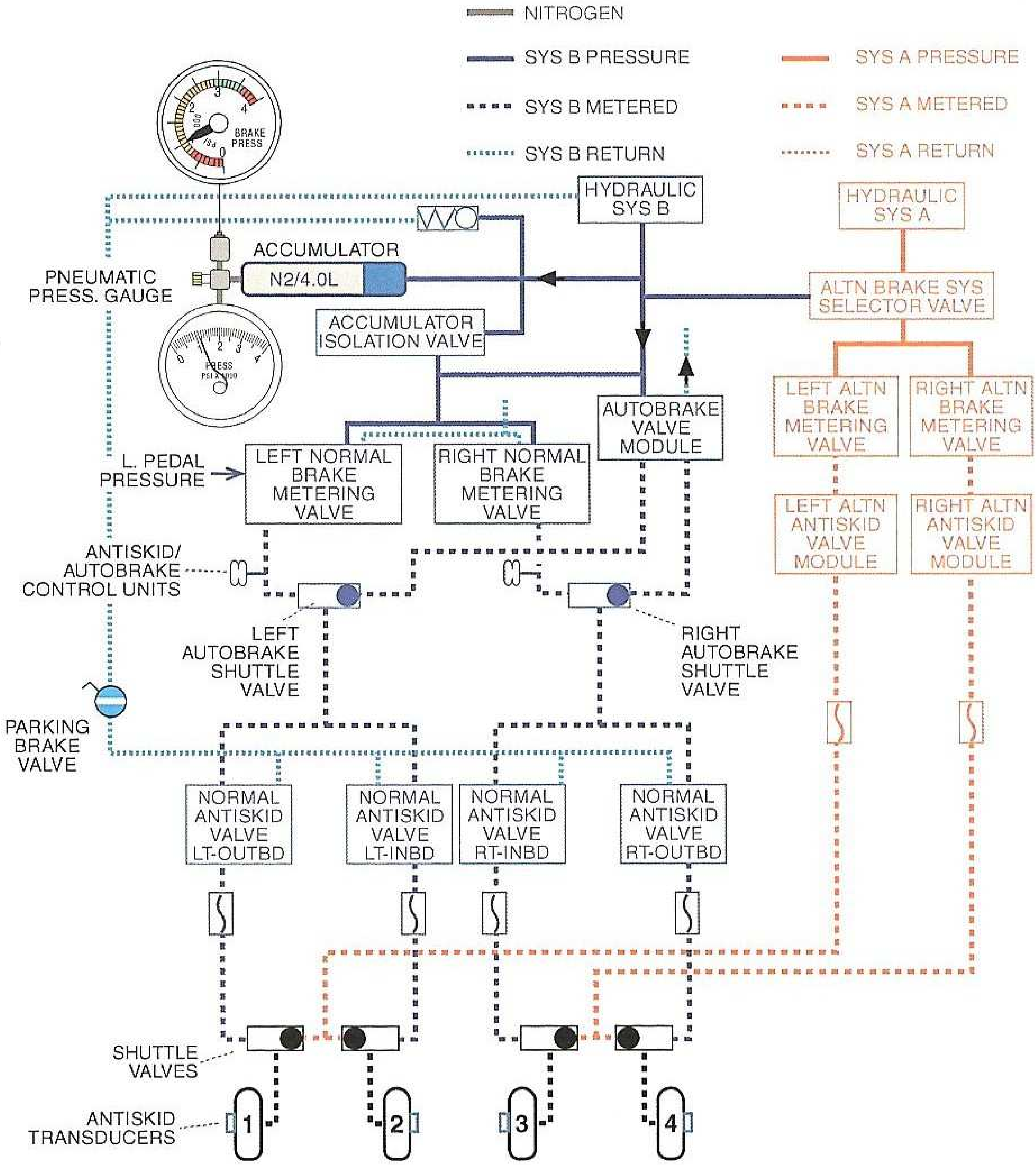
System	Normal Inflight Ops	Normal On-Ground Ops
ACARS	Sends out signal on strut extension for takeoff signal.	Sends out signal on strut compression for landing signal.
Antiskid	Releases normal or alternate brakes for touchdown protections.	Allows normal antiskid braking after wheel spin-up.
APU Fire Horn	Wheel well horn disabled.	Wheel well horn enabled.
Auto Slat	System enabled with flaps able if system B pressure is lost.	System disabled.
Autobrakes	Allows selection of landing mode.	RTO mode available and landing mode may be selected after touchdown if wheel speed is greater than 60 kts.
Autothrottle	Enables go-around below 2,000 ft radio altitude.	Disengaged 2 seconds after landing. Takeoff mode enabled.
Emergency Exit Doors*	Flight locks engaged when either engine N2 is more than 50% and 3 or more entry/service doors are closed.	Flight locks disengaged when either thrust lever is set below approximately 53°
Engine Idle Control	Enables minimum flight idle .	Enables minimum ground idle.
Flight Recorder	Operates anytime electrical power is available.	Operates anytime electrical power is available and either engine is operating.
FMC	FMC position updated from GPS, DME, or VOR/DME.	FMC position updated from GPS.
Landing Gear Lever Lock	Lever lock solenoid released.	Lever lock solenoid latched.
Landing Gear Transfer Unit	Enabled.	Disabled.
Pack Valves	With one pack operating, regulates to high flow with flaps up.	With one pack operating, regulates to high flow only when pack is operating from the APU and both engine bleed switches are off.
Pressurization	Allows programmed pressurization in the automatic modes.	Allows pressurization only at high power settings.

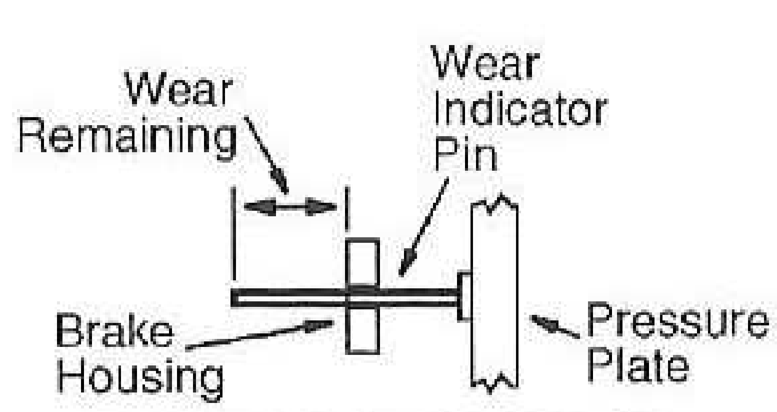
CENTER PANEL

System	Normal Inflight Ops	Normal On-Ground Ops
Ram Air	Ram air fans operate whenever air conditioning packs operate.	Ram air fans operate whenever air conditioning packs operate. Deflectors are extended.
Speed Brake Lever Actuator	Can be armed to raise ground spoilers for landing.	Activates Speed Brake lever on landing if armed. Rejected take-off feature available. Drives to Down when thrust lever advanced.
Stall Warning	Enabled.	Disabled.
Standby Hydraulic	Pump automatic operation with flaps extended and A or B pressure lost.	Wheel speed must be greater than 60 kts for automatiic operation.
Takeoff Warning	Disabled.	Enabled.
Thrust Reverser	Thrust reverse disabled.	Thrust reverse enabled.
TO/GA Switch	Flight director engages go-around mode.	Flight director engages takeoff mode.
Voice Recorder	Prevents tape erasure.	Allows tape erasure when parking brake is set.
Wing Anti-ice	Control valves open when switch is on. Thrust setting and duct temperature logic is bypassed.	With switch on, valves cycle open and closed. Switch trips to off at liftoff.

* NG aircraft only

BRAKE SYSTEM SCHEMATIC

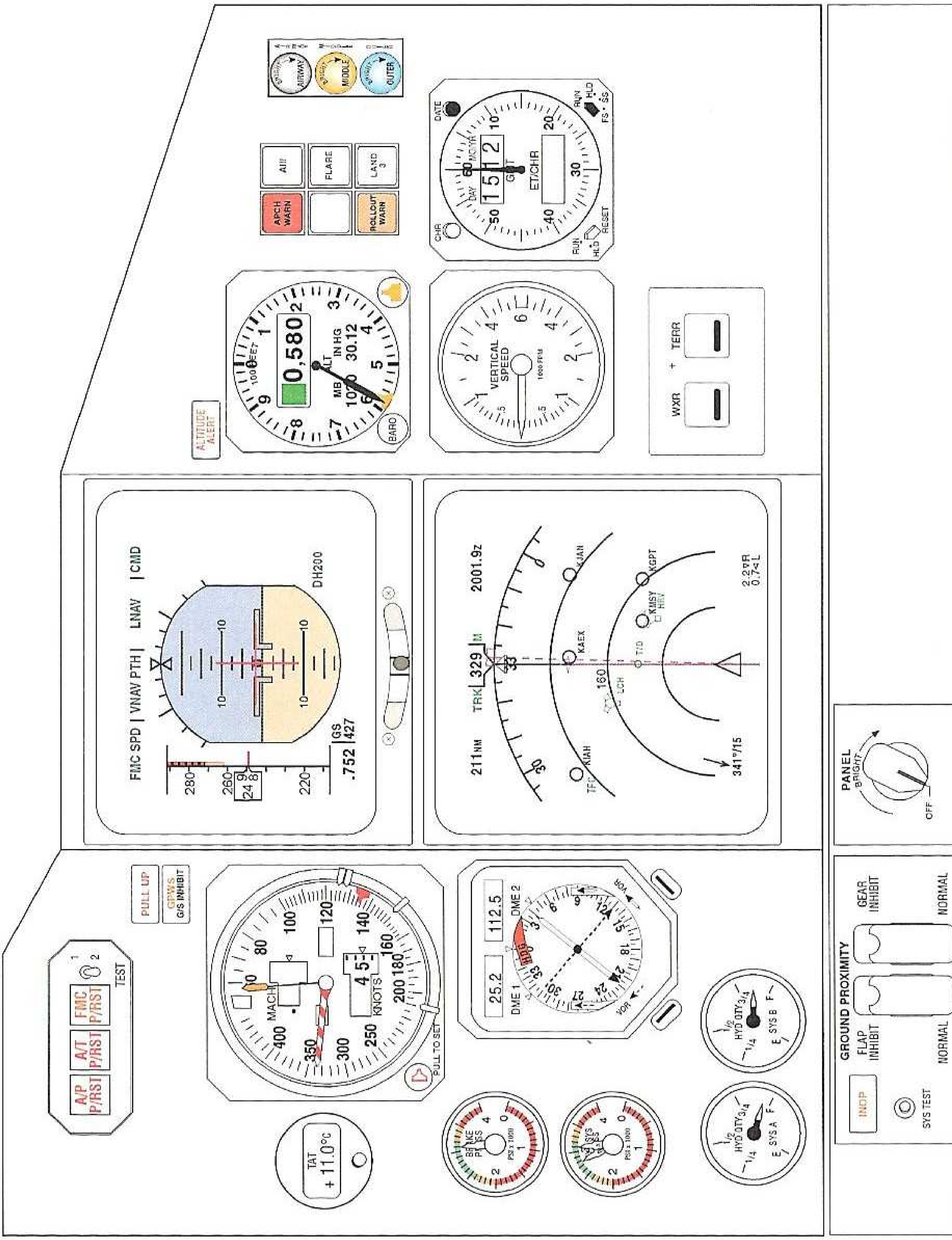




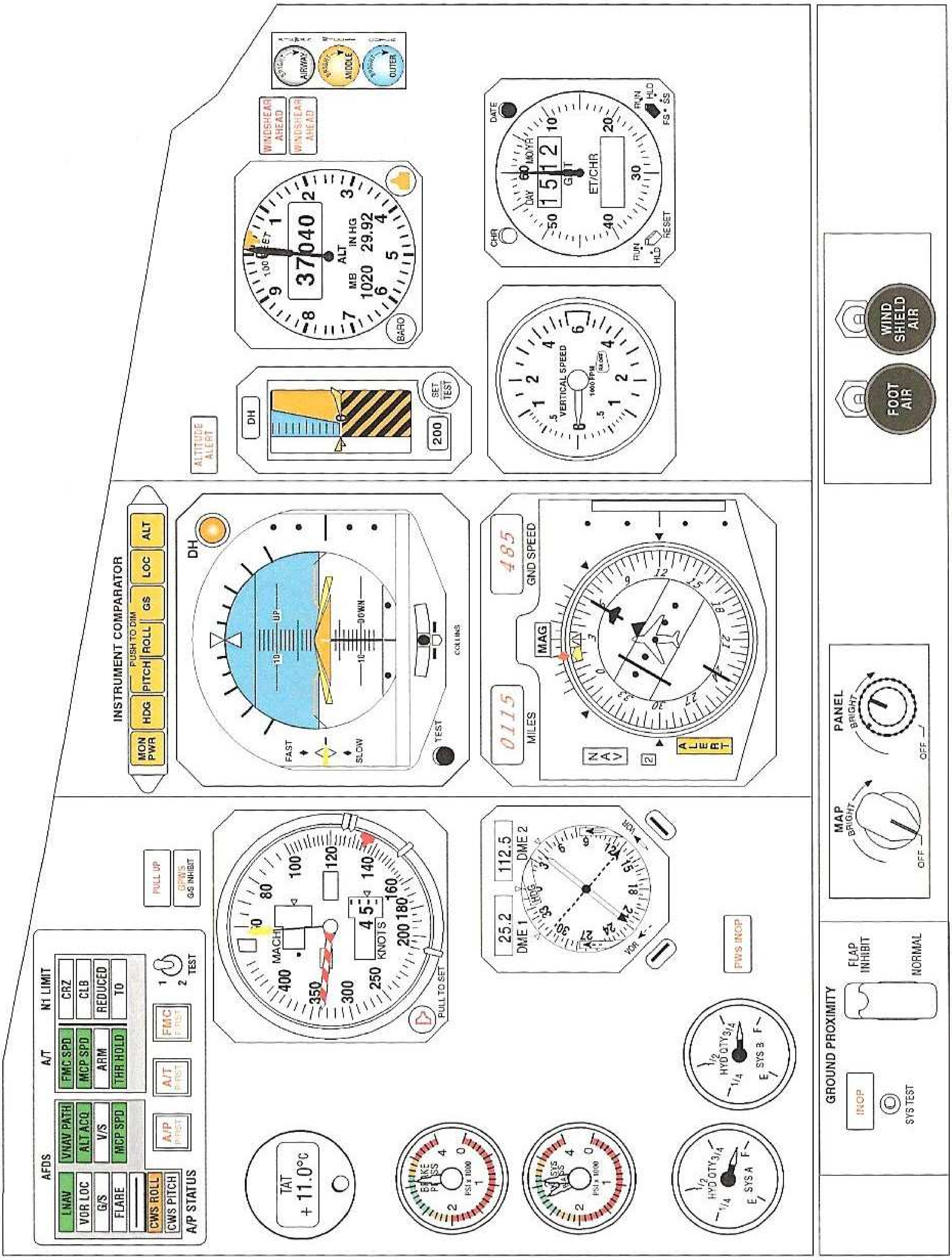
BRAKE WEAR INDICATOR

Brake Wear Indicators
- two indicator pins on the inboard side of the brake housing show brake wear
- set the parking brake prior to checking the wear indicator pins

FO PANEL - 737-500 EFIS

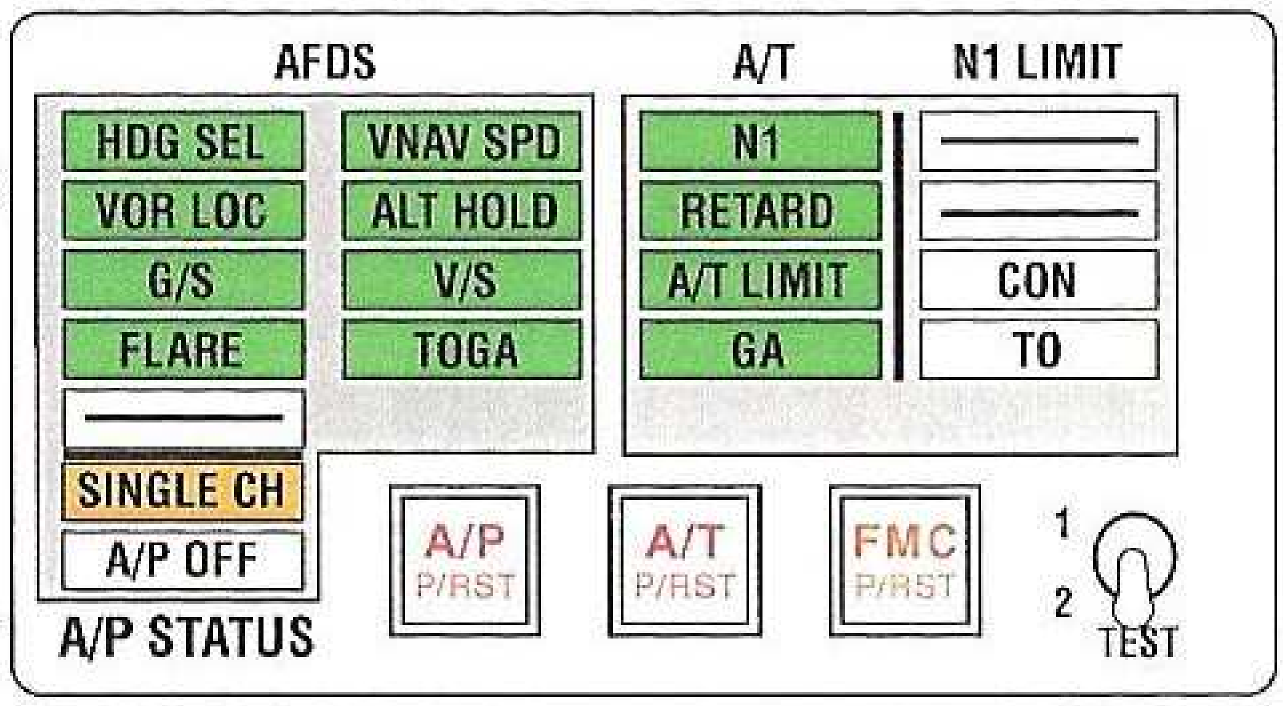


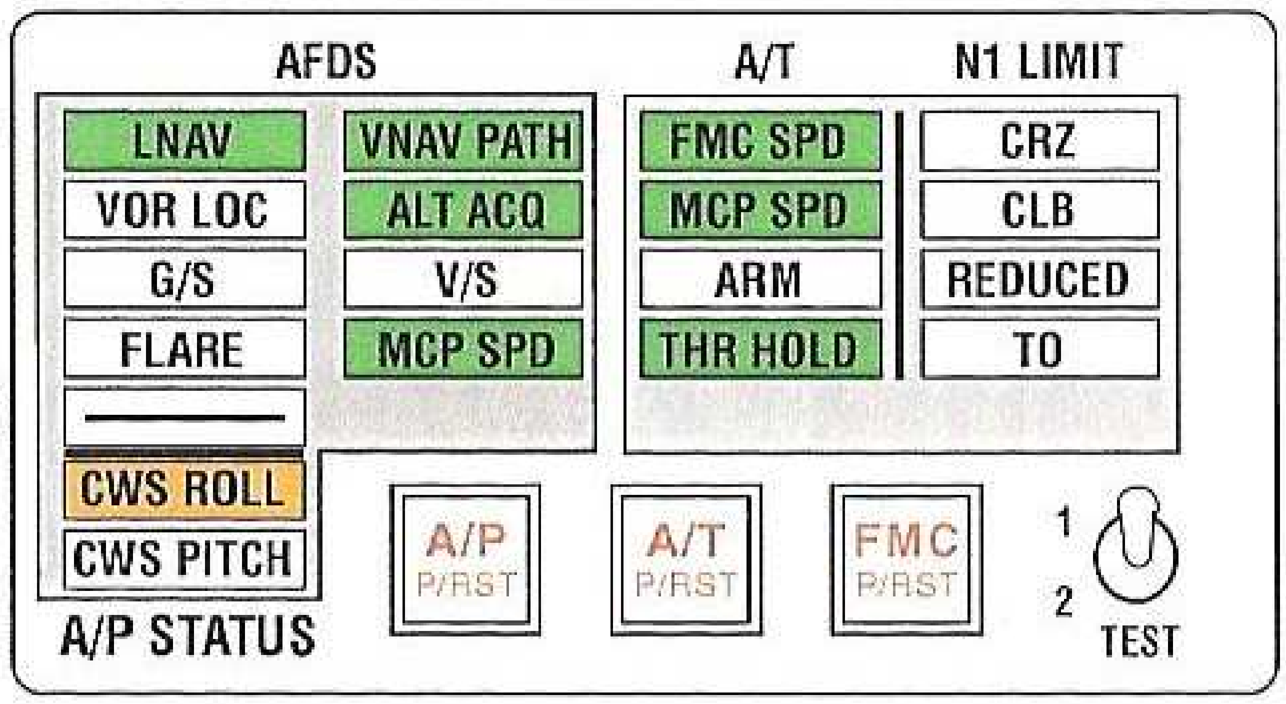
737-300 ROUND DIAL FO PANEL



FLIGHT MODE ANNUNCIATOR (non-EFIS)

- Capt and FO panels are identical; always show the same info.
- one side is blank to indicate the mode is disengaged
- annunciators are three-sided prisms which mechanically rotate to the appropriate display and are externally illuminated
- engaged= black letters on a green background
- armed = white letters on a black background (EFIS series, small white letters)
- the A/P and A/T disengage lights and FMC alert light are internally illuminated light caps
- when the test switch is held at the 1 and 2 positions, the following displays are annunciated
- a white horizontal line on a black background indicates a spare annunciator and is displayed only during test





AFDS annunciations (engaged mode)

LNAV: FMC lateral nav (roll mode)
HDG SEL: heading select (roll mode)
VOR LOC: annunciates capture of course (roll mode)
G/S: annunciates capture of GS (pitch mode)
FLARE: (pitch mode)
VNAV PATH: FMC vertical path (pitch mode)
VNAV SPD: FMC speed descent (pitch mode)
ALT ACQ: altitude acquire

- transition maneuver from a VS, LVL CHG, or VNAV climb or descent to a selected level off. Inhibited if ALT HOLD pressed or GS capture. After altitude is acquired, the ALT HOLD is engaged (pitch mode)

ALT HOLD

- at the MCP selected altitude or the ALT HOLD switch engaged at altitude (pitch mode)
- inhibited after GS capture

V/S

- pitch commands to hold selected vertical speed (pitch mode)
- engages the A/T in the "SPEED" mode to hold the selected speed
- has an "armed" and an "engaged" state

MCP SPD: holds selected speed (pitch mode)
TO/GA: Takeoff / Go Around (pitch mode)
Note: LVL CHG, V/S, and VNAV inhibited until a new altitude is selected

- altitude selected on the MCP is referenced to Captains barometric altimeter setting for "A" A/P and F/D, and to the FOs barometric altimeter setting for "B" A/P and F/D. Changes to settings after ALT HLD engages, do not change the selected altitude reference

A/P STATUS annunciations (engaged mode)

CWS ROLL: roll axis in CWS
SINGLE CH: annunciated in APP mode from LOC capture until the APP mode is disengaged
CWS PITCH: pitch axis in CWS
A/P OFF: neither autopilot engaged and at least one F/D is ON

A/T annunciations (engaged mode)

FMC SPD annunciation: maintains speeds commanded by FMC during VNAV. Speed display is blank, airspeed cursors show speed, and A/T maintains speed

N1 annunciation: maintains limit N1 thrust selected from FMC (N1 mode switch)
- can not manually use N1 bugs when this mode is in operation

MCP SPD annunciation: maintains speeds selected on MCP speed display

RETARD annunciation: power back after engaging LVL CHG and VNAV; then goes to ARM when throttles at aft stop (after 2 secs) OR manually stopped. Activates during landing flare at 27' RA (thrust reduced) with or without AFDS or FMC, then A/T disengages 2 secs. after landing

ARM annunciation: A/T armed and no A/T mode engaged; pilot can manually move throttles

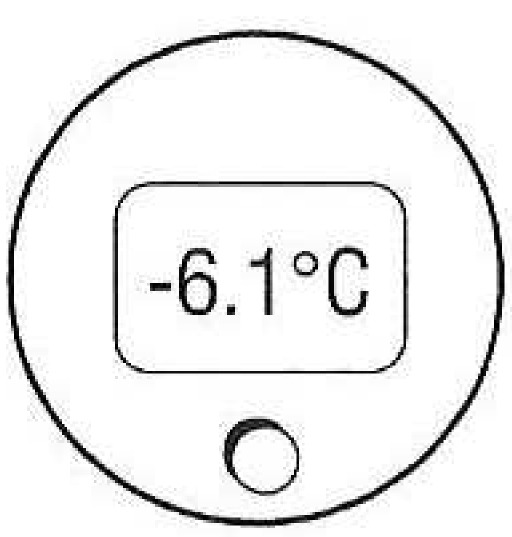
A/T LIMIT annunciation: indicates degraded A/T operation due to loss of FMC or N1 signals; appears with active A/T mode
- N1 limits now being computed by (3-4-5) A/T computer (NG) EECs.

If happens during a TO, the A/T are disengaged

THR HOLD annunciation: throttles released from A/T; can manually be moved
- annunciates at 84 kts (64 kts for airplanes with earlier model A/T computer) to indicate the A/T cannot change thrust lever position, but thrust levers can be positioned manually
  - takeoff into a headwind of 20 kts or greater may result in THR HOLD before the A/T can make final thrust adjustment
- this mode protects against thrust lever movement if a system fault occurs
- changes to "ARM" after 18 secs and 400' AGL

GA annunciation: go around mode is armed (need A/T "armed" and below 2000' RA). Can engage anytime (before 2 secs. after landing touchdown) with TO/GA buttons on throttles. Engagement gives a reduced thrust setting (2000 fpm climb), then once set a second button push gives full N1 limit thrust. Can then terminate by selecting another AFDS pitch mode

AIR TEMP / TRUE A/S INDICATOR



- displays air tempemperature (TAT °C and SAT °C), or TAS (knots) on liquid crystal display
- push selector button to sequence through TAT, SAT, and TAS
  - TAT range from -99°C to +50°C; SAT range from -99°C to +60°C
- TAT indications are only valid in-flight
  - on the ground, if pitot heat is off, approximate OAT can be read
- to convert in-flight TAT to actual OAT, see chart in Flight Manual
  - M.80 is approximately +30 correction; M.74 is approximately +24 correction
- inputs from TAT probe to left IRU to ADC to airspeed indicator
  - TAT Rosemont probe only on left side of aircraft (SAT plus "rise" = TAT)

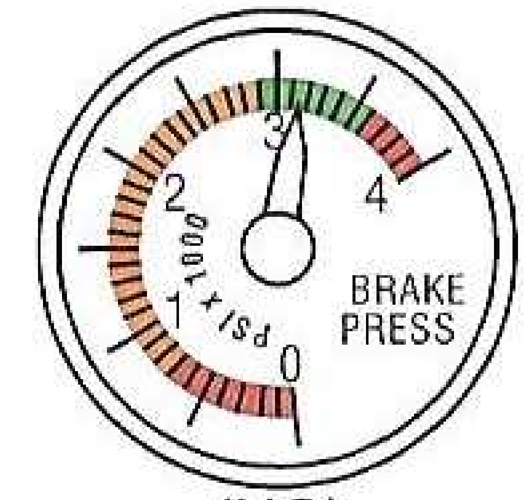
TAT Indicator flags
- TAT Indicator blank
  - If the TAT indicator is blank, and you have problems with other systems such as "A" channel Autopilot and/or Flt. Director, or Ground Prox, then replace #1 ADC
  - if the TAT indicator is blank and no problem with the other systems that receive digital info from ADC #1, replace the indicator

(MEL) Total Air Temperature Indication
- may be inop provided an alternate air temp indicator operates normally (FMC, SAT)
- with static air temp available, the following table can be used to determine TAT

TOTAL AIR TEMP vs STATIC AIR TEMP

SAT°C	M.50	M.60	M.68	M.70	M.72	M.74	M.76	M.78	M.80	M.82
40	56	62	69	70						
35	41	57	64	65	66	68	70			
30	45	52	58	59	61	63	65	67	68	70
25	40	47	52	54	56	57	59	61	63	64
20	35	41	47	48	50	51	53	55	57	58

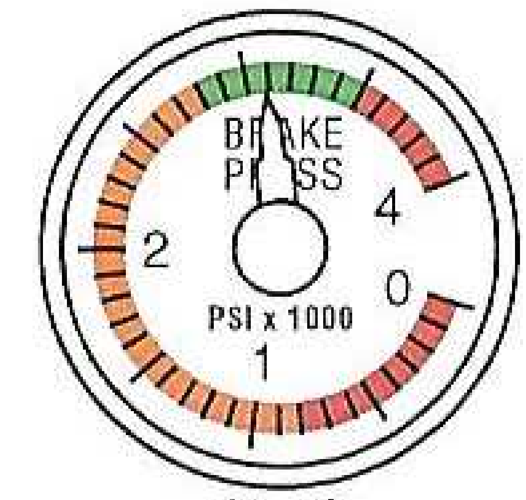
HYDRAULIC INDICATORS



(NG)

HYDRAULIC BRAKE PRESSURE INDICATOR

- indicates accumulator precharge plus residual hydraulic pressure prior to activation of any hydraulic pump
- nominal operating pressure: 3000 psi
- maximum operating pressure: 3500 psi
- will read the same as the brake accumulator gauge



(3-5)

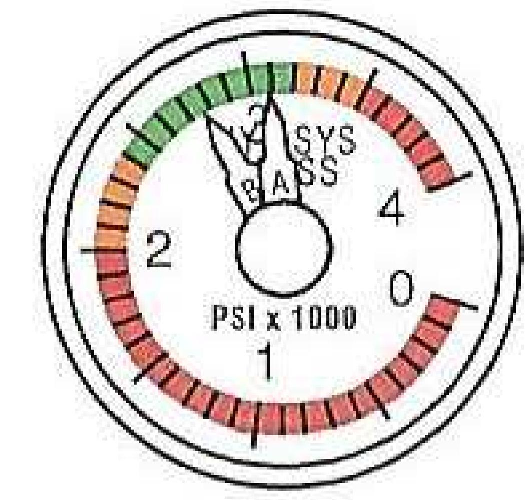
HYDRAULIC SYS PRESSURE INDICATOR

- indicates system A and B pressures
- indicates combined pressure of both the engine and electric pumps each side
- nominal operating pressure: 3000 psi

(3-4-5) located on the FO forward panel

(NG) located on the CDS (lower right)

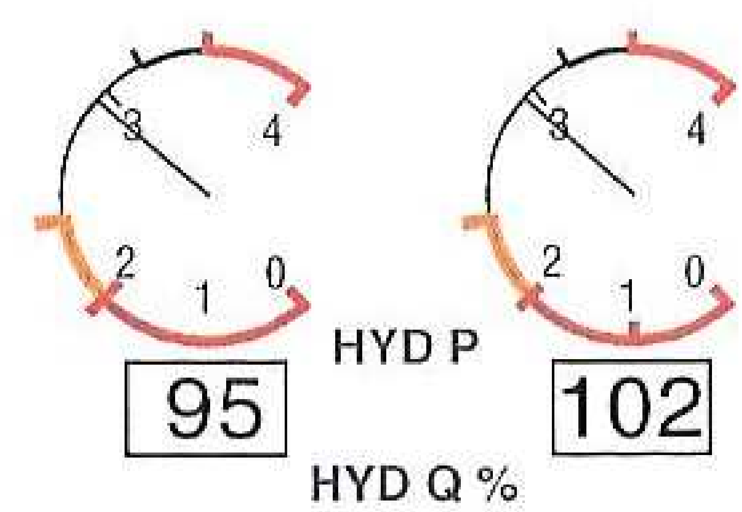
- (white) is normal operating range
- (amber) indicates caution range
- (red) indicates operating limit



(3-5)

(MEL) Hydraulic Pressure Indication - ATA 29

- may be inop provided sys pressure is checked prior to each departure
- System A: verify System A Flight Control LOW PRESSURE extinguishes when system is pressurized
- System B: with system B depressurized verify brake pressure indicator shows less than 2800 psi. Pressurize hydraulic system. Verify brake pressure rises to between 2900 and 3100 psi

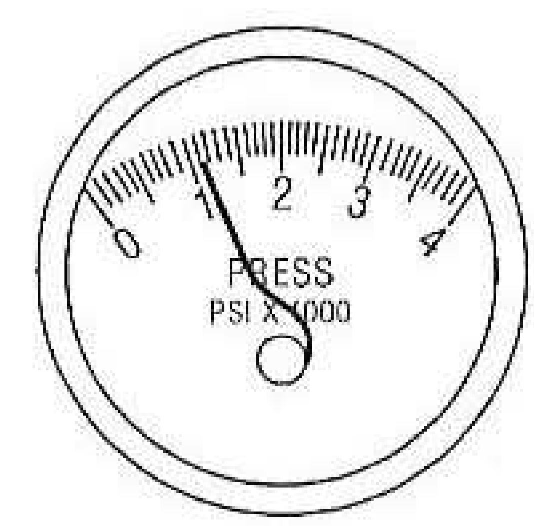


(FIX) Hydraulic Brake/Sys Press Gauge

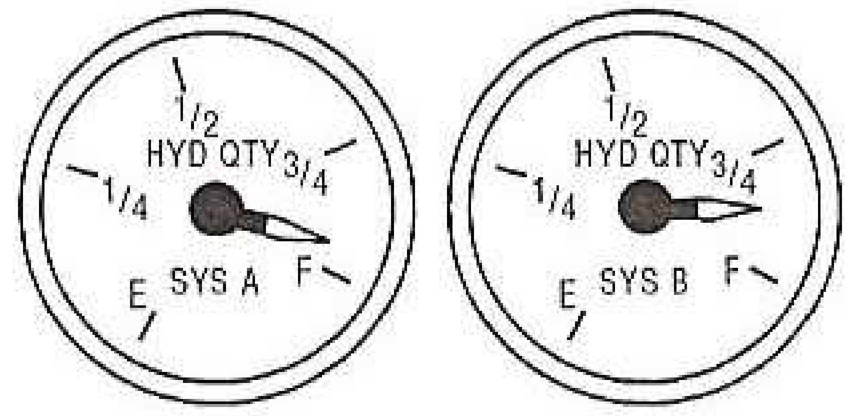
- if either analog gauge is inop but indicator in wheel well indicates normal pressure, take instrument out of panel, disconnect cannon plug, and roll instrument back and forth in hands and reinstall

BRAKE ACCUMULATOR GAUGE

- direct reading pressure indicator located in wheel well
- precharge, normally 1000 psi, taken from air side of brake accumulator

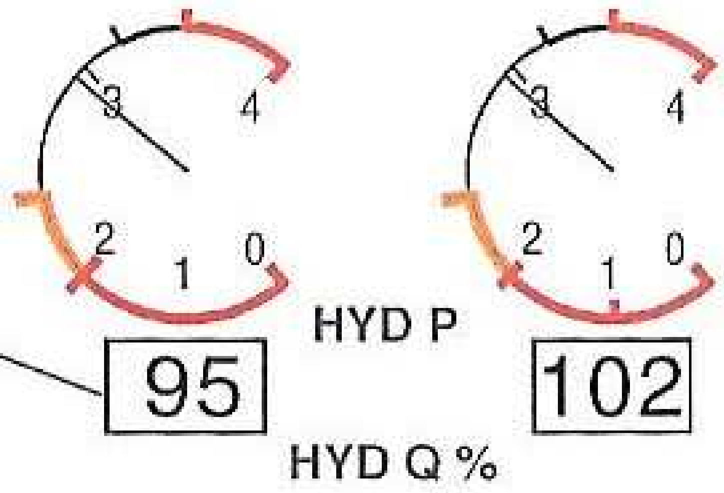


HYDRAULIC SYS QUANTITY INDICATORS



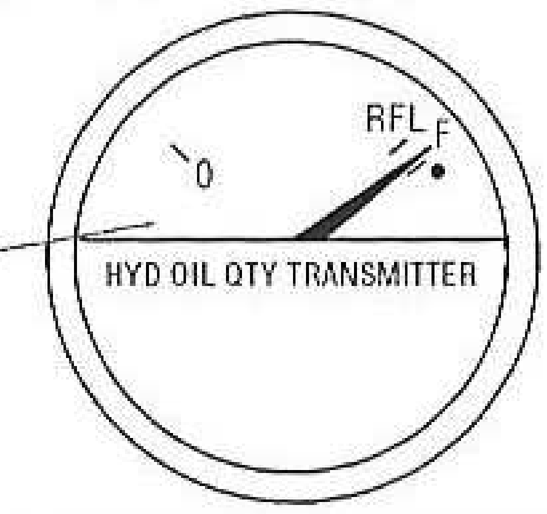
(3-4-5)
- A system
  - RFL (in blue and hard to see)
  - will drop by .8 gal. when gear is retracted
    - 2 needle widths
- B system
  - RFL (in blue and hard to see)
  - will drop by .4 gal. when slats are extended

(NG)
- located on the CDS in percent (0 to 106%)
  - A will drop approx. 15% when gear is retracted
  - B will drop approx. 10% when slats are extended
- Refill indication (RF) illuminated (white)
  - valid only when airplane is on the ground with both engines shutdown or after landing with flaps up during taxi-in



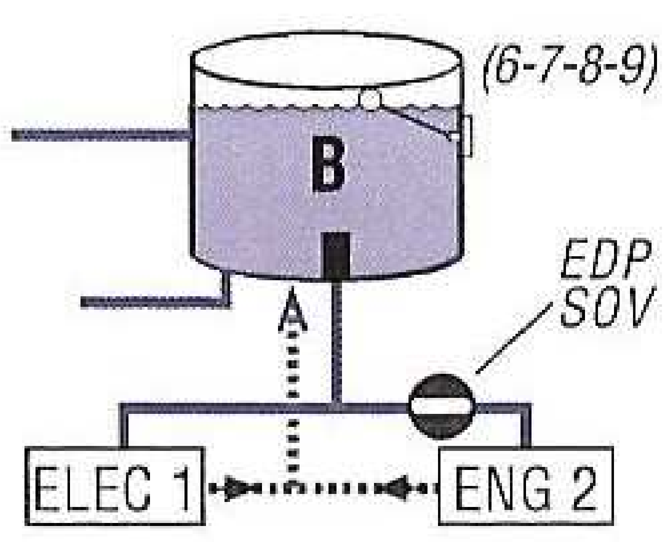
(L/OP) Hydraulic, Min Quantity
- minimum fuel for operation of electric hydraulic pump ground is 250 gal (1,676 lbs) (760 kg) in respective wing tank

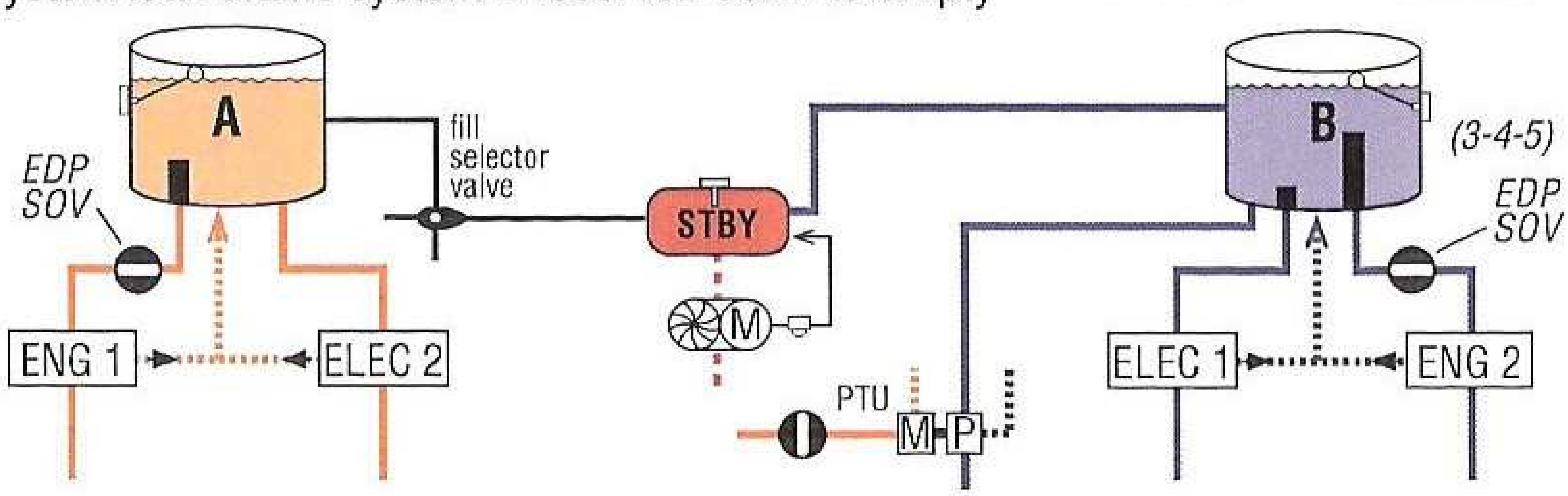
(MEL) System A Quantity Indication - ATA 29
- may be inop provided quantity is verified (reservoir) prior to each departure, system pressure indicator and engine and electric pump low pressure lights operate normally

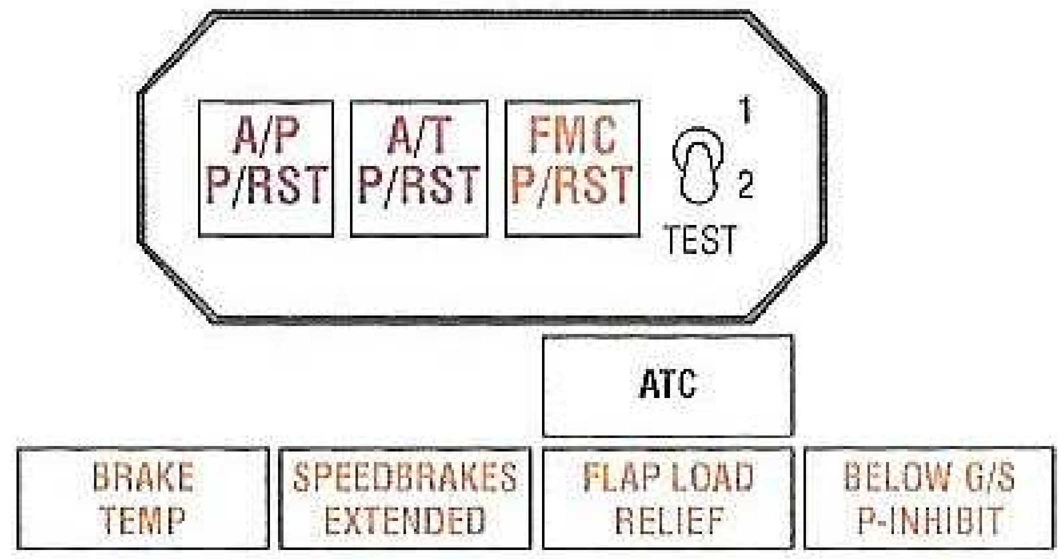


Hydraulic Leak Levels
- SYS A leak levels:
  - EDP leak drains reservoir down to 1/4 full (2.3 gal/20%)
  - electric pump leak drains reservoir down to empty
- SYS B leak levels
  (3-4-5) EDP leak drains reservoir down to 1/2 full
  (3-4-5) electric pump leak drains reservoir down to near empty (enough for PTU)
  (NG) single standpipe in B system. EDP fed through same standpipe as EMDP
  Qty gauge will indicate zero but 1.3 gal remains for PTU
- standby system leak drains system B reservoir down to (3-4-5) 3/4 and (NG) 72%
  - standby hyd LOW QUANTITY light would be illuminated
- PTU system leak drains system B reservoir down to empty

RESERVOIRS		3-4-5 QTY (GAL)	6-7-8 QTY (GAL/L)	CDS
A	Full	4.7	5.7 / 21.6	100%
	Refill	4.2	4.7 / 17.1	76%
	EDP Standpipe		2.3 / 8.5	20%
	Overfill		> 5.7 / 21.6	101-106%
	Total	5.7	6.8 / 25.8	
B	Full	7.2	8.2 / 31.1	100%
	Refill	6.4	6.9 / 26.0	76%
	Fill & Balance		6.6 / 25.1	72%
	EDP / EMDP Standpipe		1.3 / 4.9	0%
	Overfill		> 8.2 / 31.1	101-106%
	Total	8.7	10.7 / 40.6	
STBY	Total	2.8	3.5	



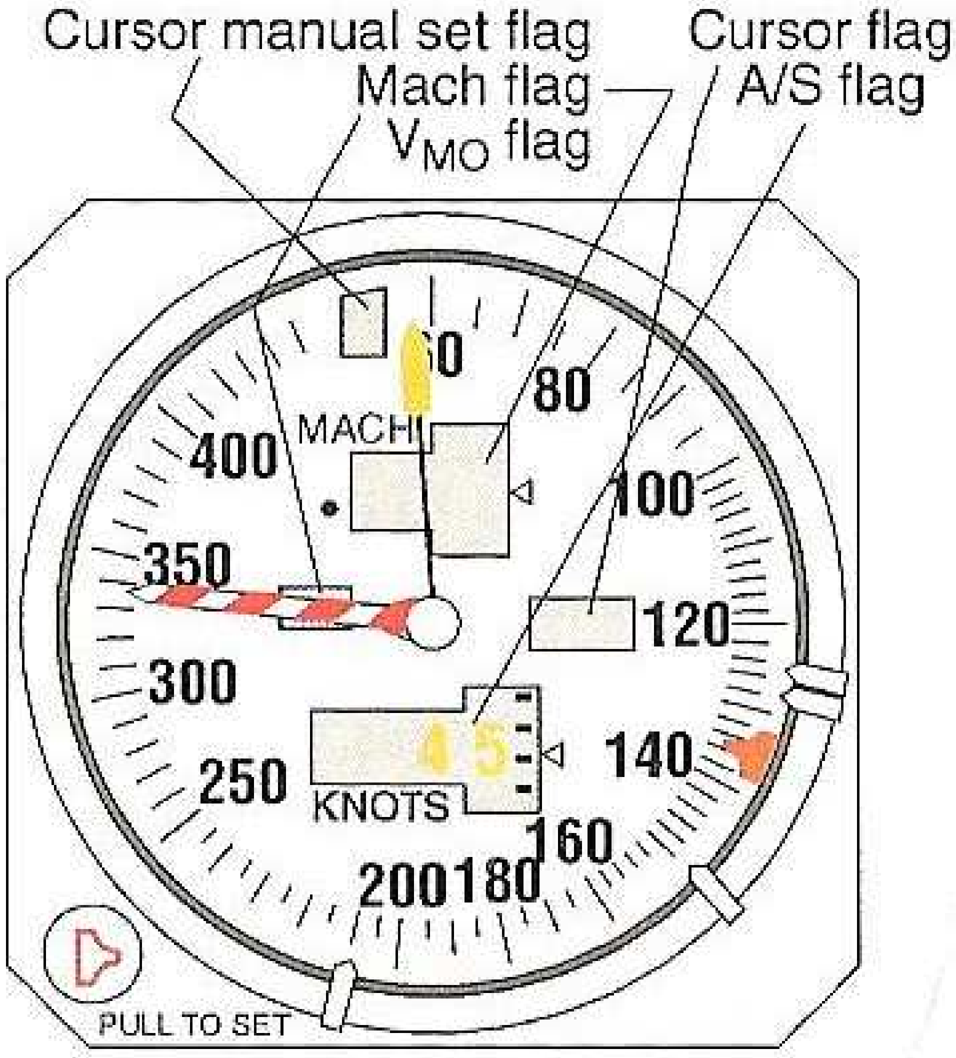




BRAKE TEMP light (amber) (option)
- temperature of one or more brakes is excessive (check multifunction display unit)
- extinguishes when hot brake condition is no longer indicated on the MFD

SPEED BRAKES EXTENDED light (amber) (NG)
- illuminates in flight when
  - the speedbrake lever is beyond the ARMED position,
  - and the trailing edge flaps are extended more than flaps 10, or
  - the radio altitude is less than 800 ft
- illuminates on ground when the ground spoiler interlock valve pressure switch has more than 750 psi, and the speedbrake lever is in the down position
  - these conditions occur if the ground spoiler actuators receive hydraulic power with the speedbrake lever in the down position. This is a failure condition
- controlled by PSEU
- if the SPEEDBRAKES EXTENDED light illuminates in flight, place the speed brake lever in down-detent position
  - if it remains illuminated, spoilers may be extended
  - on the ground, do not take off with the light illuminated

Note: there are four TE flap position switches in the flap control unit:
  - TE flap-up switch (S245)
  - TE flap-down switch (S246)
  - TE flap switch (S1051)
  - flap landing warning switch (S138)
    - S138 operates at the 15 unit position and interfaces with the PSEU for landing gear red lights and aural warning and SPEEDBRAKES EXTENDED light, and the PTU system to disable the automatic operation



MACH / AIRSPEED INDICATOR (3-4-5)

AIRSPEED CURSOR MODE ANNUNCIATOR
  - Auto mode (pushed in): flag out of view
  - Manual mode (pulled out): flag in view

AIRSPEED CURSOR
  - indicates target airspeed
  - positioned manually or automatically, as selected by the Airspeed Cursor Control
  - cursor flag is retracted in manual mode
  - in auto mode, flag (INOP) in view if Airspeed Cursor signals, as determined by the AFDS FCC, are unreliable

AIRSPEED MARKERS (white bugs)
  - positioned manually to the desired airspeed references

MACH DIGITAL COUNTER
  - shows Mach number, from .40 to .99 Mach, in digital form
  - masked below .40 Mach
  - digits are covered by a warning flag (MACH) when the display is unreliable

Airspeed indicator flags (MASI)
  - all flags in view, check the power source
  - single flag either A/S or MACH or VMO flag in-view by itself (no other flags on MASI), replace the indicator
  - A/S Flag In-view (with MACH and VMO Flags), replace ADC
  - MACH and VMO Flags in-view (no OFF flag on Elec Alt), replace indicator
  - MACH and VMO Flags (with OFF Flag on Elec Altimeter), replace ADC

AIRSPEED DIGITAL COUNTER
  - digital display of indicated airspeed in knots
  - warning flag (A/S) covers the counter when the Airspeed Pointer and Airspeed Digital Counter are unreliable

AIRSPEED POINTER
- indicates airspeed in knots

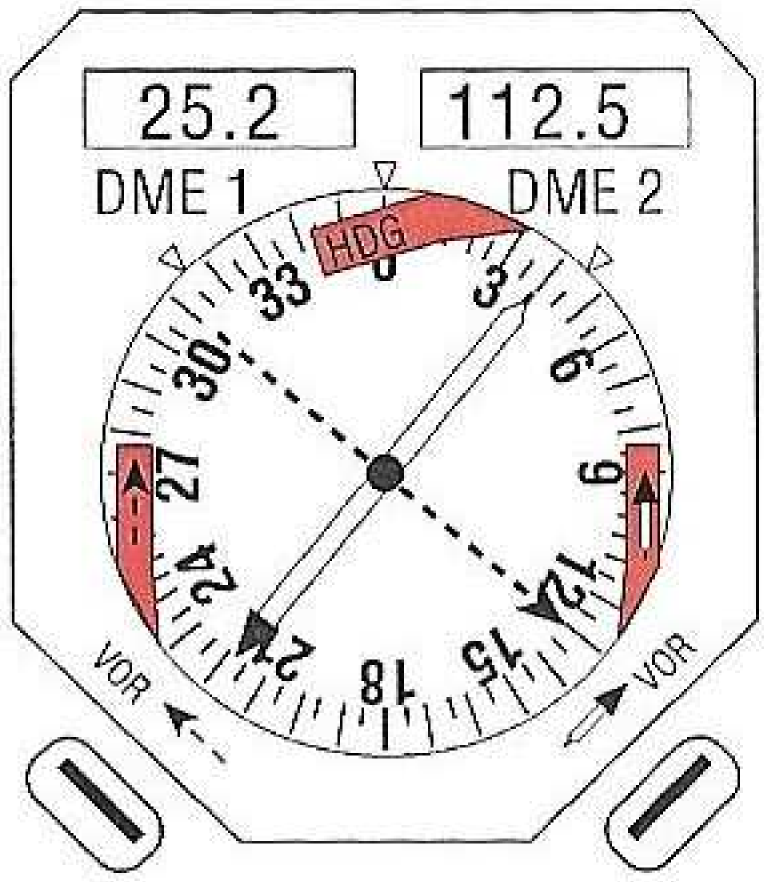
AIRSPEED CURSOR CONTROL KNOB (on airspeed gage)
- PUSH IN - auto mode; airspeed cursor is positioned from the MCP window setting or from the FMC in VNAV. If speed is Mach, it will position to the corresponding Mach
- PULL OUT - manual mode; airspeed cursor is positioned by rotating the knob

VMO POINTER (barber pole needle)
- indicates the maximum operating airspeed in knots
- flag in view (VMO) - indicates the VMO pointer is inoperative

Note: airspeed indicator is electrically powered; inputs from respective ADC

AIR DATA COMPUTER (ADC) (3-4-5)
- Captain pitot system to #1 ADC; FO pitot system to #2 ADC
- #1 ADC supplies Captain instruments; #2 ADC supplies FO instruments
- solid-state device that uses pitot and static pressure and air temperature inputs
- converts these analog inputs to electrical signals used to compute altitude, mach number, and airspeed
- data is sent to the CA and FO's altimeters, altitude alert, autoflight, flight data recorder, Flight Directors, GPWS, mach/airspeed indicators, mach airspeed warning, pressurization controller, transponder, V/S indicators, and yaw damper
- power from transfer buses
- corrects for static pressure source error for the airspeed

(MEL) Air Data Computer - ATA 34
- (3-4-5) both required for CAT II and CAT II Autoland



RADIO DISTANCE MAGNETIC INDICATOR (RDMI) (3-4-5)
- HSI and RDMI compass cards are "ON SIDE"
  - compass card inputs from respective IRS

DME INDICATORS (1 and 2)
- 300 nm maximum search for all DME stations
- "barber pole" warning flag = electrical power lost or invalid DME receiver
- " – I – I – I – " = DME receiver powered but not receiving a DME station or during Agility Tuning

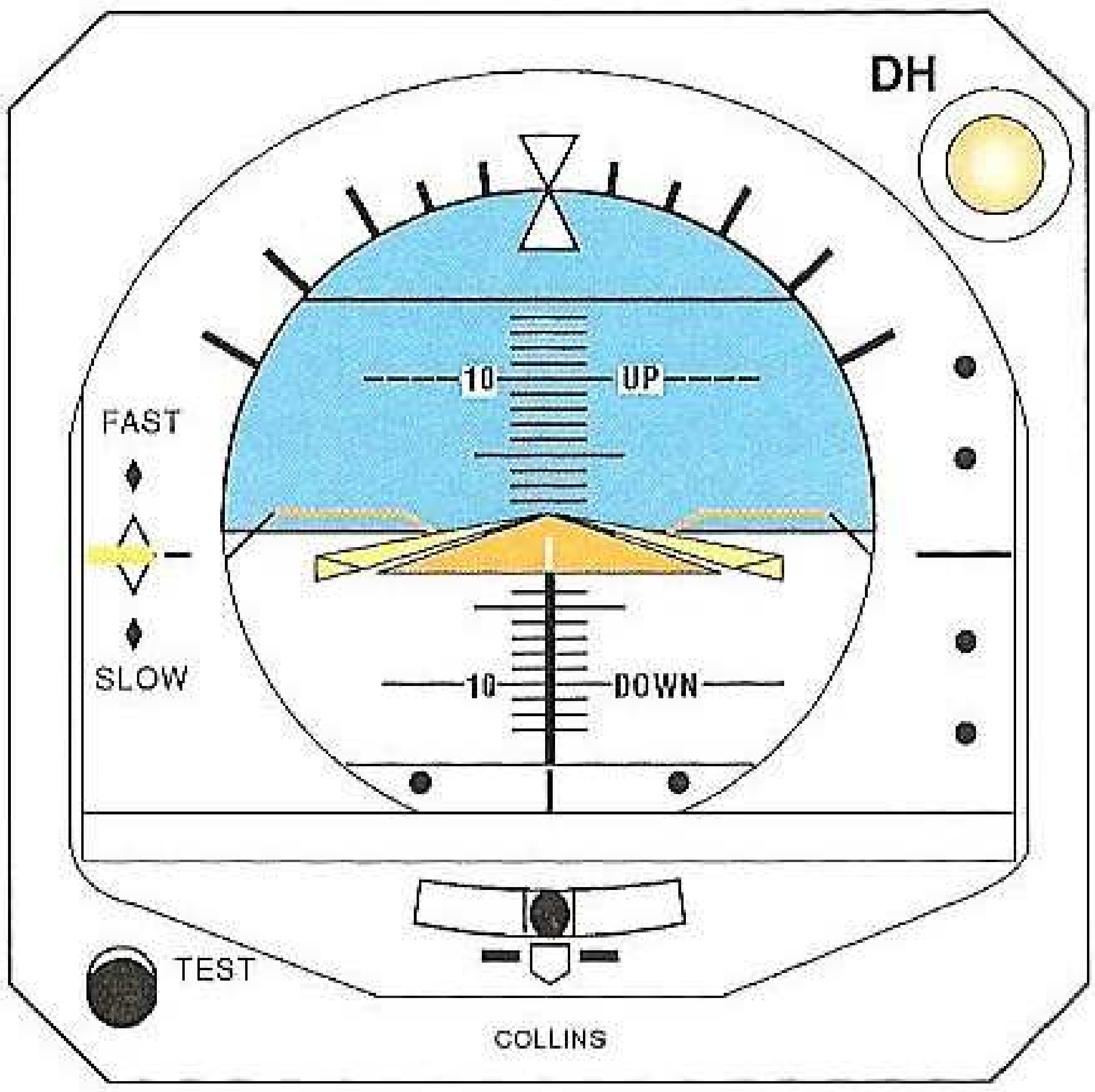
BEARING POINTERS
- narrow pointer: uses signals from the VHF NAV #1 receiver or ADF #1 receiver
- wide pointer: uses signals from the VHF NAV #2 receiver or ADF #2 receiver
- signals to the VOR bearing pointers are not affected by the VHF NAV transfer switch (i.e. if BOTH ON 2, your narrow VOR arrows on both RMDIs are inop)
- the transfer switch has nothing to do with ADF's. ADF #1 always drives narrow needles in RMDIs; #2 always drives wide needles
- ADF / VOR bearing pointer switches
  - press- selects ADF or VOR for the bearing pointer

- all flags in-view indicates a power loss
  - the power loss can be caused by a power failure to the indicator or an internal power supply in the RDDMI

Loss of Heading, HDG flag appears
- move COMPASS transfer switch to BOTH ON 1 or BOTH ON 2, depending on the indicator that is flagged
- if the HDG flag pulls when transfer switch is moved to the secondary compass source then replace the DAA that normally feeds the indicator
- if the HDG flag stays in view when transfer switch is moved, then replace the indicator

Loss of DME (invalid DME signal or power failure)
DME flag appears

Loss of NAV (unreliable signal to pointer or power failure)
flag appears (arrow) on appropriate side



ATTITUDE DIRECTOR INDICATOR (ADI)

- each ADI displays pitch and roll attitudes from respective IRU, left or right
- attitude reference can be supplied in both NAV and ATT IRS modes as selected by the respective IRS mode switch on the aft overhead panel
- Flight Director commands come from respective FCC

Bank indicator and scale
- index indicates roll angle against calibrated scale
- scale has minor markings at 10° and 29° and major markings at 30°, 45°, and 60°

Attitude display
- tape moves relative to symbolic aircraft, displaying pitch and roll signals from the IRS
- pitch up or down scaled in 1° increments to 25°, then every 5° to 80°

Decision Height (amber light)
- illuminated = the radio altimeter altitude pointer is at or below the altitude selected with the decision height cursor control

Glide Slope pointer and scale
- display vertical position relative to the GS

Command Bars (yellow)
- displays computed pitch and / or roll commands
- biased out of view if FD switch turned off

Rate of Turn indicator and shutter (bottom of instrument)
- driven by the on-side IRS through the on-side DAA
- one mark right or left is equal to 3° per second
- IRU must be in NAV mode for shutter to retract and expose rate of turn indicator
- shutter in-view, replace ADI; next, replace on-side DAA

SLIP / SKID indicator
- ball monitors slip or skid for coordination

SLOW / FAST indicator
- receives information from the autothrottle computer
- small diamond represents 5 kts fast or slow
- pointer at FAST or SLOW
  - represents 10 kts fast or slow
- when using "manual" throttle control, indicators show " anticipatory indications;" and you should move throttles to keep the indicators "centered". A centered indicator means proper thrust to capture the commanded speed; fast means too much thrust; slow means not enough thrust

TEST switch
- pressing displays 20° roll to right and 10° pitch up from present attitude
- ATT flag appears

Runway symbol in view
- localizer frequency is tuned and localizer signal is valid
- indicates localizer deviation of one dot or less (one dot is 1° displacement)
- rises toward symbolic aircraft for last 200 ft of radio altitude during LOC or ILS approach if respective radio altitude is valid

ADI FAILURE FLAGS

- a Flight Director failure will be indicated by a CMPTR flag
  - no switching available for this condition; the FD command bar retracts from view

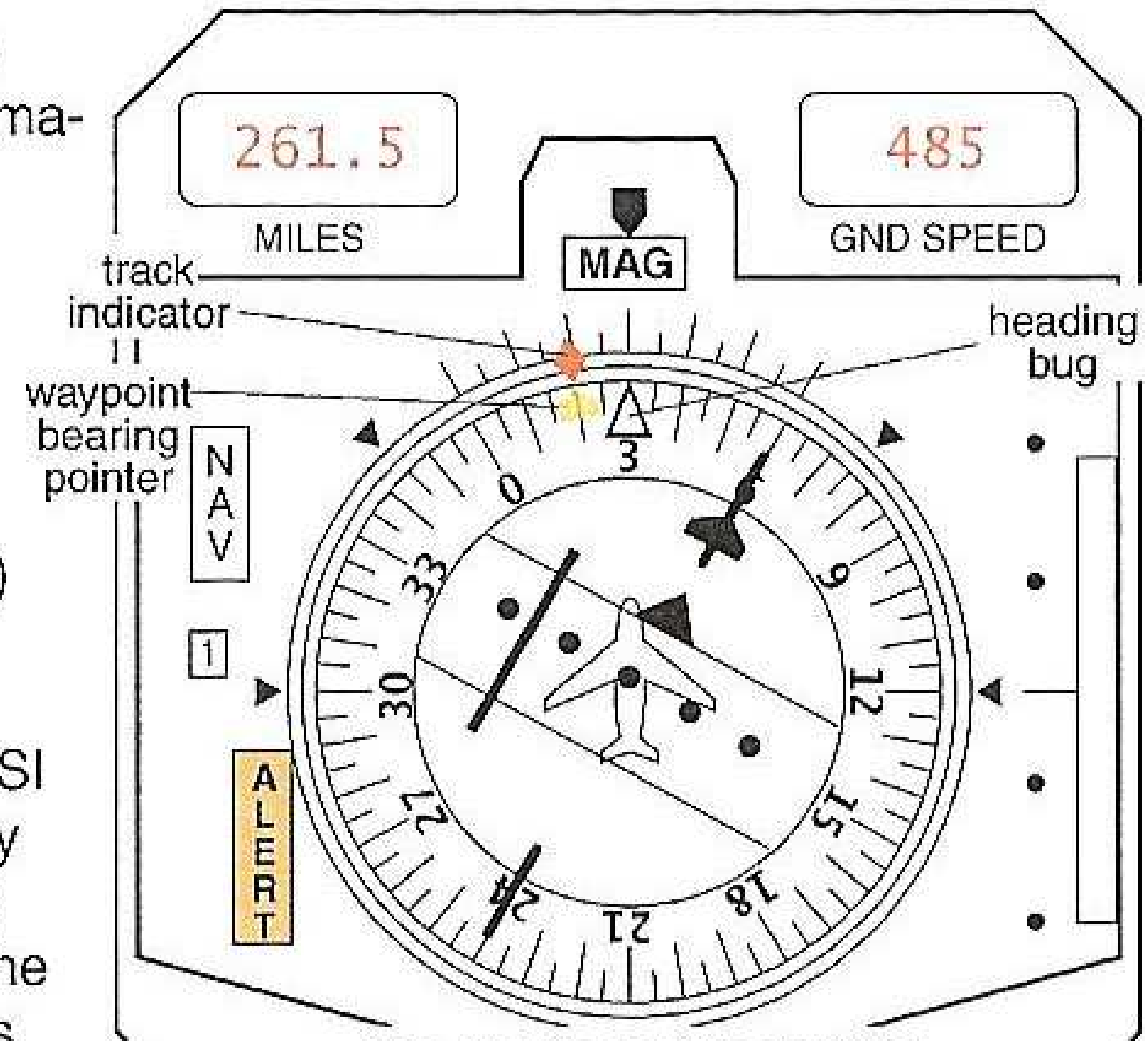
  Computer (CMPTR) Flag
  - the CMPTR flag will be in-view when the Flight Director function of the FCC is invalid or the Flight Director circuitry in the indicator has failed
  - on the Captains ADI only, the CMPTR flag will come into view when the static inverter powers the AC Standby Bus
- if the autothrottle system is inop a SPEED flag will appear on left side
- if the IRS fails to provide rate signal, a shutter covers the rate of turn indicator
- all five flags in-view indicates a power loss. The power loss can be caused by a power failure to the indicator or an internal power supply in the ADI
  - if power is available at the cannon plug then replace the indicator
  - the Captains ADI receives power from the 115v AC standy bus. If this bus is not powered you will get all flags in-view on the Captains ADI and HSI, and the F/O's RDMI. If this happens check the standby power switch. Lift the cap and ensure that the switch is fully in the AUTO position. This switch has a tendency to hang up between OFF and AUTO when the cap is closed
- if an IRU fails to generate attitude information or if the instrument fails, an ATT flag appears in that ADI
  - the IRS transfer switch is used to place the failed ADI to the good unit

  Attitude Flag (ATT)
  - before trouble shooting an ATT flag, make sure the IRUs are in NAV mode, the fault light on the MSU is not illuminated, and status codes 02, 05 or 06 are not displayed on the ISDU. If the fault light is on and/or any of these codes are indicated, trouble shoot the IRU or DAA first

  ATT flag In-view:
  - move IRS transfer switch to BOTH ON 1 or BOTH ON 2 (depending on the indicator that is flagged)
  - if the ATT flag pulls when transfer switch is moved to the secondary attitude source then replace the DAA that normally feeds the indicator
  - if ATT flag stays in view when transfer switch is moved to the secondary source then replace the indicator
- when a nav failure occurs, a RUNWAY or GS flag appears
  - use the VHF NAV transfer switch to restore nav information
- the runway and glideslope flags, runway symbol, and GS pointer are biased out-of-view when a VOR frequency is tuned
  - tuning an ILS frequency causes them to bias into-view.
  - with a valid glide slope signal, the GS flag will bias out-of-view exposing the GS pointer
  - with a valid localizer signal, the funway flag will bias out-of-view, and the runway symbol with come into view. The runway symbol moves left and right to indicate localizer deviation, and starts to rise as the airplane descends below 200 feet radio altitude.
  - the vertical movement of the runway symbol is controlled by the on-side Radio Altimeter R/T unit. The RUNWAY flag circuit does not look at the radio altitude signal, only the localizer input and the indicator itself
- RUNWAY Flag In-view:
  - place the HSI selector switch in the VOR/ILS position and observe the NAV flag on the HSI directly below the ADI with the RUNWAY flag in-view:
  - if the NAV flag is not in-view on the HSI, then the problem is with the ADI
  - if the Runway flag on the ADI and the NAV flag on the HSI are both in-view, then you have a source problem. Do the following to verify:
    - for both the RUNWAY flag and the GS flag, move the VHF NAV transfer switch to BOTH ON 1 or BOTH ON 2 and observe the Runway flag on the ADI and Nav flag on the HSI. If both flags pull from view, then the normal source feeding those indicators is at fault. Proceed to trouble shoot the VHF Nav receiver

- GS Flag In-view:
  - place the HSI selector switch in the VOR/ILS position and observe the VERT flag on the HSI directly below the ADI with the GS flag in-view
    - if the VERT flag is not in-view on the HSI, then the problem is with the ADI
    - if the GS flag on the ADI and the VERT flag on the HSI below are both in-view, then you have a source problem

HORIZONTAL SITUATION INDICATOR (HSI)



This graphic depicts a/c flying directly to a wpt. How can you tell? The track indicator is right on top of the wpt bearing pointer.

- HSI and RMI cards receive heading information from respective IRU

MILES DISPLAY
  - with HSI switch in NAV, shows miles to next waypoint and generated by the FMC
  - if power loss or with HSI switch in VOR/ILS or NAV shows blank ("   ")
  - if no computed data is present, shows dashes ("– – – –")
  - if the FMC data is not available both HSI displays will be affected and will display dashes. If only one of the HSI displays indicates dashes, the on-side DAA is the most likely cause. If the miles display is blank, the indicator is the likely problem.

GROUND SPEED DISPLAY
  - if power loss, shows blank ("   ")
  - if no computed data is present, shows dashes ("– – – –")
  - on the ground, groundspeeds from IRS; inflight speeds from FMC
  - the source of ground speed information displayed on the HSI depends on the position of the HSI selector switch
    - with the HSI switch in VOR/ILS the on-side IRU is the source of ground speed
    - with the HSI switch in NAV the FMC is the source of ground speed
    - the ground speed data from the IRU and the FMC both go through the on-side DAA that feeds the respective HSIs. With the on-side IRU in NAV and the FMC functioning normally, if ground speed data is not present with the HSI switch in either VOR/ILS or NAV, dashes will be in-view on the gnd speed display. Replace the on-side DAA first. If the gnd speed display is blank, the problem is most likely the indicator.

HEADING BUG (white triangle)
  - displays heading as set by Heading Selector

TRACK INDICATOR / DRIFT ANGLE POINTER (orange diamond)
  - controlled by either the IRU or the FMC
  - with the HSI selector switch in VOR/ILS the source is the IRU
  - with the switch in NAV the source is the FMC
  - the inputs from the IRU or the FMC go through the on-side DAA first
  - there is a mask at 6 o'clock. The pointer will stow behind the mask if the source signal is non-computed data, failed, or if the indicator circuit is failed
  - it is normal for the pointer to be stowed behind the mask on the ground
  - pointer moves to and stays at the bottom of the HSI when track angle source is lost

COURSE POINTER
  - HSI switch in VOR / ILS - the pointer is set with the course selector on the MCP
  - HSI switch in NAV - the pointer is set automatically by the FMC

VERTICAL DEVIATION POINTER and SCALE
  - HSI switch in VOR / ILS - indicates displacement above and below GS
  - pointer in view when LOC frequency is tuned and HSI is powered
  - HSI switch in NAV - path deviation from FMC. 1 dot = ±400' from vertical path

WAYPOINT BEARING POINTER (yellow bug)
- HSI switch in VOR / ILS
  - the pointer stows at the 3 o'clock position when the HSI in the VOR/ILS mode
- HSI switch in NAV
  - indicates relative bearing of the next FMC waypoint in the active route
    - signal generated by the FMC and is read relative to the compass card
- if the bearing pointer on both HSIs fail to work, the FMC is the likely problem
- if the bearing pointer fails on only one of the HSIs then it's either the indicator or the on-side DAA

NAV DATA SOURCE INDICATOR
- "VOR / ILS" - the VOR or ILS is supplying course deviation information
- " NAV" - the FMC is supplying course deviation information
- "1 or 2" - source of navigation: VHF NAV 1 or 2, FMC 1

ALERT ANNUNCIATOR (amber)
- signal generated by FMC
- illuminates 10 secs before course change (waypoint passage)

COURSE DEVIATION BAR
- VOR: 1 dot = 5°
- LOC: 1 dot = 1°
- NAV: 1 dot = 2 nm cross-track deviation

HSI FAILURE FLAGS

All Flags In-view indicates a power loss
- the power loss can be caused by a power failure to the indicator or the internal power supply in the HSI
  - if power is available at the cannon plug then replace the indicator
- the Captains HSI receives power from the 115v AC STBY Bus. If this bus is not powered you will get all flags in-view on the Captains ADI and HSI, and the F/O RDMI. If this happens check standby power switch. Lift the cap and ensure that the switch is fully in the AUTO position. This switch has a tendency to hang up between OFF and AUTO when the cap is closed

HEADING FAILURE FLAG (HEADING)
- the selected compass is invalid or the HSI has lost power

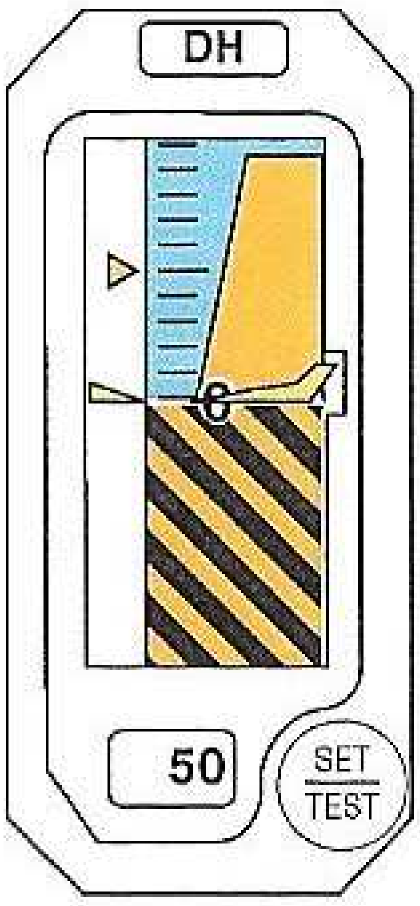
HDG Flag In-view:
- move COMPASS / IRS transfer to BOTH ON 1 or BOTH ON 2, depending on the indicator that is flagged
  - if the HDG flag pulls when the transfer switch is moved to the secondary compass source then replace the DAA that normally feeds the indicator
    - the DAA that normally feeds heading information to the respective HSI also sends data to the opposite RDMI on most classics
  - if the HDG flag stays in view when the transfer switch is moved then replace the indicator

NAVIGATION FAILURE FLAG (hatch marks)

NAV Flag
- the source that affects operation of the NAV flag is determined by the position of the HSI source selector switches. With the HSI switch in VOR/ILS, the flag circuit is tied to the VHF Nav receiver. With the HSI switch in NAV, the flag circuit is tied to the FMC through the DAA
- HSI switch in VOR / ILS: VHF nav signal is not being received
- HSI switch in NAV: FMC failure to provide navigation signal to the HSI
- Note: this flag is critical; i.e., if on an ILS loc, with CDI centered, and get this flag, you may not realize you have no localizer info! You must transfer to a good nav receiver

VERTICAL FAILURE FLAG (VERT)
- HSI switch in VOR / ILS: LOC frequency set and GS signal not being received
- out of view with VOR frequency set
- HSI switch in NAV: FMC failure to provide path Deviation signal

Note: if the VHF NAV transfer is Both On 1 or Both On 2, the CDI is referenced to the respective receiver and must be set by that course selector



RADIO ALTIMETER

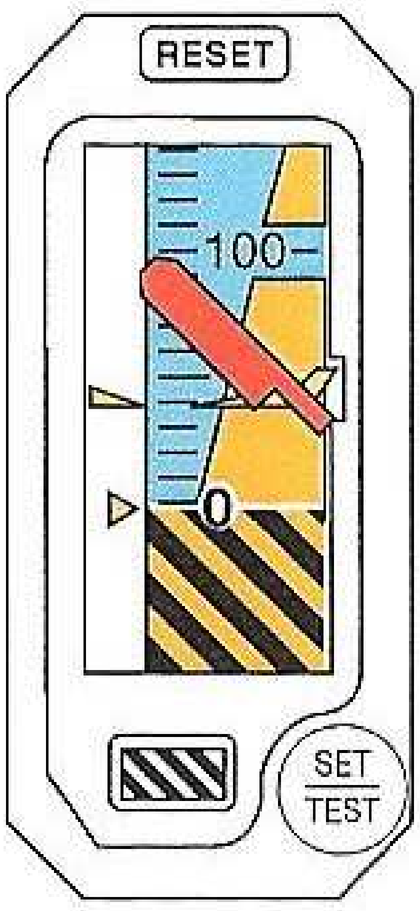
DECISION HEIGHT POINTER (amber triangle)
- moves in response to rotation of set switch
- after pointer is set, moves with altitude tape

DECISION HEIGHT indicator (example: 50 ft)
- shows decision height selected by the set switch
- range of 0 to 499 ft

RESET button
- extinguishes the decision height light on the ADI

ALTITUDE TAPE
- moveable tape is read against altitude reference line

DECISION HEIGHT light (option - DH or RESET)
- illuminated when airplane descends through the altitude at which the decision height pointer is set (DH)
- push to extinguish



ALTITUDE REFERENCE LINE (two pointers, left and right sides)
- altitude tape moves past stationary reference line showing actual height above ground up to 2500'

SET / TEST switch

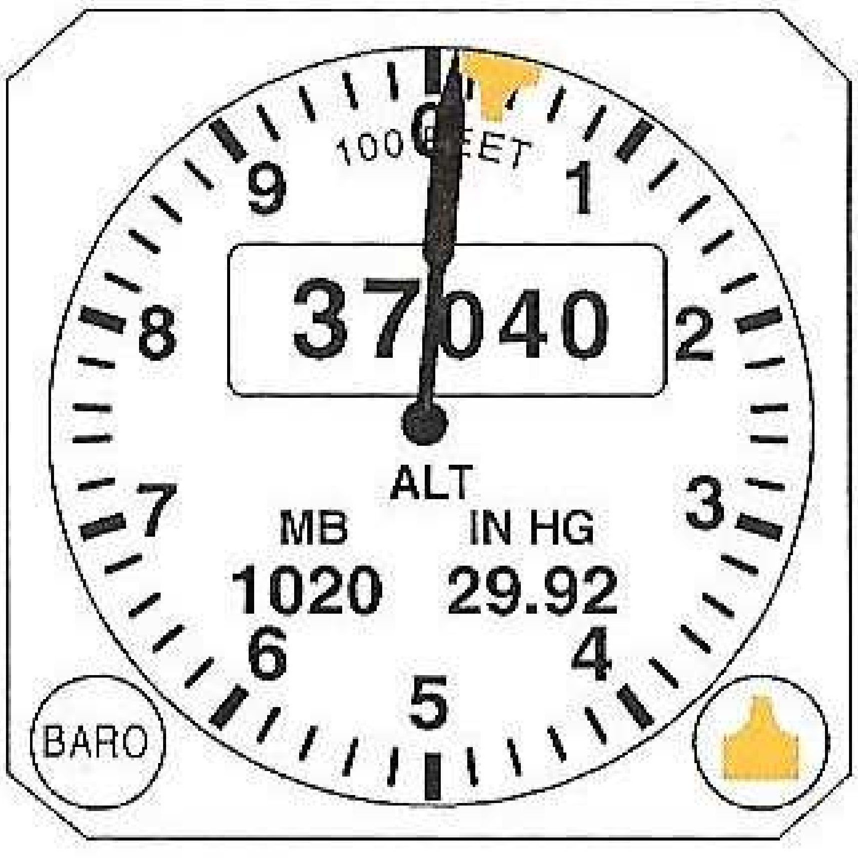
SET - rotation causes DH pointer to move along tape
- DH altitude is shown on DH indicator

TEST - when pushed, altitude tape drives to 40 ±5 feet, warning flag appears, and DH light illuminates

Radio Altimeter Flag
- in view when TEST switch is pressed, or power off, or altitude signal is not valid

OFF flag In-view (Rising runway function on ADI operates normally), replace indicator
OFF flag In-view (Rising runway function on ADI does not work), replace R/T unit

ALTIMETER (3-4-5)



- electric, for Captain and FO
- range of -1,000 to 50,000 ft
- electric power; inputs from respective ADC
- range of -1,000 ft to 50,000 ft
- standby altimeters do not meet altimeter accuracy requirements of RVSM airspace

(L/OP) Instr. and Nav, Altimeter Differences

Max difference between:

(3-4-5)

ALTITUDE	ELEC / PNEU	ELEC / ELEC
Sea level	50 ft	50 ft
5,000 ft	80 ft	50 ft
10,000 ft	120 ft	60 ft
20,000 ft	220 ft	80 ft
30,000 ft	280 ft	120 ft
35,000 ft	350 ft	140 ft

(L/OP) Instr., Altimeter Differences-RVSM

- Max difference on ground between:

FIELD ELEV.	CAPT vs FO	CA or FO vs field elevation
SL	40 ft	75 ft
5,000 ft	45 ft	75 ft
10,000 ft	50 ft	75 ft

- Max allowable in-flight difference between Captain and FO altimeters for RVSM operations is 200 ft

DIGITAL COUNTER
- displays altitude in increments of thousands, hundreds, and twenty feet
- warning OFF flag appears whenever the ADC signal is lost or malfunction exists
- green flag appears in the left window when altitude is below 10,000'
- a NEG flag appears in the two left-hand windows when altitude below zero

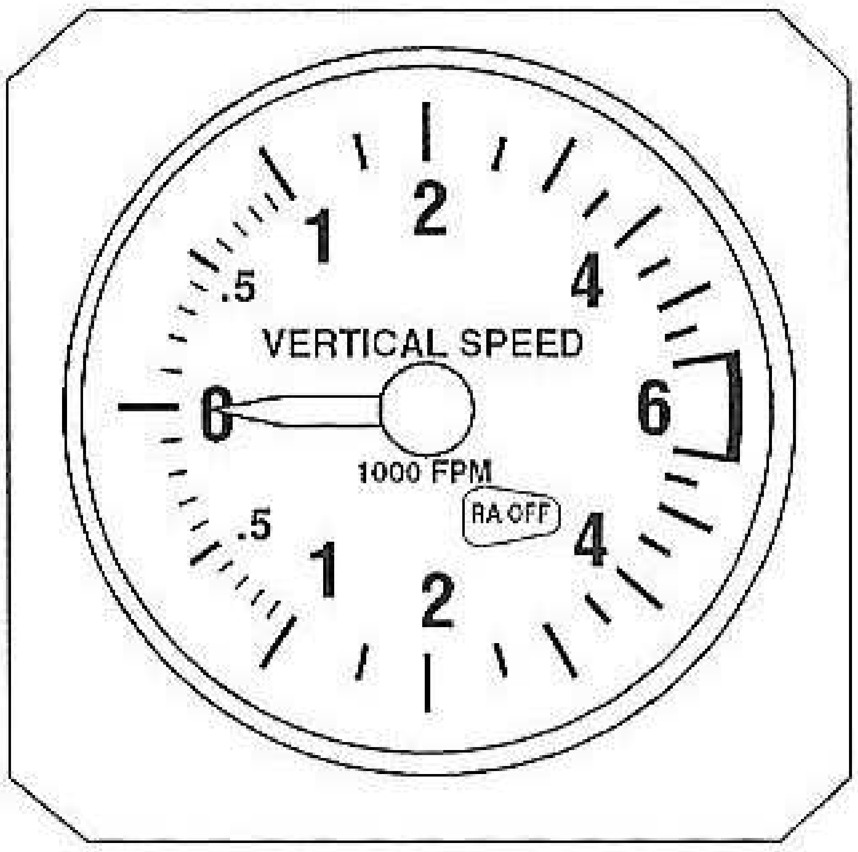
ALTITUDE POINTER
- makes one revolution each one thousand feet

BAROMETRIC SETTING WINDOW
- reflects barometric correction (in inches and millibars) as set by the BARO knob

REFERENCE ALTITUDE MARKER control knob
- manually sets reference altitude marker

Altimeter OFF flag indicates failures associated with the indicator, the source information from the ADC to the indicator, or a power failure. Using the MACH and VMO flags on the corresponding Mach Airspeed Indicator will help you determine whether the problem is with the indicator or the source data to the indicator
- OFF flag In-view (no Flags On MASI), replace indicator
- OFF flag In-view (with MACH and VMO Flags On MASI), replace ADC

VERTICAL SPEED INDICATOR (3-4-5)
- displays IRS instantaneous vertical speed
- the captain's and FO's VSI's receive vertical speed data from both IRU 1 and IRU 2
- depicts inertial vertical speed rate of climb or descent from 0 to 6,000 fpm
- the scale is expanded between 0 and 1000 fpm for better resolution of vertical speed in low operating ranges
- OFF flag in view if the air data computer altitude rate signal is lost, or a malfunction exists



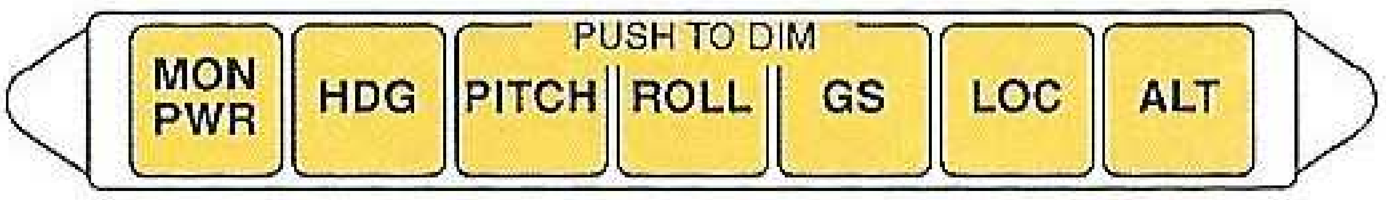
STATIC SOURCE SELECTOR SWITCH (non-EFIS)
- located on the Captain (below the tiller) and F/O sidewalls

NORMAL (guarded position)
- the primary pitot-static system is providing static inputs to the respective ADC system

ALTERNATE
- the alternate static system provides static inputs to respective ADC left side selector
- alternate static system selected to standby altimeter and airspeed indicator
- (EFIS) or (NG): not installed. Capt always on #1 ADC, F/O always on #2 ADC

INSTRUMENT COMPARATOR TEST switch (bottom of Captain's panel)
- pressing illuminates all instrument comparator lights (except MON PWR; need to pull its CB to check it) and verifies circuit continuity
- required for first flight of day check

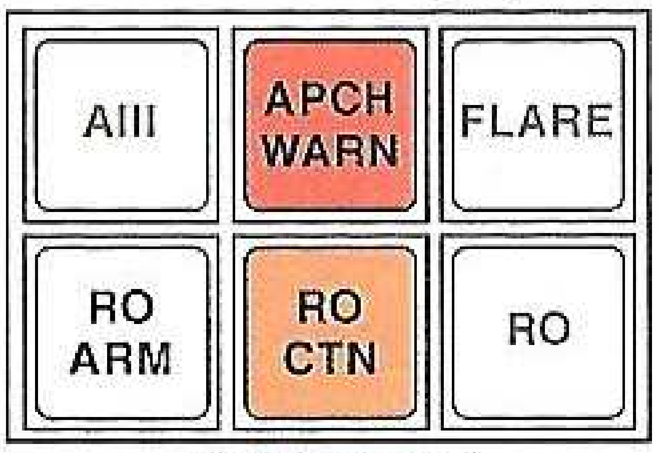
INSTRUMENT COMPARATOR



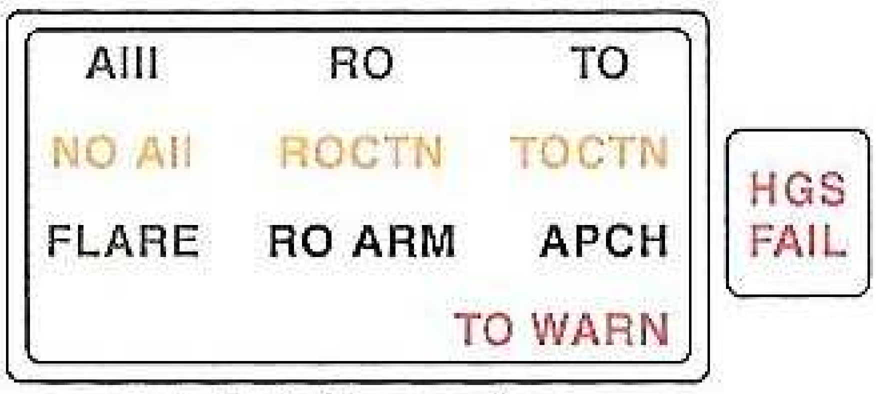
INSTRUMENT COMPARATOR lights
- MON PWR - illuminates = 115V AC power loss to the comparator unit
- HDG, PITCH, ROLL, GS, LOC, ALT - illuminates = respective instruments being compared have exceeded established tolerances
- to dim, press the bar
- tolerances between Captain's and FO'S instruments:
  - ADI PITCH AND ROLL: 4° or 3° if GS captured
  - HSI HEADING: wings level: 6° or 20° bank: 10° or GS captured: 4.5°
  - NAV UNITS 1 and 2 GS: 1 dot
  - NAV UNITS 1 and 2 LOC: 1/2 dot
  - Radio Altimeter limits
    - below 2500 ft - 65 ft; below 500 ft - 50 ft; below 100 ft - 6 ft

HUD ANNUNCIATOR PANEL

3 light panel



6 light panel



9 light panel

AIII light
- illuminated (green) = AIII mode is active and all required systems and equipment are valid

APCH WARN light
- illuminated (red) = system or approach conditions out of tolerance

FLARE light
- illuminated (green) = HUD system derived flare guidance is active

HGS FAIL light
- illuminated (red) = indicates HGS failure below 500 ft AGL
- push to extinguish
  - will not illuminate again until failure is cleared and another failure occurs
  - resets system for another failure

NO AIII light
- illuminated (amber) = loss of AIII capability above 500 ft AGL

RO ARM light
- illuminated (white) = HUD system capable of providing ground roll guidance during rollout
- displayed prior to touchdown during an AIII approach

RO CTN light
- illuminated (amber) = rollout guidance capability lost during the last 500 ft of an AIII approach or during landing rollout

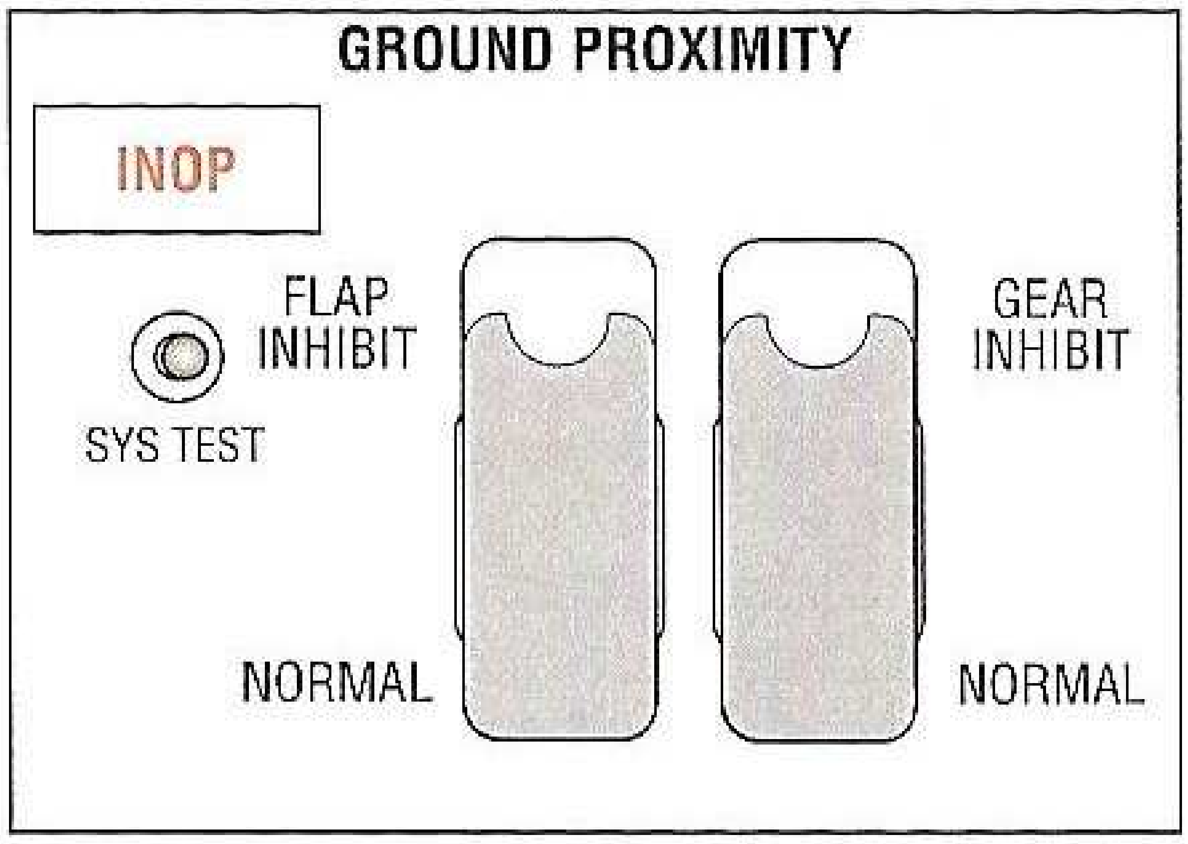
RO light
- illuminated (green) = rollout guidance is active

TO light
- illuminated (green) = displayed only during maintenance test

TO CTN light
- illuminated (amber) = displayed only during maintenance test

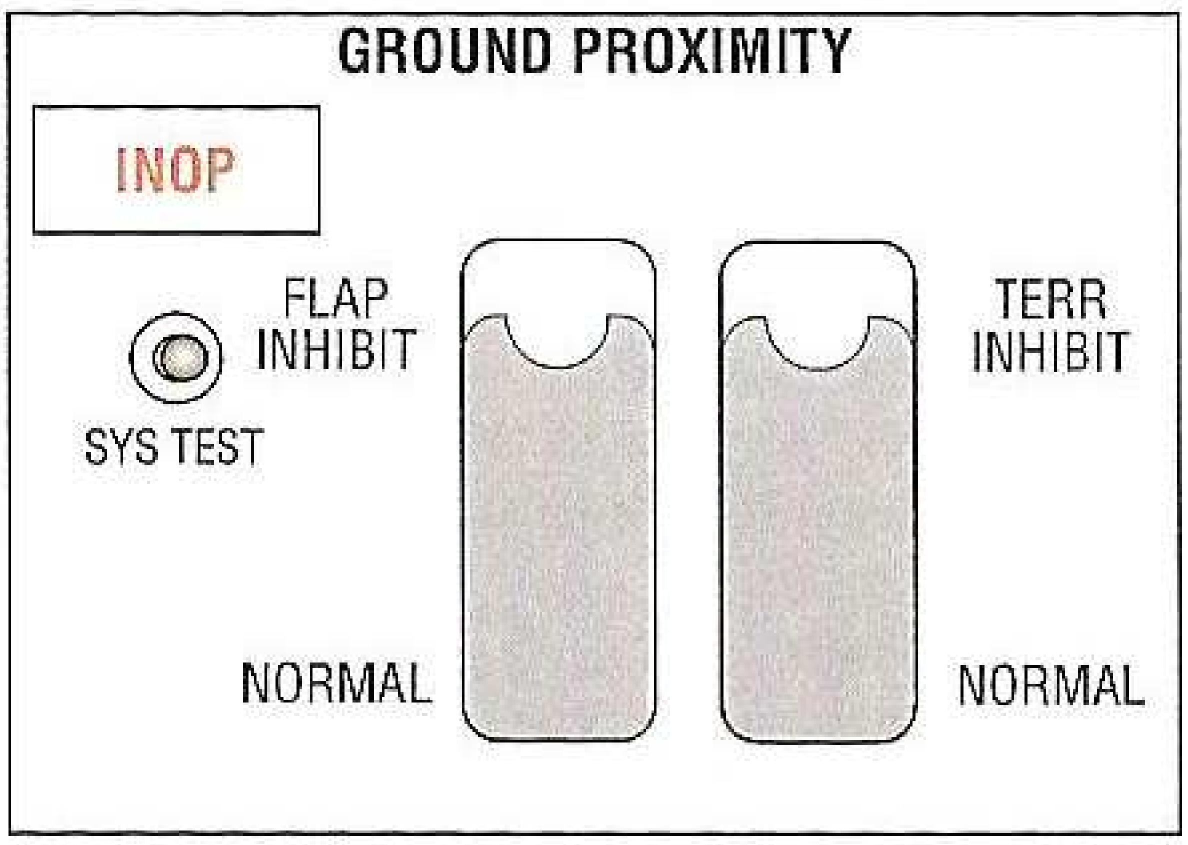
TO WARN light
- illuminated (red) = displayed only during maintenance test

GPWS

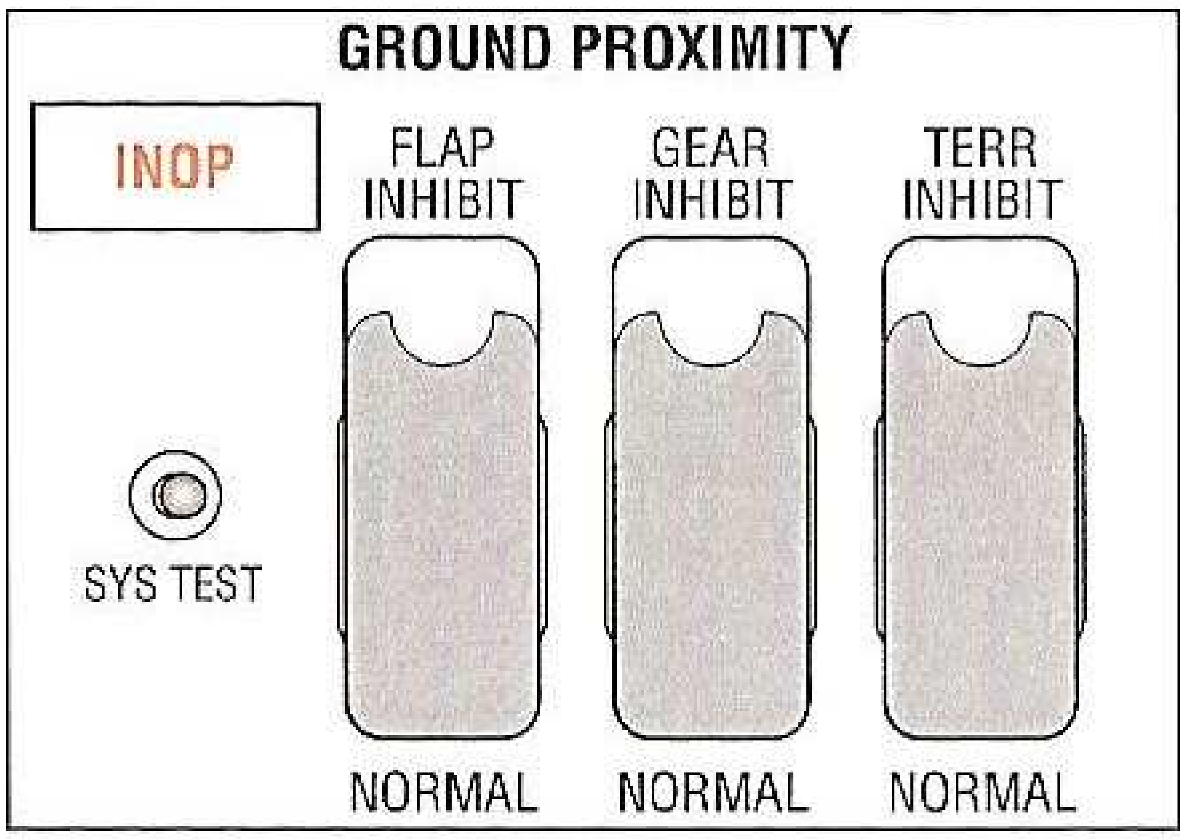


INOP light (amber)
- power lost or GPWS (EGPWS) computer malfunction or,
- invalid inputs from RA, ADC, ILS, IRS, FMC, SMYD, or displays control panel

TEST BUTTON
- test on ground or above 1000' RA (EGPWS inhibited in flight)
- runs through GPWS warning in 1 through 7 modes
- PULL UP lights illuminate and WINDSHEAR annunciation occur
- BELOW G/S and INOP lights illuminate
- "PULL UP", "WINDSHEAR", and "GLIDESLOPE" aural warnings sound
- if held for longer than a few seconds, above indications occur first, followed by any additional aurals



EGPWS option
  - TERR FAIL and TERR TEST show on nav display
  - terrain display test pattern shows on nav display
  - "TERRAIN CAUTION" aural sounds and TERRAIN CAUTION message shows on nav displays
  - TERR map switch turned on by test



FLAP INHIBIT switch

FLAP INHIBIT
  - inhibits or cancels warnings caused by flaps not in landing configuration (30 or 40)
    - simulates flaps in landing configuration
  - do not use (or pull CB) unless specific procedure required to land with flaps in non standard landing positions
  - will illuminate the INOP light if placed to INHIBIT above 250 kts but functions normally
    - when speed is reduced below 250 kts, the INOP light goes out

NORMAL - flap position logic active ("TOO LOW FLAPS")

GEAR INHIBIT switch

GEAR INHIBIT
  - inhibits or cancels warnings caused by landing gear not down
    - simulates gear down

NORMAL - landing gear position logic active ("TOO LOW GEAR")

TERR INHIBIT switch

TERR INHIBIT
  - inhibits look-ahead terrain (caution and warning) alerts and terrain display

NORMAL - terrain (caution and warning) alerts and terrain display is active

GPWS Modes

- provides pilots with aural and visual warning of potentially dangerous flight path
- #1 VHF NAV, RA, IRU, stall warning computer, ADC, FMC, flap and gear switches
- 1 thru 4 are Terrain Avoidance and gives PULL UP light

PULL UP

PULL UP warning light (red)
  - illuminated indicates one of following conditions:
  - excessive descent rate, excessive terrain closure rate, altitude loss after takeoff or go-around, unsafe terrain clearance when not in landing config.

MODE 1
  - excessive descent rate based on radio altimeter and sink rate
  - ***"sink rate"*** as well as ***"whoop whoop pull up"*** if sink continues

MODE 2 (A and B)
  - not in landing configuration or level / too shallow climb towards rising terrain
    2A = terrain closure rate with flaps not in landing configuration
    2B = excessive closure rate
  - ***"terrain, terrain"*** then ***"whoop whoop pull up"*** if closure continues
    - caution stops after climbing 300'
  - no ***"pull up"*** when in landing configuration. Do hear ***"terrain"***
  - mode 2 warnings are inhibited below 50 ft RA

MODE 3
  - altitude loss after takeoff or go-around (armed between 50' and 700')
  - visual pull up and aural alert ***"don't sink"***
  - silence with pullup

MODE 4
  - unsafe altitude while not in landing configuration (armed above 700' after takeoff)
    - gear lever up is mode 4A and flaps not in landing configuration is mode 4B
  - ***"too low terrain"*** (< 1000') and pull up light, changes to ***"too low gear"*** (< 500 ft)
  - ***"too low terrain"*** (< 1000') and pull up light, changes to "too low flap" (< 200 ft)
  - use ground proximity switch for partial flap landing or gear up landing

MODE 5

amber BELOW G/S P-INHIBIT

  - excessive deviation below the glideslope
  - armed when #1 glideslope receiver has a valid signal and aircraft is < 1,000 ft RA
  - excessive deviation below an ILS GS (1.3 dots) between 1000 ft and 150 ft

  BELOW GLIDE SLOPE GPWS alert light (amber)
    - pressing inhibits or cancels if pressed while in the alerting area (50' to 1,000' RA)
    - as RA decreases or glide slope deviation increases rate of warning increases
    - all at half volume (full volume if well below)

MODE 6
  - descent below selected minimum radio altitude, ***"minimums"*** between 50' - 1000', for Cat II only
  - on EFIS aircraft: from 1000' down to 10' (landing gear down), also have aural alerts ***"bank angle"*** (if over 35°) and
    - aural RA callouts: "100, 50, 40, 30, 20, 10 "
    - (option) "2500" (RA) "1000" (baro), "500" (RA)

Reactive WINDSHEAR

MODE 7 (Reactive windshear mode)
  - windshear encountered (operates from 50' to 1500' RA) gives ***"windshear, windshear"*** and WINDSHEAR light

  ACTIONS:
  - hit TOGA to get Flight Director bars
  - for all ***"Whoop Whoop Pull Up", "Terrain",*** and / or ***"Configuration"*** warnings, do a Go Around!
  - for all other warnings, pull up until warning stops
  - this light is not on "glass" series aircraft (incorporated into the EADI symbology)

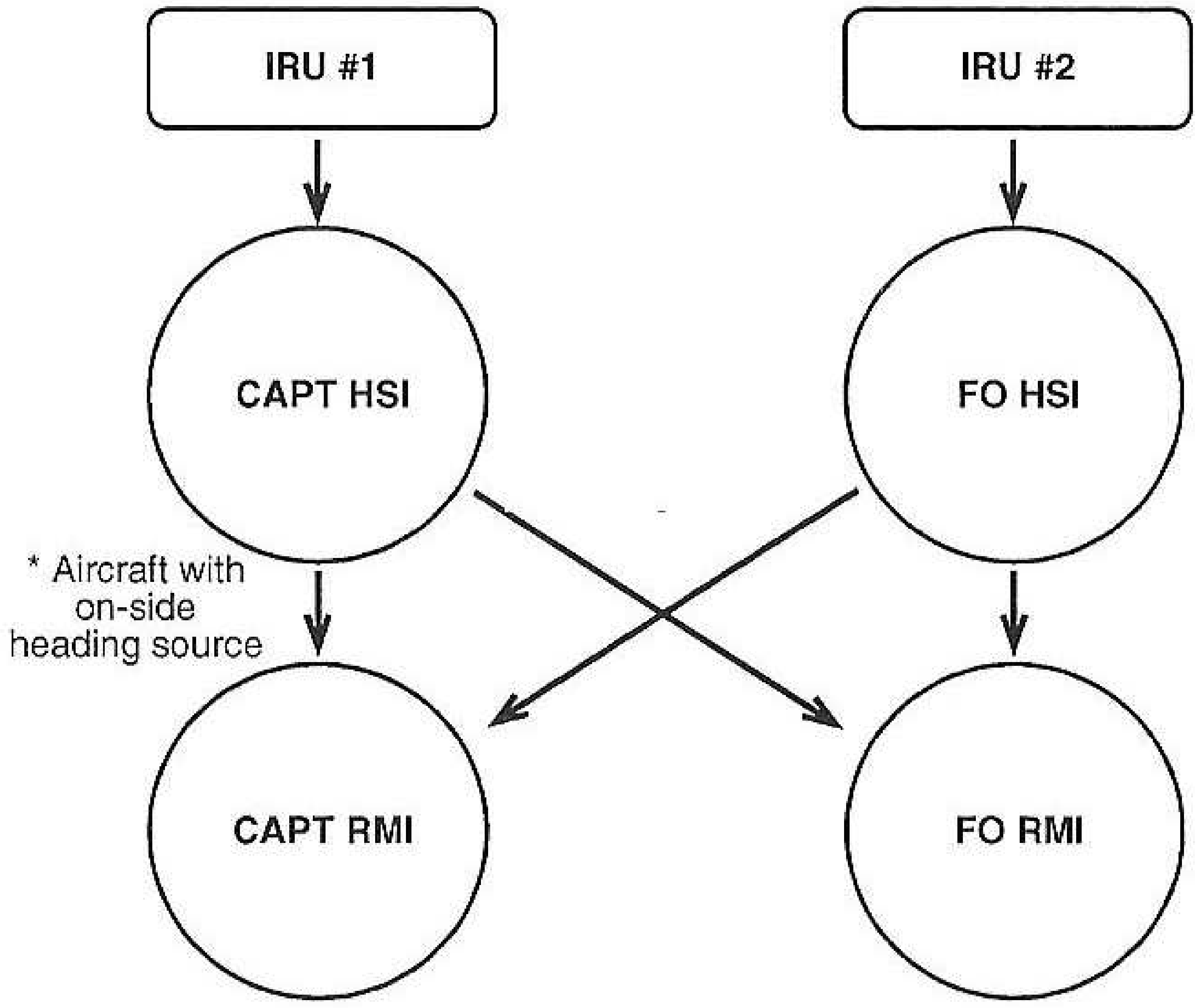
Priority: ***windshear, whoop whoop pull up, terrain, too low-terrain, too low-flaps, sink rate don't sink, glideslope***

GPWS System Notes

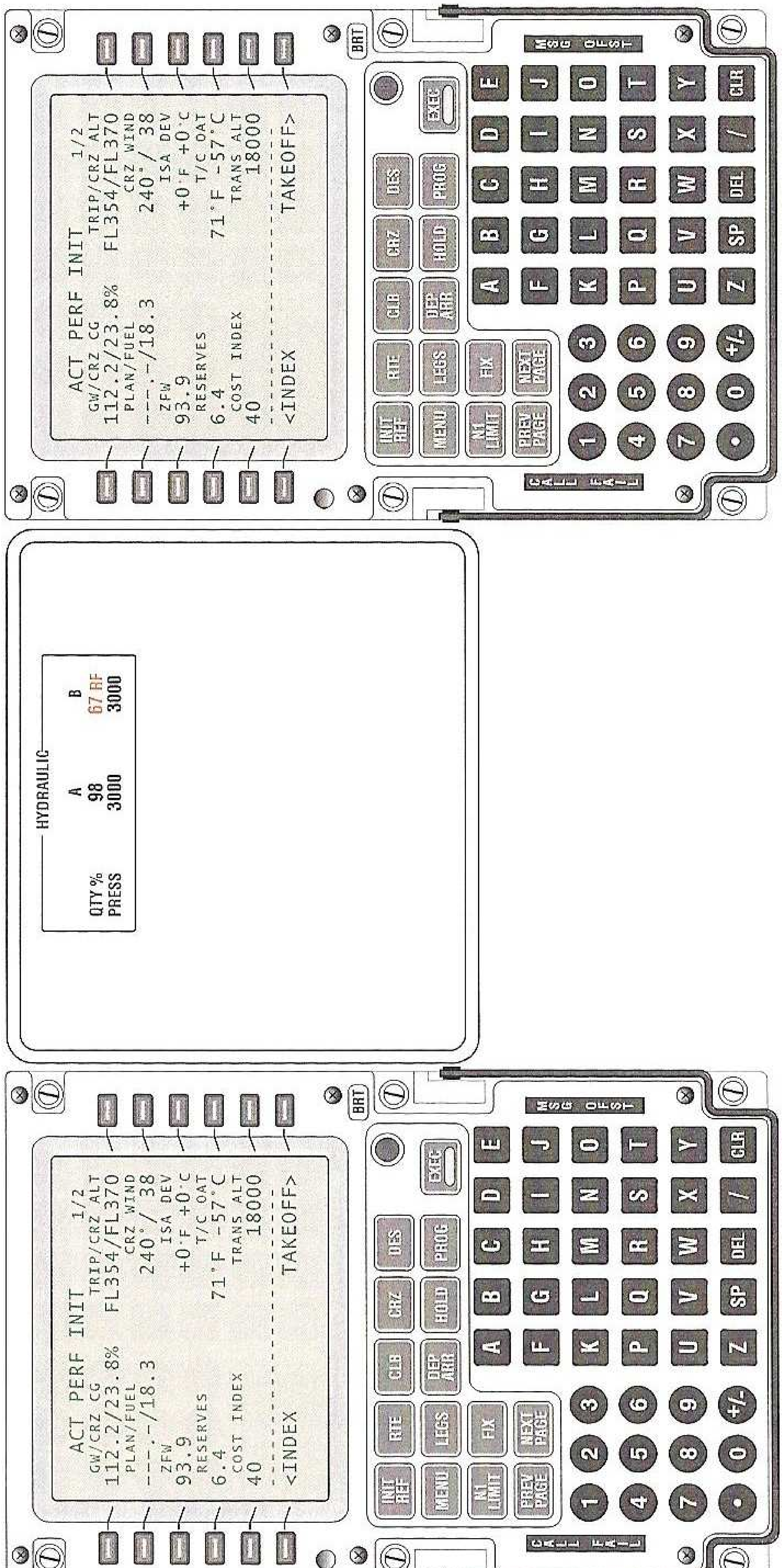
- Ground Proximity Warning System inputs : Capt radio altimeter, #1 GS, FMC, #1 ADIRU, landing gear and flap switches, SMYD
- if you lose Capt's radio altimeter, you lose all modes of the GPWS
- gives aural and light warnings
- windshear alerts take precedence over the other GPWS mode alerts
- GPWS alerts take precedence over TCAS alerts
- no alert in shallow descent in landing configuration
- no alert when flying toward structures or steeply rising terrain
- all modes operate from 50' to 2450' RA (except Mode 5 and 7)

(3-4-5) Aircraft with on-side heading

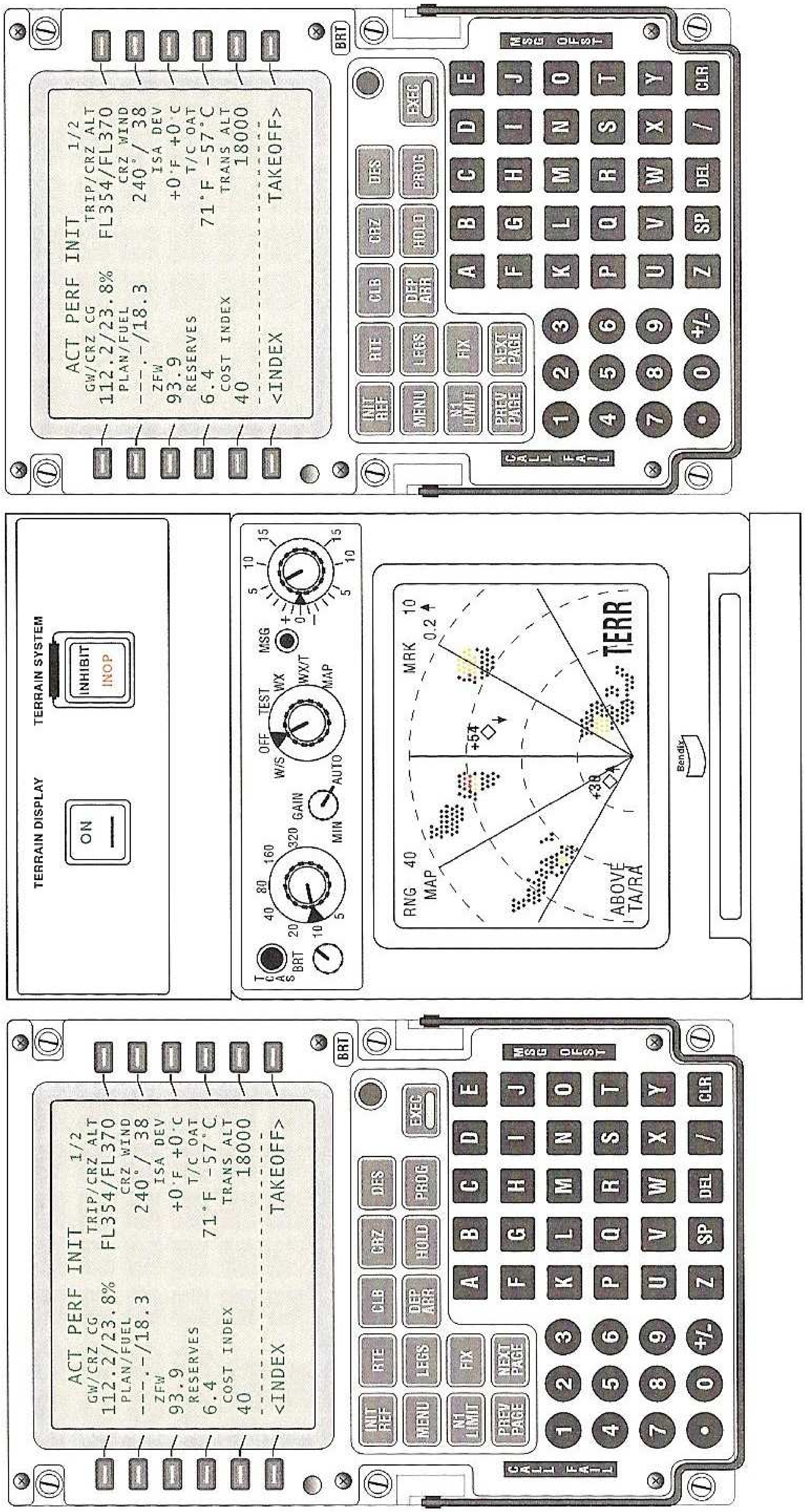
- the RMDI can get its heading information from the same side (on-side) HSI or the opposite HSI
- you can check this during the standby power check
- if the Captain's RMI heading flag appears during the stand-by power check, it gets its heading information from the on-side HSI

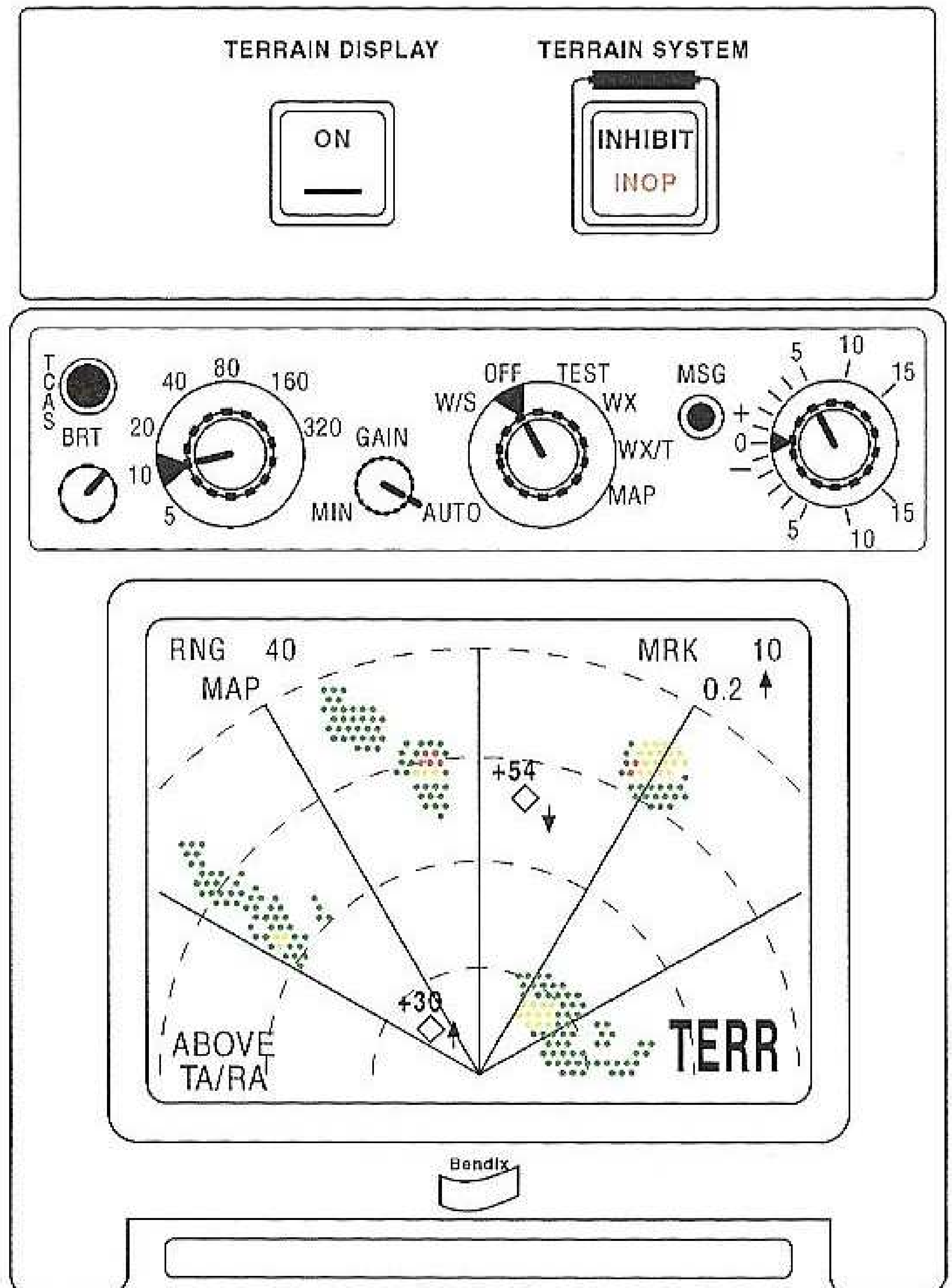


Forward Electronics Panel -NG



Forward Electronics Panel -300





(3-4-5)

TERRAIN COMING OUT OF LAS VEGAS, RW25R, LEFT TURNOUT

EGPWS (non EFIS Option)

ON (green)

- MAP displays on upper left corner of radar display and blinks
- TERR displays in lower right corner
- cannot work when radar is on
- requires IRS alignment and transponder in TA or TA/RA
- use on departure and arrival where significant terrain features exist

INHIBIT (white)

- push to inhibit terrain awareness alerting and display, and terrain clearance floor functions
- if ANP exceeds RNP during approach, consider inhibiting the EGPWS as it may not see a runway on final and deliver a terrain warning

INOP (amber)

- terrain alerting and display and terrain clearance floor functions are inop
- windshear detection remains operational
- EGPWS reverts to basic GPWS protection

Operation

- uses FMC position so at least one nav radio should be in AUTO for as long as possible on approach

(MEL) GPWS - ATA 34

- may be inop provided repairs are made within 2 days

WEATHER RADAR

- X-band color radar
- detects and locates various types of precipitation based on rainfall intensity by displaying colors contrasted against black background

Map mode

- radar displays surfaces in red, yellow and green (most reflective to least reflective)
- enable identification of coastlines, hilly or mountainous regions, cities or large structure
- ground mapping can be useful in areas where ground-based nav aids are limited
  - it should not be relied on for proximity warning or anticollision protection

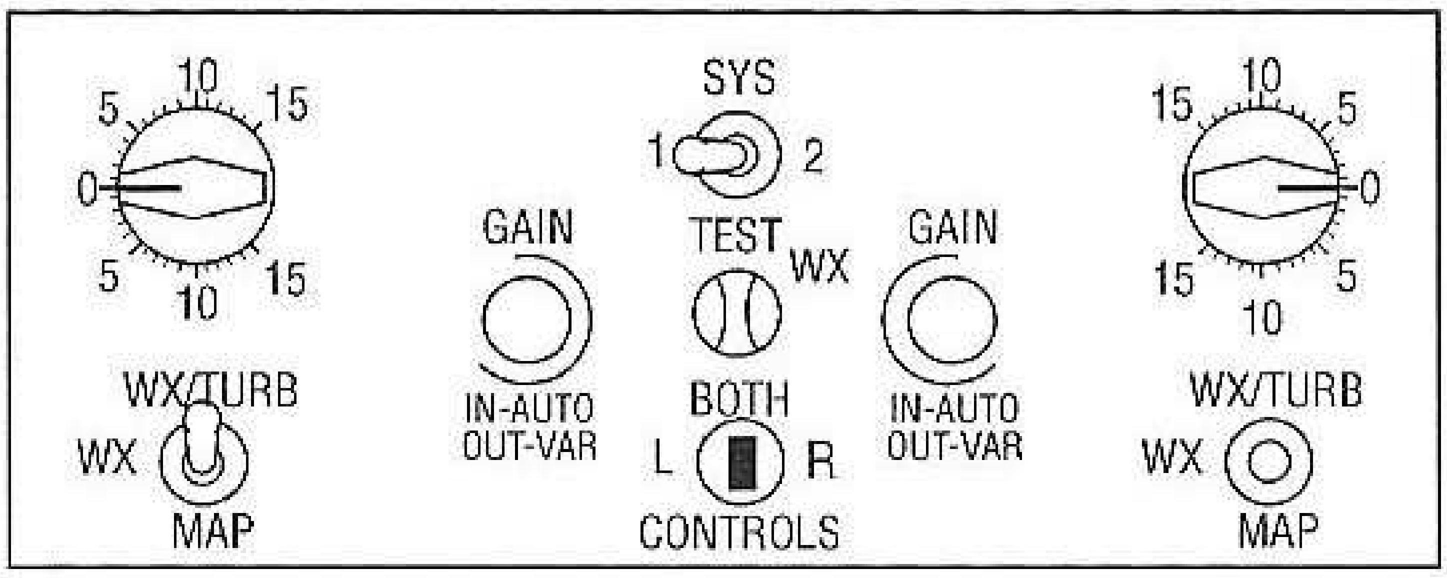
WX mode

- areas of heaviest rainfall will appear in red, the next level of rainfall in yellow, and the least rainfall in green

WX/TURB

- displays normal precipitation and precipitation associated with turbulence
- when the radar detects a horizontal flow of precipitation, with velocities of 5 or more meters per second, toward or away from the radar antenna, that target display becomes magenta
- this magenta area is associated with heavy turbulence

WEATHER RADAR - Collins WRC 701



SYStem switch

- selects transmitter/receiver system for operation when radar is on

TILT Control

- rotating manually controls radar antenna tilt position from 15° up to 15° down

MODE switch

WX / T - activates display of detected precipitation and turbulence returns; WX+T on EHSI
WX - activates display of detected precipitation; WX displays on EHSI
MAP - activates display of detected ground returns; MAP displays on EHSI

GAIN control

IN-AUTO presets an optimum receiver sensitivity for best weather radar display
OUT-VAR manually sets receiver gain; VAR displays on EHSI (Example: VAR / WX)

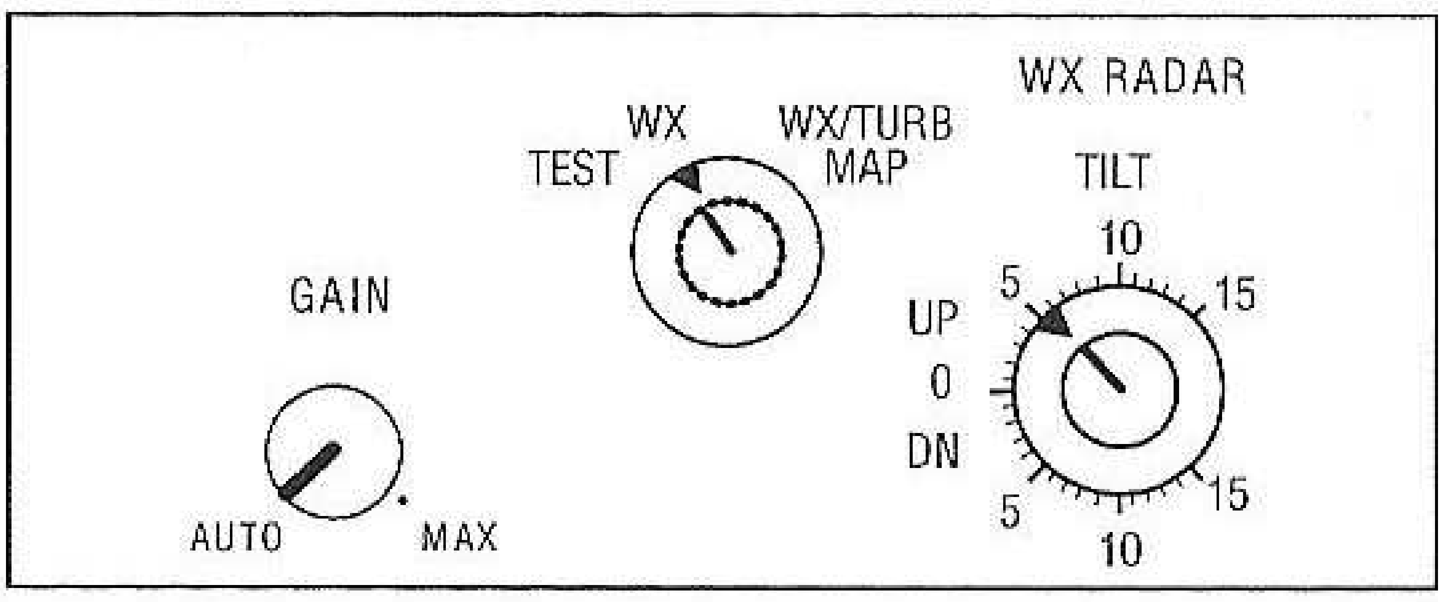
MODE selector

TEST - displays test pattern (leave in TEST when not in use)
WX - displays selected radar mode switch returns

CONTROLS

L - both displays controlled by Captain's side; both sweeps are active
R - both displays controlled by FOs side; both sweeps are active
BOTH
- each side controlled by respective controls (tilt, mode, and gain)
- Captain's display updates only on left-to-right sweep; some latency in data
- FO's display updates only on right-to-left sweep; some latency in data

WEATHER RADAR - Bendix RDR-4A/B



GAIN Control

AUTO - system automatically sets gain in all modes except MAP

Rotating manually sets receiver sensitivity to enhance ground mapping in MAP mode only

MODE selector switch

TEST - displays test pattern; (leave in test when not in use)

WX - activates display of detected precipitation

WX/TURB - activates display of detected turbulence (within 40 nm) along with display of detected precipitation

MAP - activates display of detected ground returns

TILT control

- rotating manually controls antenna tilt position from 15° up to 15° down

Radar Annunciations - EFIS

WXR FAIL - indicates weather radar has failed (no weather data displayed)

WXR WEAK - indicates weather radar calibration fault

WXR ATT - indicates loss of attitude input for antenna

WXR STAB - indicates antenna stabilazation is off

WXR DSPY - indicates loss of display unit cooling or an overheat condition of the HSI
- weather radar display is blanked

MAP/WXR RANGE DISAGREE - indicates selected range on the EFIS Control Panel is different than the MAP and WXR display range

MAP RANGE DISAGREE - indicates selected range on the EFIS Control Panel is different than the MAP display range

WXR RANGE DISAGREE - indicates selected range on the EFIS Control Panel is different than the WXR display range

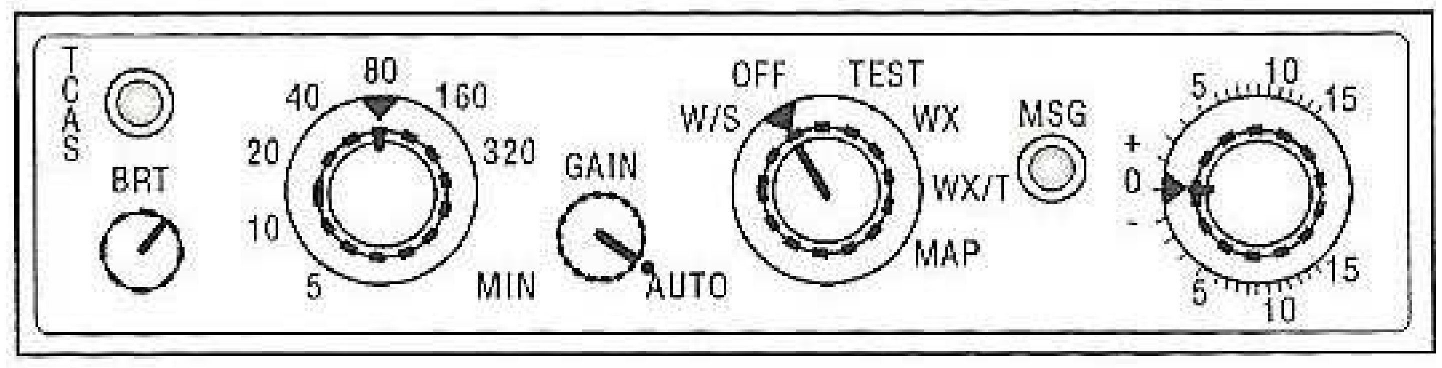
(MEL) Weather Radar - ATA 34

- may be inop provided Captain and Dispatcher agree that current weather reports do not indicate thunderstorms or other potentially hazardous weather conditions, that can be detected with weather radar, may be expected along the route to be flown.

(L/OP) Weather Radar

- do not operate weather radar during refueling, near fuel spills or people except in test mode

WEATHER RADAR - Bendix RDR-4B / TRA-4B



TCAS mode selector
- windshear has priority over TCAS alerts
- while in TCAS only mode, a windshear event pops the system into WX/TCAS overlay mode displaying both windshear and TCAS information

TCAS pushbutton selects mode of operation
- with radar off
  - causes display to alternate between TCAS and NO WXR
  - TCAS button turns TCAS display off or on
- with radar on, 3 displays

  TA/RA - no radar; TCAS controlled by TXP head

  TA/RA AUTO - radar displayed; TCAS auto displays if traffic in vicinity

  TA/RA - radar and TCAS traffic displayed

BRT control
- adjusts picture brightness

RANGE selector
- selects radar display range

GAIN control
- controls receiver gain; rotate fully clockwise for automatic gain
- gain is automatic in windshear only mode

MODE selector
W/S - windshear mode; icon only, no weather returns
- W/S ONLY annunciated, tilt and gain removed
- above 2300', NO W/S DATA AVAILABLE appears at the screen center indicating inappropriate mode selection

OFF - indicator is off unless turned on by ACARS or TCAS
- below 1500' AGL a windshear event automatically turns on the PPI-4B, the antenna sweeps ±60° (±40° display), indicates selected range, annunciates W/S ONLY, TILT and GAIN are removed and the display shows the windshear icon only
- windshear icon overlays test pattern and radar returns in all modes

TEST - displays test pattern; (leave in TEST when radar not in use)
- first flight of day test place controls in Auto gain and range to 40 nm
- initial display before radar test pattern, is the TCAS display arcs

WX - displays weather radar returns

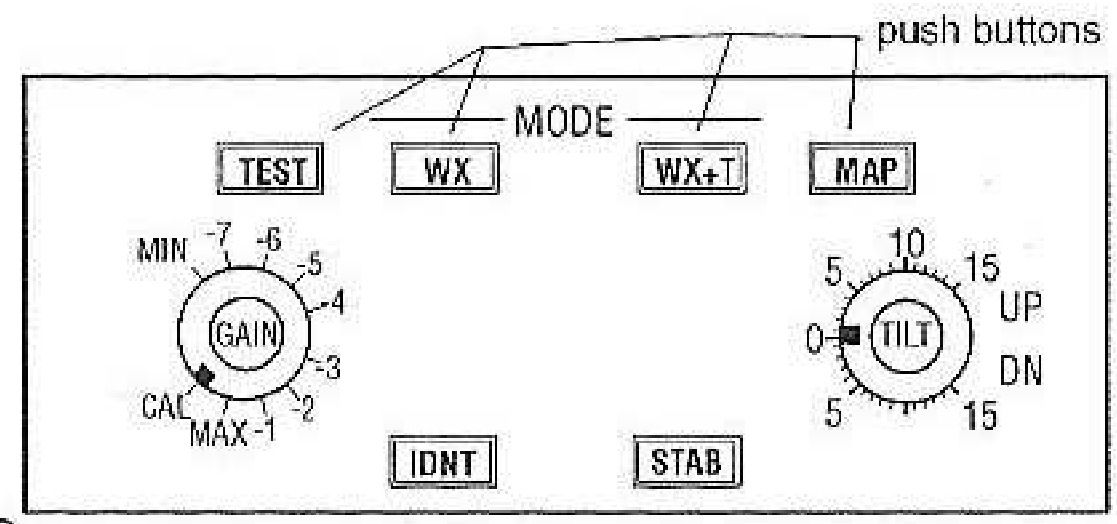
WX/TURB - display weather and turbulence returns

MAP - displays ground returns

TILT control
- controls antenna tilt ±15°
- automatic tilt in windshear mode only

MSG
- enables ACARS mode
- while in ACARS mode, a windshear event pops the system into WX/TCAS overlay mode
- when advisories clear, the system reverts to MSG mode

WEATHER RADAR - Collins WCP-701



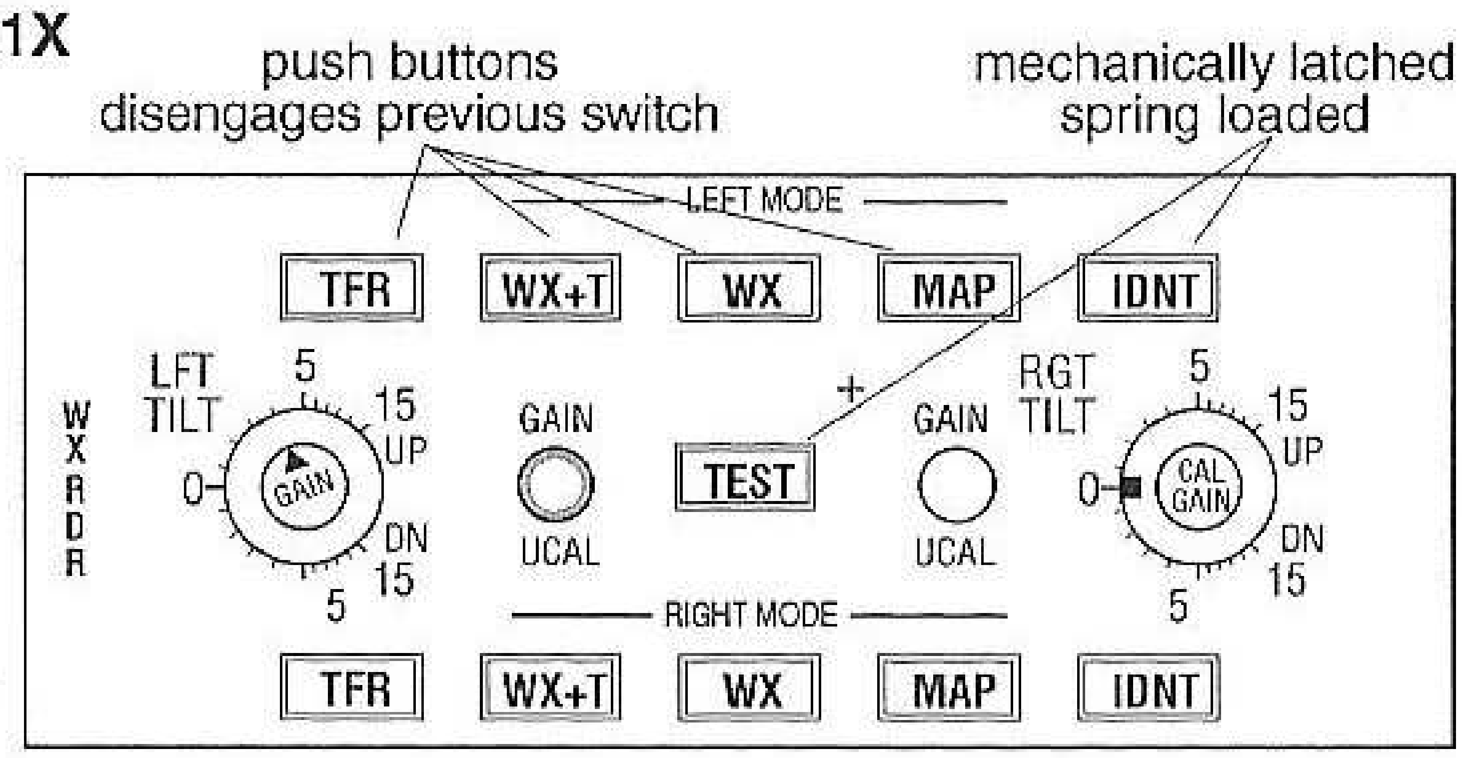
Control Buttons

WX - activates the precipitation detection mode
WX+T - activates precipitation and, if within 50 nm range or less, the turbulence detection mode
MAP - activates the ground map mode
STAB - stabilization is engaged by depressing the mechanically latching STAB push-button. Stabilized operation places the antenna under control of the receiver-transmitter to correct for changes in aircraft attitude
IDNT - mechanical latch button controls the clutter suppression mode of the indicator. Activation of clutter suppression in WX mode reduces the intensity of the ground clutter
- spring loaded = mechanically latched

GAIN - gain is controlled in the WX, WX+T and map modes by rotating the control through its 10 detented positions
TILT - tilt range is from 15° down to 15° up
TEST
- push button - on or off; (leave in TEST when not in use)
- selecting the TEST push button activates the test mode, if WXR radar switch is on, and causes the following to occur:
  - transmitter is enabled for less than 1 sec and then muted for the rest of the test
  - indicator displays a test pattern containing four concentric arcs consisting of one color each: magenta, red, yellow, and green
  - antenna system performs a test sequence, ending with the antenna stopping at the boresight (electrical zero) position. During the test sequence the actual elevation angle will be displayed on the indicator

WEATHER RADAR - Collins WRT-701X

- two modes, left and right



Other Control Buttons

Always press TEST switch when not in use. Radiates if WXR switch on EFIS control panel is pushed even if WX+T or WX buttons on radar control panel are not pressed. Leaving WX+T or WX button up provides false sense of security.

TFR
LEFT TFR displays data from the right side; updates on both sweeps
RIGHT TFR displays data from the left side; updates on both sweeps

IDNT - controls the clutter suppression mode of the indicator. Activation of clutter suppression in WX mode reduces the intensity of the ground clutter
GAIN - gain is controlled in the WX, WX+T and MAP modes by rotating the control CCW through its 10 detented positions
- check this knob during preflight to be in AUTO position
- GAIN light illuminates in the air if gain control is rotated out of the auto position
- gain knob design on left rotates clockwise for max and counter-clockwise for min
  - index straight up for AUTO position
- gain control knob design on right only goes up! Full min gain = auto calibration!
  - this can lead to *red-out* in moderate rain in the terminal area
  - if less sensitivity is needed, try MAP position on one display
    - reduces gain by 10 dB, equivalent to one color level change, so a 40 dB red cell would appear to be a 30 dB yellow cell

Predictive Windshear System (PWS)

(3-4-5) WARNING: Radiation Hazard on earlier systems:
On certain systems: Failure to return transponder to STBY after landing or selecting any mode except STBY prior to leaving the ramp area allows the radar to operate in the windshear mode creating a radiation hazard to personnel on the ground. This hazard exists even if the weather radar mode is selected OFF or TEST.

- forward looking Doppler weather radar system (X-band)
- PWS is activated for windshear when:
  - (3-4-5) transponder is on
  - (NG)thrust levers are set for takeoff, (53° thrust lever angle) or
    - in flight below 2,300 feet RA
- predictive windshear alerts are issued below 1,200 feet RA
  - inhibited above 1200' RA
- PWS turns off above 2300' RA and when the airplanes lands
- predictive windshear alerts can be enabled prior to takeoff by pushing WXR switch
- unlike Reactive Windshear Systems, a mode of GPWS that gives alerts after penetration, the PWS provides detection up to 3 nm ahead of the airplane - 10 to 70 seconds at takeoff and approach speeds (CAUTION and WARNING coverage starting at 1.5 nm)
- detects horizontal wind and makes assumptions about vertical wind
  - moisture or particulate matter is required
  - cannot detect wind rotors or wake turbulence
- the crew does not have to change the display range to view the windshear hazard
- windshear alerts take priority over TCAS alerts
- when PWS is enabled, radar antenna scan sweep is reduced
- single RT unit uses alternate scan (sweeps) if weather radar is operating in any mode
  - single radar display
    - radar uses one sweep, windshear mode uses next
  - EFIS radar display without PWS
    - clockwise sweep (takes 4 seconds) for captain's WXR data
    - counterclockwise sweep (takes 4 seconds) for FO WXR data
    - so WXR is updated each 4 seconds
  - EFIS display with PWS added
    - clockwise sweep (takes 4 seconds) for captain's WXR data
    - counterclockwise sweep (4 seconds) PWS for both pilots
    - clockwise sweep (takes 4 seconds) for FO WXR data
    - counterclockwise sweep (4 seconds) PSW for both pilots
- only the WXR data is delayed with PWS functionality added
  - example: captain must wait for 2 PWS sweeps and the FO sweep before his WXR screen is updated (4+4+4=12 seconds)
  - PWS is delayed 4 seconds when activated
- during takeoff and approach, new windshear cautions are inhibited at airspeeds greater than 80 kts and less than 400' RA
  - new warnings are inhibited during takeoff and approach at airspeeds greater than 100 kts and less than 50' RA

Alerts

Predictive

WINDSHEAR AHEAD

WINDSHEAR AHEAD

- "***Monitor radar display***" are issued below 1200' RA on takeoff and approach if the w/s is greater than 0.5 nm but less than 3 nm and the w/s is not in the warning area. During approach below 1200' RA at greater than 0.5 nm but less than 1.5 nm a warning alert is issued as "***Go around, windshear ahead***"
- during takeoff, ***Windshear ahead***" is heard if below 1200' RA and w/s is greater than 0.5 nm but less than 3 nm
- windshear icon on radar display (red/black bands) depict the event
- yellow radial lines provide directional information
- all alerts are inhibited on the ground above 100 KIAS until 50' AGL

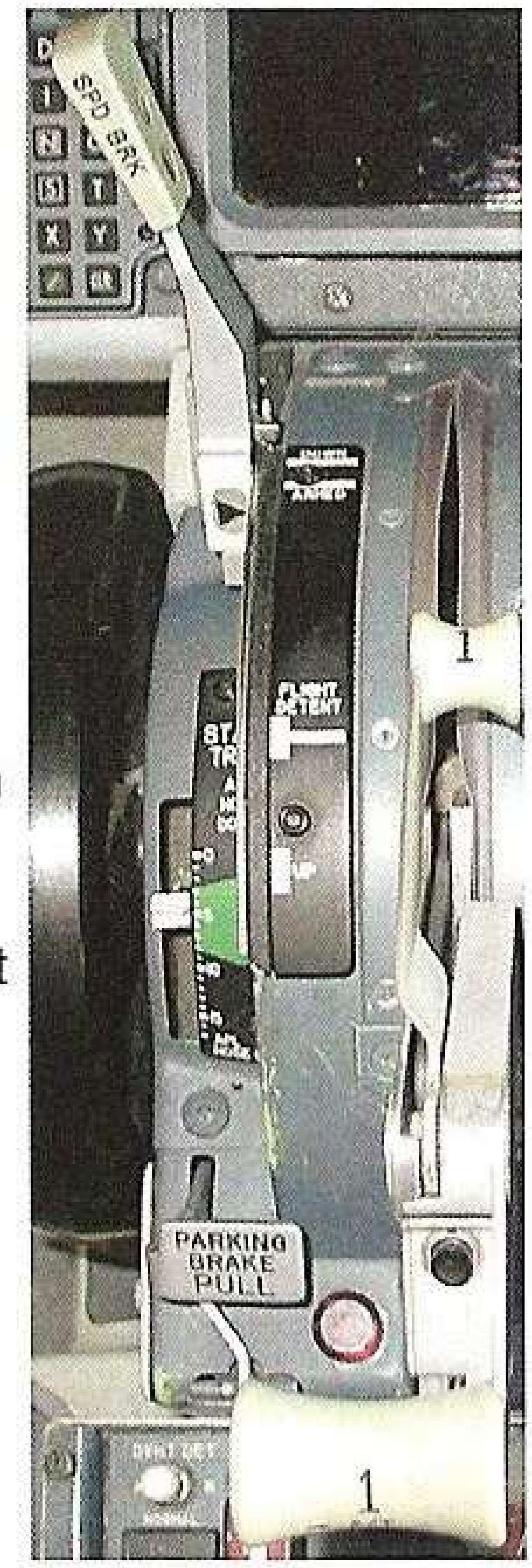
TEST (Radar Control Panel)
- selecting TEST on the radar also tests the predictive windshear system (if installed)
- windshear icon is displayed and aural warning "***Go around, windshear ahead, windshear ahead, windshear ahead***" is played

PWS INOP

PREDICTIVE WINDSHEAR INOP light (amber)
- (EFIS) PWS INOP illuminated indicates Predictive Windshear System is inop (fault detected)
- (PFD/ND) have an amber PWS FAIL annunciation displayed on the left side (center) of the ND if the Predictive Windshear System fails

(L/OP) Instr. and Nav, Windshear
- no takeoff if Forward Looking Windshear Warning Alert is displayed

Radar System Notes *(under development)*
- Calibrated position
  - position which utilizes an optimum power setting

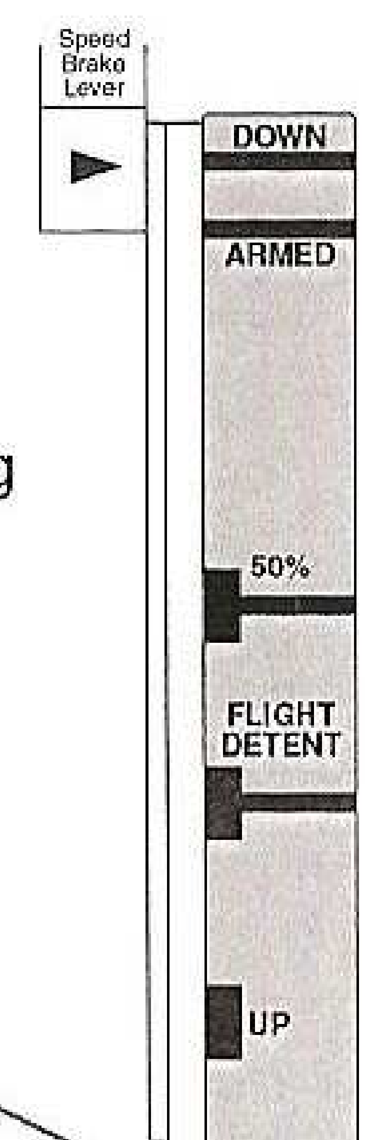


SPEED BRAKE LEVER

- gives mechanical input to the spoiler mixer and ratio changer. The spoiler mixer mechanically moves the ground spoiler control valve. The ground spoiler control valve sends hydraulic system A pressure to the ground spoiler interlock valve. A cable from the right main landing gear torsion links moves the ground spoiler interlock valve when the a/c is on the ground - it is spring-loaded closed. The ground spoiler interlock valve then sends hydraulic power to the ground spoiler actuators, which move all the ground spoilers
- during auto spoiler deployment, the auto speedbrake actuator gives input to the same cables and backdrives the speedbrake lever

DOWN (detent) - all flight and ground spoiler panels in faired position

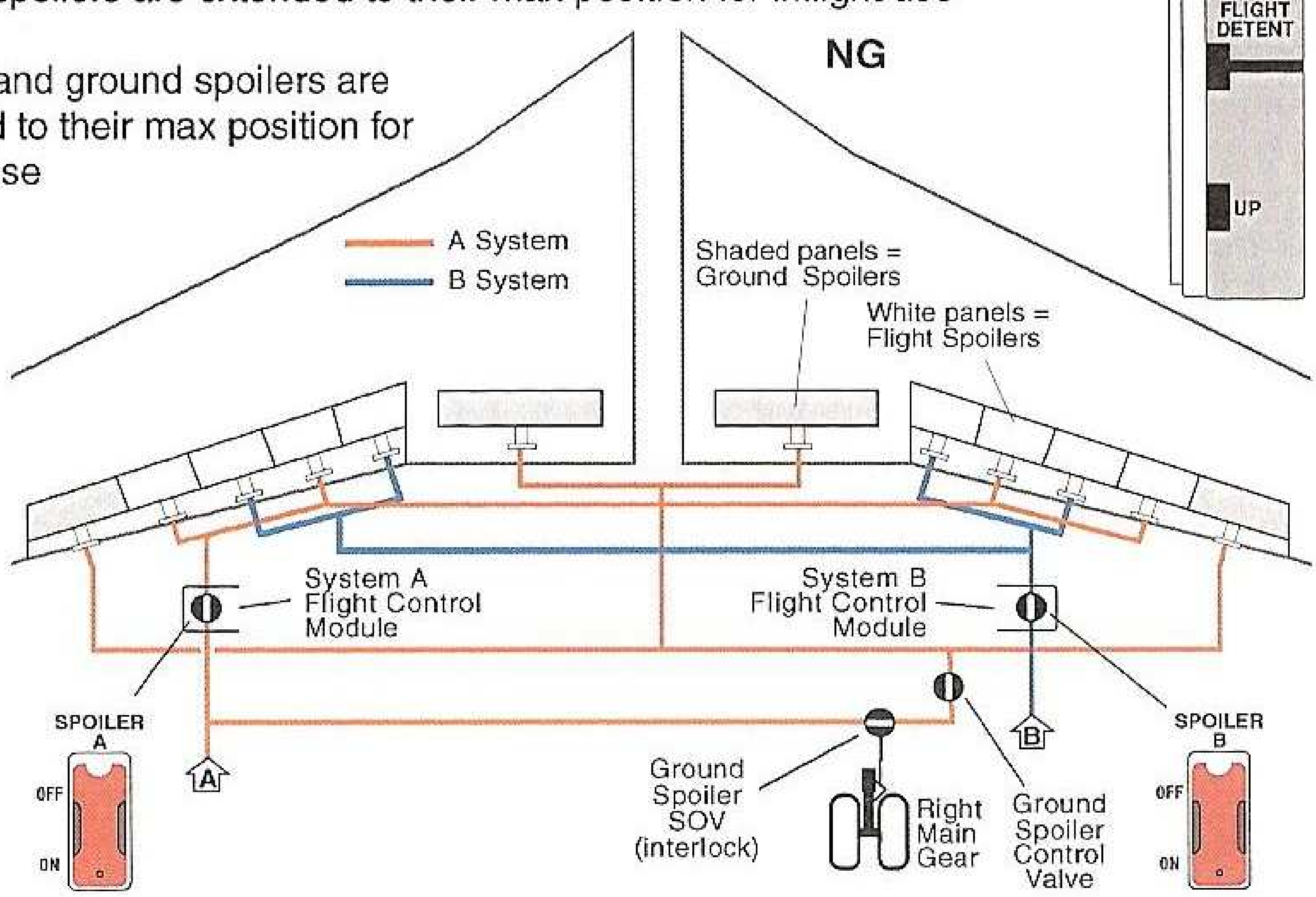
ARMED
- for speedbrakes to auto-deploy, the speedbrake lever must be in the armed position, SPEED BRAKE ARMED light on, both thrust levers must be at idle, sensed main gear wheel spin-up (> 60 kts) and RA less than 10'
  - if wheel spin up is not detected (i.e. antiskid inop) speed brake lever will not move to the UP position until after any gear strut is compressed, extending landing rollout
- upon touchdown (wheel spin-up) the lever moves to the UP position and all flight spoilers extend
- ground spoilers come up when the right gear is compressed
  - so if you land on the left main gear first, touchdown is smoother but spoiler deployment is delayed, extending landing rollout
- auto speedbrake actuator retracts if either thrust lever is more than the idle position
  - the auto speedbrake actuator does not retract when you move the speedbrake lever to the down position



50% - (if installed - certain winglet equipped aircraft)
- maximum aft position of the speedbrake lever when the speedbrake wing load alleviation system is activated

FLIGHT DETENT
- all flight spoilers are extended to their max position for inflight use

UP
- all flight and ground spoilers are extended to their max position for ground use



(L/OP) Flight Controls, Speed Brake

- (NG) do not deploy in excess of 320 kts; vibration causes damage to horizontal stab
- should not deploy in flight below 1000' radio altitude
- do not extend beyond FLIGHT DETENT in flight; the high buffeting loads results in accelerated fatigue damage to the empanage
  - if the ground spoiler SOV is failed open the speed brakes and the ground spoilers will deploy
  - should not deploy with flaps greater than 15

PARKING BRAKE LEVER

- brakes can be set using the Captain's or FO's brake pedals with system A or B press
- if hydraulic systems do not supply pressure, brake accumulator pressure will be used
- brake pressure is maintained by brake accumulator if A and B are off (8 hrs)
- antiskid is deactivated when parking brake is set
- the normal antiskid valves release unwanted brake pressure through the parking brake valve. Therefore, the antiskid system monitors the parking brake system for a fault. When the PB valve is not in its commanded position, the ANTI SKID INOP light comes on.

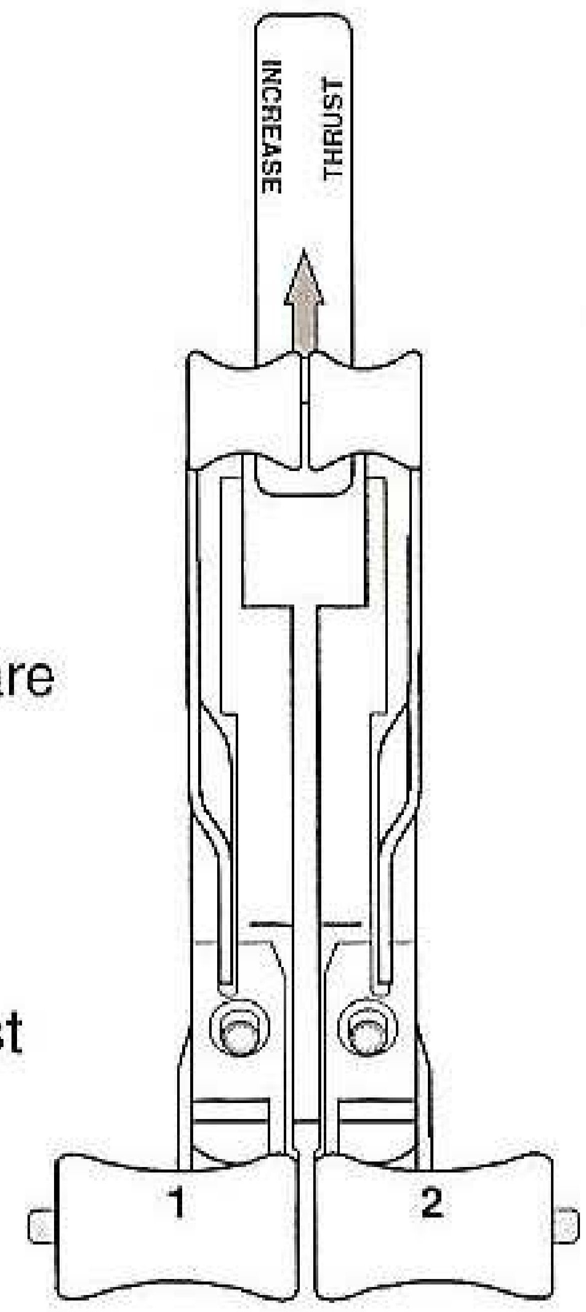
(QRH) Parking Brake

- should not be set following a high energy stop or following touch and goes as hot brake surfaces tend to fuse together. Cool for 40-60 minutes

PARKING BRAKE WARNING light (red)

- parking brake light illuminated = parking brake lever shutoff valve is in closed position
- bulb power from battery bus
- only checks linkage - need pressure to actually get brakes
- extinguished = parking brake lever released
- (option) light on nose gear for ground crew to see if parking brakes are set or released

THRUST LEVERS



FORWARD THRUST LEVERS

- controls engine thrust
- cannot be advanced if the Reverse Thrust Lever is in the reverser deployed position

REVERSE THRUST LEVERS

- controls engine reverse thrust
- reverse thrust cannot be selected unless the forward thrust levers are in IDLE
- reversers are electrically controlled, hydraulically operated
  - battery switch must be on
  - engine fire handle must be down
  - air ground sensor (RMLG) must be in ground or Captain's or First Officer's radio altimeter less than 10' (3 meters)

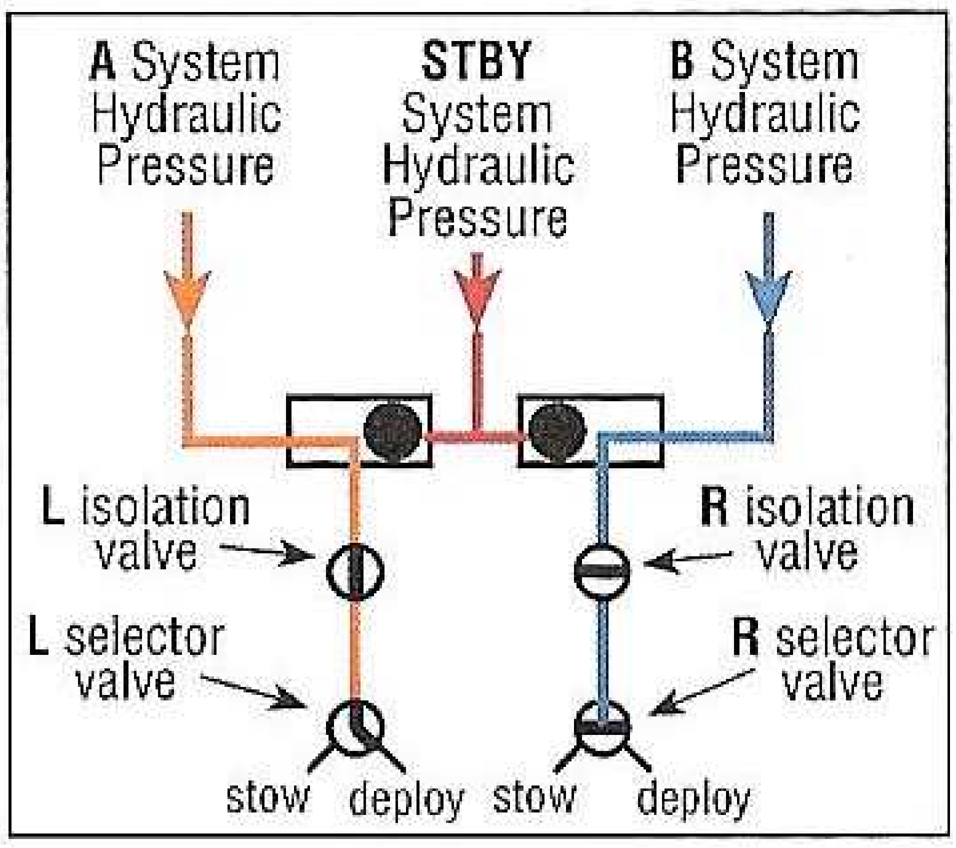
(L/OP) Flight Controls, Reverse Thrust

- for ground use only; do not use in flight

Thrust Reverser System Notes

- fan exhaust provides 78% of the total forward thrust
  - 22% of the total exhaust (the core) cannot be reversed
- each T/R has a left and right half. Each half has a translating sleeve (outer wall) which moves aft for reverse thrust. The sleeves work at the same time, but are independent from each other
  - the sleeves are lined with acoustical material for sound suppression
  - 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
- three hydraulic actuators move each sleeve
  - one is a lock actuator, providing positive locking when the system is stowed
- the T/R selector valve controls hydraulic power to the hydraulic actuators
- the reverse thrust lever operates the switches necessary to send a deploy or stow signal to the selector valve
  - reverse thrust lever is blocked at reverse idle position by an interlock until the related thrust reverse sleeve is more than 60% deployed
  - the interlock mechanism also restricts the forward thrust lever increase command if the reverser sleeves do not fully stow
    - additionally, the interlock cams will drive the forward thrust levers toward flight idle if either half of the reverser sleeves depart from their command position
  - the ability of each reverse thrust lever and its corresponding forward thrust lever to move depends on the position of the other lever because each is capable of locking out the other pawl attached to the forward thrust lever
- sync shafts on each translating sleeve make sure the sleeve's three actuators operate at the same speed and can operate only if the shaft is free to turn
- when de-energized, plungers are spring loaded to the locked position
  - this sync lock prevents the operation of the actuators when there is no deploy signal
- operation of the reverse thrust lever opens the isolation valve, releasing the sync lock, and opening the selector valve to the deploy position
  - sleeves translate aft extending the blocker doors
    - when retracted, the doors form part of the outer duct for fan exhaust air
    - the fan exhaust is redirected by the blocker doors, forcing air in the reverse direction through the cascade segments
    - the cascades are arranged to direct airflow away from the aircraft structure or engine air inlet during thrust reverser operation

- flow control valve synchronizes the thrust reverser halves to within three seconds of each other
- # 1 engine uses A sys; # 2 engine uses B sys
- standby system backs up both but has less volume
  - the shuttle valves move whenever the pressure difference between the primary hydraulic system and the standby system exceeds 125 psi. For example, 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 second detent provides adequate reverse thrust for normal operations
- downward movement of the reverse thrust lever commands the selector valve to the stow position allowing hydraulic press. to stow and lock the reverser sleeves. After the reverser is stowed, the electro-mechanical lock engages and the isolation valve closes
  - the isolation valve is solenoid operated open and spring loaded to close
- when the reverser sleeves are in the stowed positon, an electro-mechanical lock and a hydraulically operated locking actuator inhibit motion of each reverser sleeve until reverser extension is selected
- as the translating cowl reaches the stowed position, the electrical circuit to the auto restow logic card is energized through the restow sensors. The auto-restow circuit compares the actual reverser sleeve position and the commanded reverser lever position. In the event of incomplete stowage or uncommanded movement of the sleeves toward the deployed position, the auto-restow circuit will open the isolation valve and command the control valve to the stow position. Once the auto-restow circuit is activated, the isolation valve remains open and the selector valve is held in the stowed position until the thrust reverser is cycled or until maintenance action is taken.
- only multiple failures could allow the engine to go into reverse thrust
  - such failures may preclude returning the engine to forward thrust
  - unstowed reverser sleeves produce buffet and increase drag
- volumetric fuses in the standby system pressure lines to the thrust reversers close when fluid flow exceeds 175 cubic inches
- one thrust reverser may be inop provided thrust reverser is locked in the forward thrust position
  - check MEL - ATA 78

On engine cowl

TAKEOFF / GO AROUND BUTTONS

- on throttles; engages F/D and A/T in takeoff or go-around mode if previously armed

TAKEOFF WARNING HORN

- armed when on ground and either throttle advanced to takeoff thrust (beyond 30°)
  - intermittent horn sounds when:
    - stab trim not in takeoff range (green band), or
    - TE flaps not in takeoff range (3-4) 1-15, (5) 5-15, (NG) 1-25, or
    - LE devices not in correct position for takeoff, or
    - speedbrake lever not in down position (this is the usual problem), or
    - parking brake is set; option on (3-4-5) standard on (NG)

    (NG) spoilers not down with the speedbrake lever in the DOWN position
- Note: rudder trim not in the takeoff warning system

LANDING GEAR WARNING HORN

(3-4-5)

- steady warning horn is provided to alert the crew any time the airplane is in a landing configuration and any gear is not down and locked
- the horn is activated by flap and thrust lever position as follows:
  flaps 1 through 10:
  - either or both thrust levers between idle and approximately 10° thrust lever angle
    - the horn can be silenced

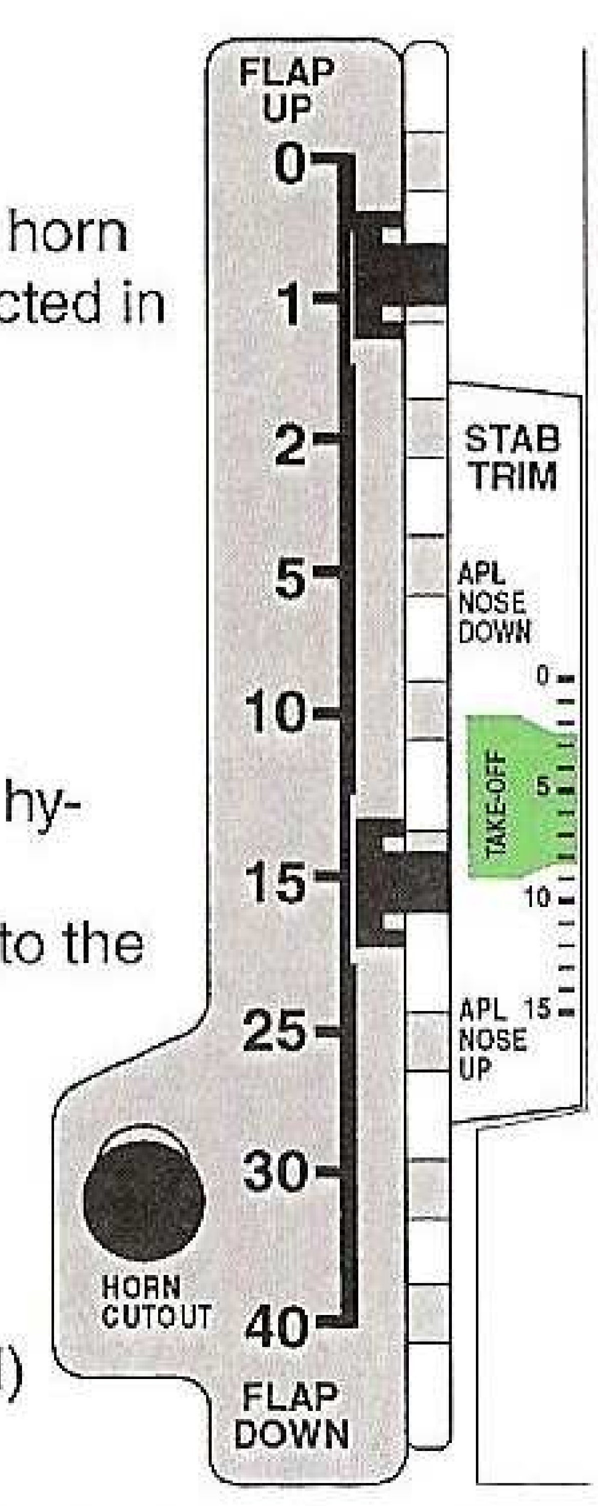
  flaps 15:
  - either thrust lever between idle and approximately 10° and the opposite thrust lever greater than approximately 30°
    - the horn can be silenced
  - both thrust levers set below approximately 30°
    - the horn cannot be silenced

  flaps greater than 15:
  - regardless of thrust lever postion
    - horn cannot be silenced

* When either thrust lever is less than 20° thrust lever angle (TLA) and the other is less than 34° TLA, or an engine not operating and the remaining thrust lever less than 34° TLA.

(NG)

- the PSEU sends a steady "gear not down" warning horn to alert the crew whenever a landing attempt is made and any gear is not down and locked
- there are 2 types of warnings,
  - one that can be silenced using the horn cutout switch, and
  - one that cannot be silenced
- the aural warning does not operate for 20 sec. if the gear lever is in the down position
- the horn is activated by trailing edge flap and thrust lever under 3 conditions:
  - gear not down and locked
  - flaps Up through 10
  - thrust levers set for landing
    - 200 - 800 ft RA, *
    - **the horn can be silenced**
      - if the airplane descends below 200 ft RA the horn cannot be silenced
  - gear not down and locked
  - flaps 15 to 25
  - thrust levers set for landing*
    - the horn cannot be silenced
  - gear not down and locked
  - flaps greater than 25
    - regardless of thrust lever postion horn cannot be silenced
    - in this condition, the system inhibits the landing gear warning horn during a go-around for 12 seconds after the gear lever is selected in the up position

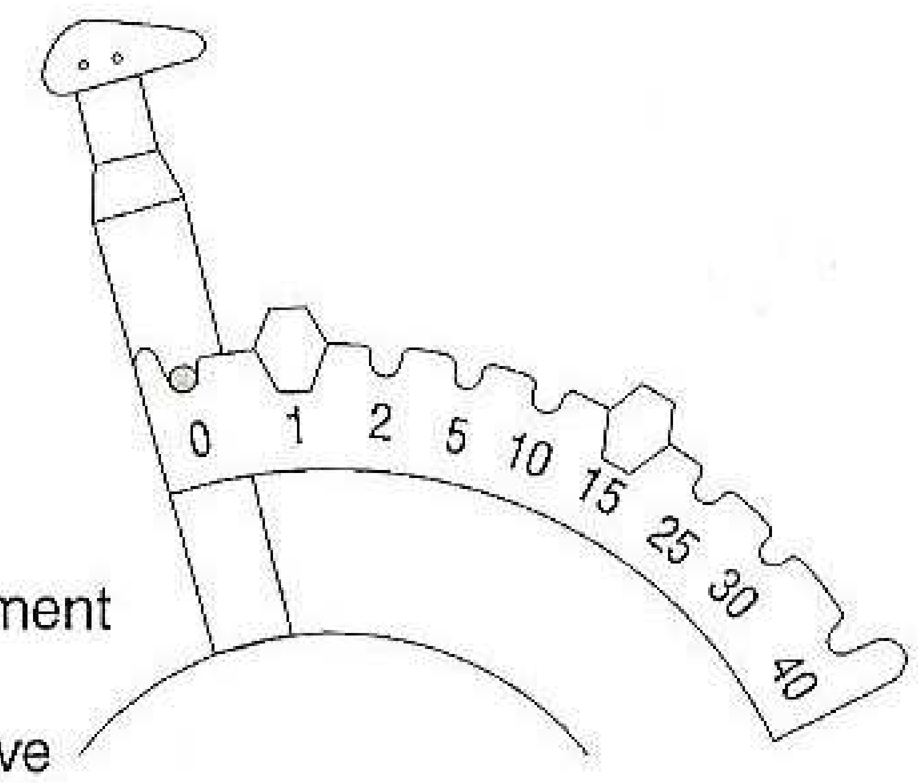


LANDING GEAR WARNING HORN CUTOUT switch

- enables thrust lever operated warning horn to be silenced

FLAP LEVER

- provides cable input to the trailing edge flap control valve directing hydraulic pressure to the flap drive unit
- follow-up cable closes the TE flap control valve and gives an input to the leading edge flaps control valve
- position of the LE devices is determined by selected TE flap position
- at 1, 2, or 5 units flaps you will have the LE slats in their EXTend (intermediate) position and the LE (Kruger) flaps in the FULL EXT
- > 5 units flaps you will have all LED's FULL EXTend (fully extended)



FLAP GATES

- prevents inadvertent flap lever movement beyond:
  - position 1 - to check flap position for one engine inoperative go-around
  - position 15 - to check flap position for normal go-around

FLAPS SETTINGS

- TAKEOFF: 5 units normal; 1 for long runway (2nd segment limited); 15 for short runway
  - 500 flaps 1 requires data your company may not have
- LANDING: 30/40 normal
  - 15 for single engine and 40 Cat II approaches (better visibility over the nose)

FLAP LIMIT SPEEDS	
300 / 500	
1 - 230 kt	15 - 195 kt
2 - 230 kt	25 - 190 kt
5 - 225 kt	30 - 185 kt
10 - 210 kt	40 - 158 kt
400	
1 - 250 kt	15 - 205 kt
2 - 250 kt	25 - 190 kt
5 - 250 kt	30 - 185 kt
10 - 215 kt	40 - 162 kt
600 / 700	
1 - 250 kt	15 - 185 / 195 kt
2 - 250 kt	25 - 170 kt
5 - 250 kt	30 - 165 kt
10 - 210 kt	40 - 156 kt
800 / 900 / BBJ	
1 - 250 kt	15 - 200 kt
2 - 250 kt	25 - 190 kt
5 - 250 kt	30 - 175 kt
10 - 210 kt	40 - 162 kt

(L/OP) Flight Controls, Flap Speeds

- Max flap extension altitude: 20,000 ft

Flap System Notes

1. High lift devices: TE and LED's
   - 2 Kruger flaps inboard of engine;
     (3-4-5) 3 slats outboard of engines
     (NG) 4 slats outboard of engines
   - flap lever controls trailing edge flaps (B sys hyd), which control LEDs
   - there are two TE flap transmissions for each TE flap
   - (3-4-5) tripple slotted (NG) double slotted
     - each transmission also has two no-back brakes. They prevent TE flaps retraction and extension if a torque tube breaks or because of airloads
2. Flap Load Relief system
   (3-4-5) protects flaps from excessive loads. At flap position 40, it automatically causes flap retraction to flaps 30 in the event of excess airspeed.
   (NG) FSEU protects flaps from excessive loads. At flap positions 30 and 40, arms the flap load relief system, which automatically causes flap retraction to flaps 25 or 30 in the event of excess airspeed load relief system
3. asymmetry protection
   (3-4-5)
   - comparator in the flap indicator senses difference between left and right needles and the TE flap bypass valve moves to the bypass position
   - do not attempt to move TE flaps using the alternate flap position switch as there is no asymmetric protection
   - comparator also monitors LE slats for failure to move to commanded position

   (NG)
   - Flaps/Slats Electronic Unit monitors the TE flaps for flap asymmetry and flap skew
     - if the TE flaps do not stay in alignment, the FSEU moves the TE bypass valve to the bypass position and the TE. flaps stop moving
   - during an asymmetry the needles on the flap indicator show actual position
   - in a skew condition one pointer will be 15° apart and the amber LE FLAPS TRANSIT light will illuminate rather than the green LE FLAPS EXT light
   - also monitors LE slats for skew or failure to move to commanded position; the LE FLAPS TRANSIT light remains illuminated and one of the following indications is displayed on the LE Devices annunciator panel:
     - incorrect green EXT or FULL EXT light illuminated
     - no light illuminated

   - no skew detection for outboard slats 1 and 8, or for the LE flaps
   - FSEU detection is inop during auto slat deployment
 - flap asymmetry condition
   - a flap on one wing does not align with the symmetrical flap on the other wing
 - flap skew condition
   - the inboard end of a flap does not align with the outboard end

4. uncommanded motion (UCM) (NG)
   - the FSEU provides protection from uncommanded motion for both LEDs and TE flaps using 3 valves, the LE UCM SOV, the LE cruise depressurization valve, and TE flap bypass
     - LE UCM SOV is normally open, permitting hyd sys B to the retract lines of the LEDs
   - LED uncommanded motion condition occurs if two or more LE flaps or three or more slats move away from their commanded position; the FSEU would then close the LE UCM SOV
     - this stops hyd sys B pressure to the retract lines of the LEDs. A hyd lock is created in each actuator preventing movement of any LED
     - the LE UCM detection function is not available when the airplane speed is less than 60 knots, alternate flaps arm switch is at ARM, or autoslat function is commanded
     - to prevent UCM on the LE devices during cruise, after the flaps are up, the FSEU maintains pressure on the retract lines and closes the LE cruise depressurization valve which stops hydraulic power to the LE flap and slat actuators (via LE cont. valve)
   - TE flap uncommanded motion is detected when no flap lever or flap load relief command is present and the TE flaps move away from the commanded position, or continues to move after reaching commanded position, or move in a direction opposite to that commanded; the FSEU then closes the TE flap bypass valve
     - the crew must use alternate flap system to control TE flaps. Shutdown indicated by flap indicator disagreeing with flap lever position. No flap needle split
   - to reset a UCM occurance, the power to the FSEU must be cycled, on the ground

5. alternate flaps
   - electric motor extends and retracts TE devices
   - standby hydraulics drives LEDs to full extend (no retraction capability for LEDs)
   - plan a flaps 15 landing
     - do not attempt to extend the flaps beyond 15 using the alternate system because
       - flap load relief protection is not provided, increasing the workload
       - for some failures, the alternate system may not override the jam
       - use of the alternate system at flaps greater than 15 may increase the possibility of a trailing edge flap asymetry
       - on a GA it takes a long time to retract and raises the crews workload
     - takes approximately 2 min to drive TE flaps to 15
     - takes approximately 2 min and 40 sec for the TE flaps to fully extend or fully retract
   - during alternate operation these features do not operate
     - (3-4-5) load relief, TE flap asymmetry detection
     - (NG) load relief, TE flap asymmetry and skew detection, and UCM detection
   - during alternate operation with system B hydraulic power applied, move the flap lever to the position that you will move the flaps to
     - this will decrease the load on the flap electric motor
   - to return to normal operation move the arm switch from ARM to OFF
       - this stops the alternate operation and normal operation becomes active
     - make sure the position of the TE flaps agrees with the position of the flap lever
       - when you supply hydraulic power, the flaps and slats will move to the position of the flap lever. This can cause injury and damage equipment

6. (NG) FSEU includes these functions for the TE flaps and LE devices
   - TE flap position indication
   - TE flap skew and asymmetry detection
   - LE flap and slat position indication
   - LE flap and slat uncommand motion detect
   - TE flap load relief
   - TE flap uncommanded motion detection
   - LE cruise depressurization
   - BITE

STAB TRIM

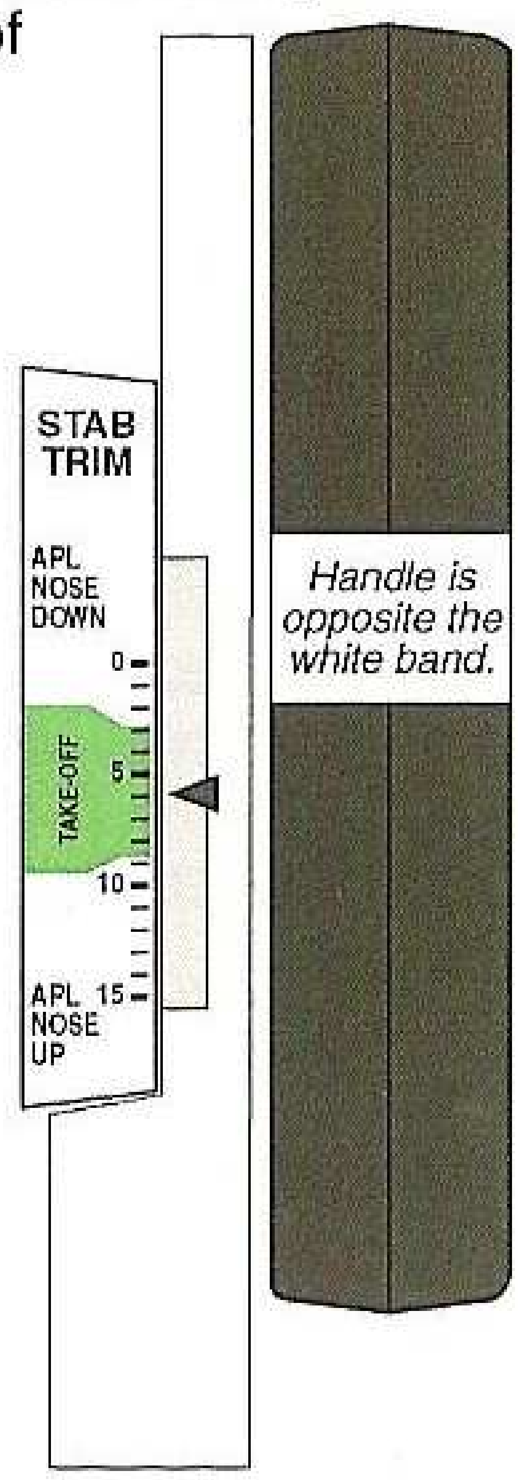
ELECTRIC STABILIZER TRIM (control column switches)

(3-4-5) horizontal stab may be operated by either a main electric trim motor, an autopilot trim motor, (both mounted near the gearbox) or by manual cable control

- electric trim rate with flaps retracted is 1/3 rate with flaps extended
- autopilot actuator trims at two speeds
  - high speed rate equal to the normal electric low speed rate
  - low speed autopilot rate is 1/2 the rate of the high speed autopilot rate

(NG) horizontal stab may be operated by a single electric trim motor (mounted near the gearbox) or by manual cable control

- flaps up switch controls the speed of the trim
  - if flaps are up, low speed trim is engaged and moves the stabilizer at .2 units/sec
  - flaps down the high speed trim engages and moves the stabilizer at .4 unites/sec
- during autopilot operation,
  - when the flaps are up, the low speed trim is .09 units per second
  - when the flaps are down, the high speed trim is .27 units per second
- in event of simultaneous actuation for opposite direction, electromagnetic clutches will engage and result in motor stall which may damage the motor due to overheating
- electric actuator must have a minimum of 13 min off for every 2 min of operation



STABILIZER TRIM WHEEL

- cables provide input to the gearbox which moves a jackscrew that moves the stabilizer
- disengages any electric actuators if these become jammed
- handle should be folded inside trim wheel for normal operation
- rotates when stabilizer is in motion

Note: horizontal stabilizer moves 17 unites by means of jackscrew and ballnut

- 3° (3-4-5) 4.2° (NG) stabilizer leading edge up (nose down)
- 14° (3-4-5) 12.8° (NG) stabilizer leading edge down (nose up)

safety rod installed in the jackscrew shaft to support the stab in the event of j.screw failure

STABILIZER TRIM GREEN BAND RANGE

- corresponds to allowable range of trim settings for takeoff (-300: 1.0 to 6.3 units; -500: 1.5 to 6.8 units)

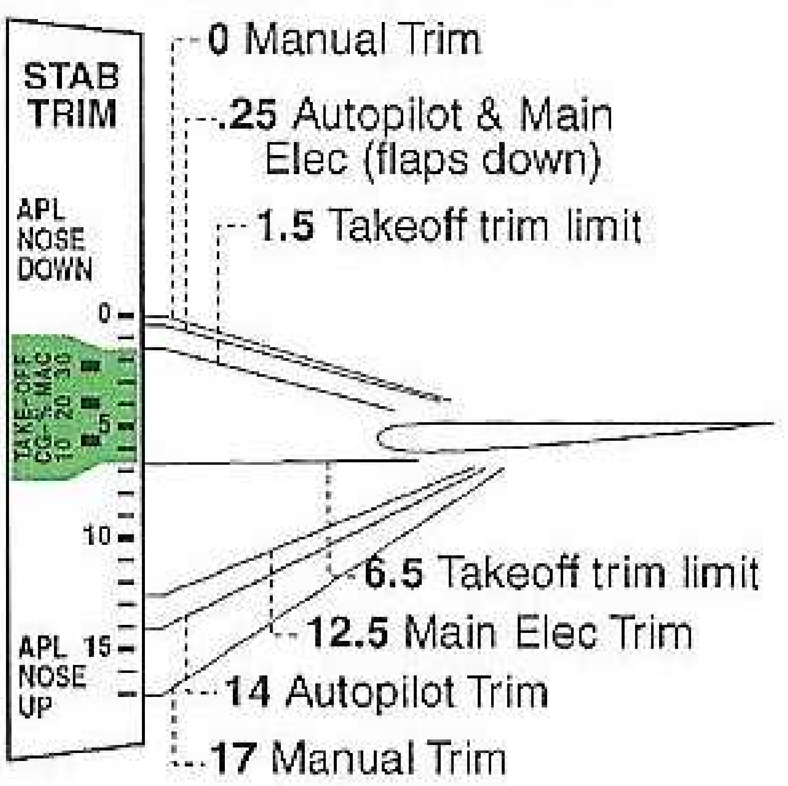
(NG) removed reference to CG and modified allowable range of trim settings for takeoff to match model as required

- if you use manual trim to max, you can use electric trim to bring back

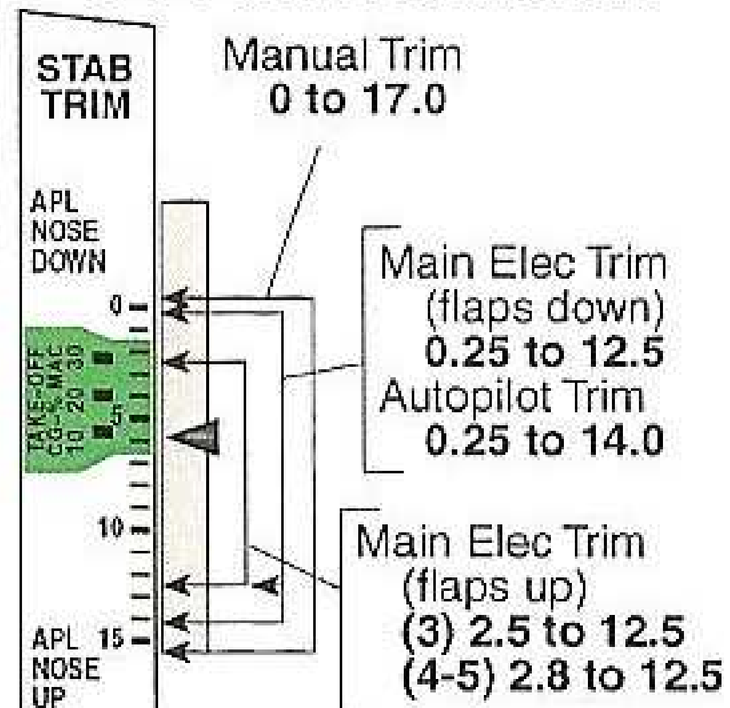
TRIM LIMIT SWITCHES

- stabilizer trim limit switches limit the range of horizontal stabilizer motion

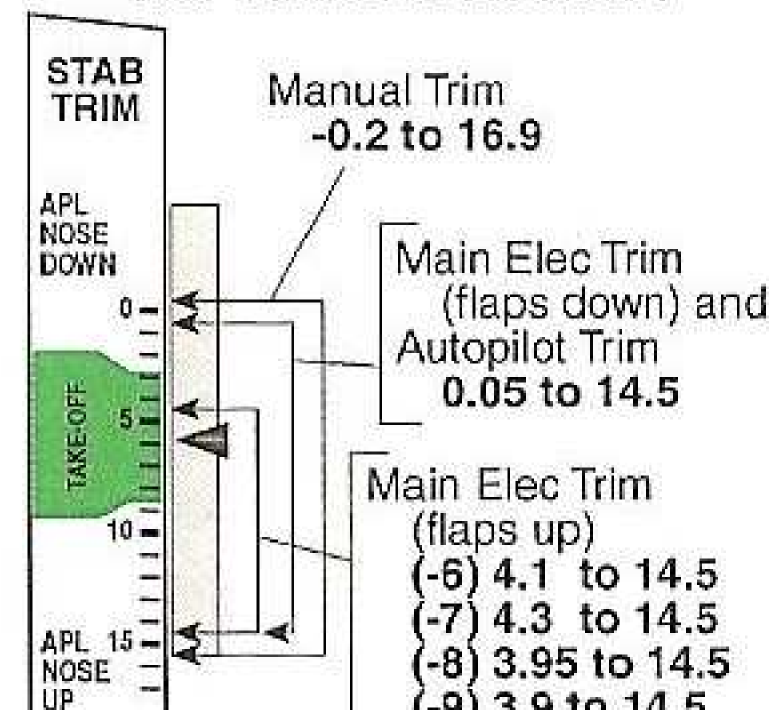
300 TRIM AUTHORITY



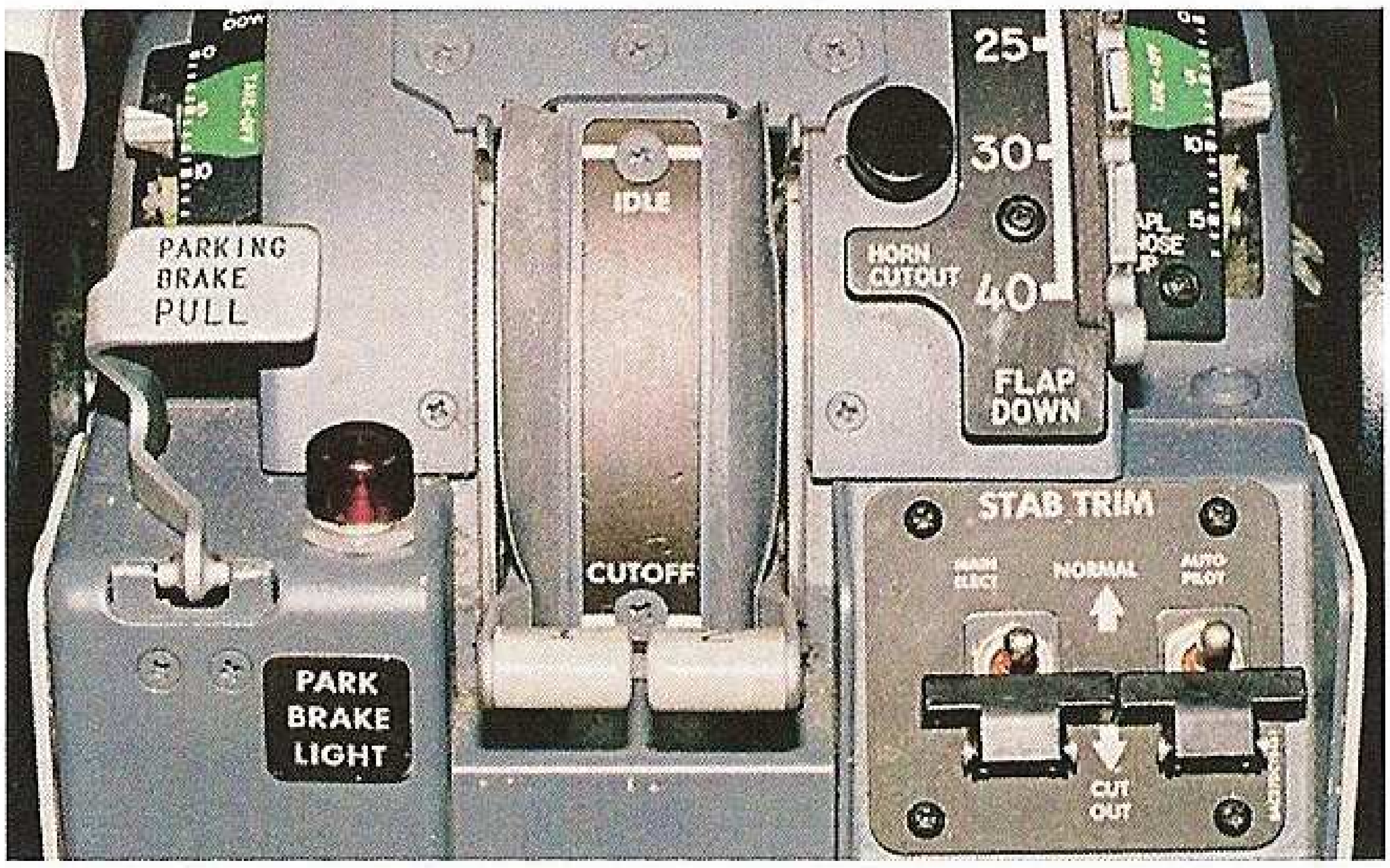
3-4-5 TRIM AUTHORITY



NG TRIM AUTHORITY



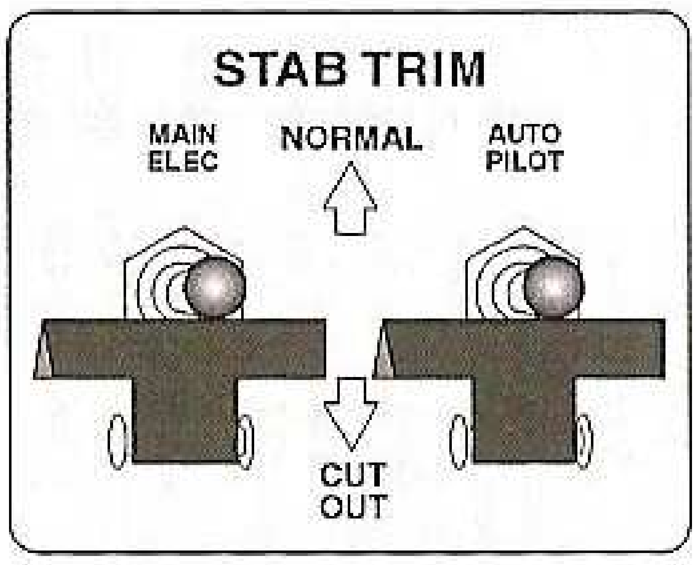
ENGINE START LEVERS



IDLE
- (3-4-5)
  - energizes the ignition system
  - mechanically opens engine shutoff valve (Main Engine Control - MEC)
  - electrically opens engine fuel valve (front spar outboard of the pylon)
- (NG)
  - energizes the ignition system through EEC
  - electrically opens engine fuel SOV via the EEC (opens FMV which opens the HPSOV on HMU)
  - electrically opens spar fuel valve (wing leading edge outboard of the pylon)

CUTOFF
- ignition system is de-energized
- (3-4-5)
  - mechanically closes engine fuel valve (MEC)
  - electrically closes the spar fuel valve
- (NG)
  - electrically closes the engine fuel valve (energizes the HPSOV solenoid on the HMU, closing the HPSOV)
  - electrically closes the spar fuel valve
    - an engine fuel spar valve battery makes sure that the engine fuel feed system always has power to close the engine fuel spar valve

STAB TRIM CUTOUT SWITCHES



STABILIZER TRIM MAIN ELECTRIC CUTOUT switch

NORMAL = normal operating position

CUTOUT = interrupts power to the main electric trim motor
- (3-4-5) main electric trim motors are disengaged
- (NG) main electric trim inputs are disconnected from the single stabilizer trim motor
- used for runaway stabilizer condition

STABILIZER TRIM AUTOPILOT CUTOUT switch

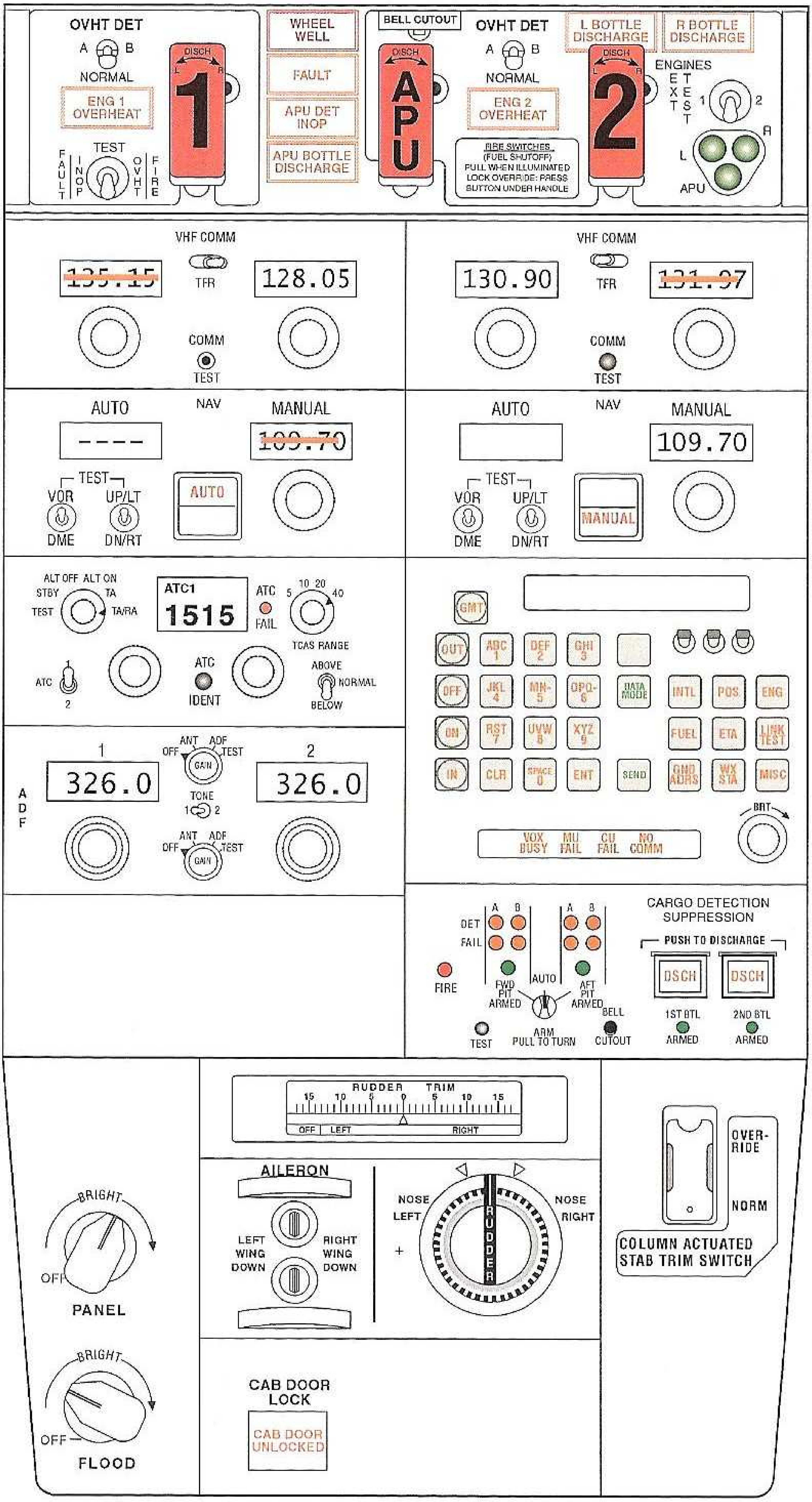
NORMAL = normal operating position

CUTOUT
- interrupts power to the autopilot electric trim motor
- autopilot disengages if engaged
- (3-4-5) autopilot trim motors are disengaged
- (NG) autopilot trim inputs are disconnected from the single stabilizer trim motor

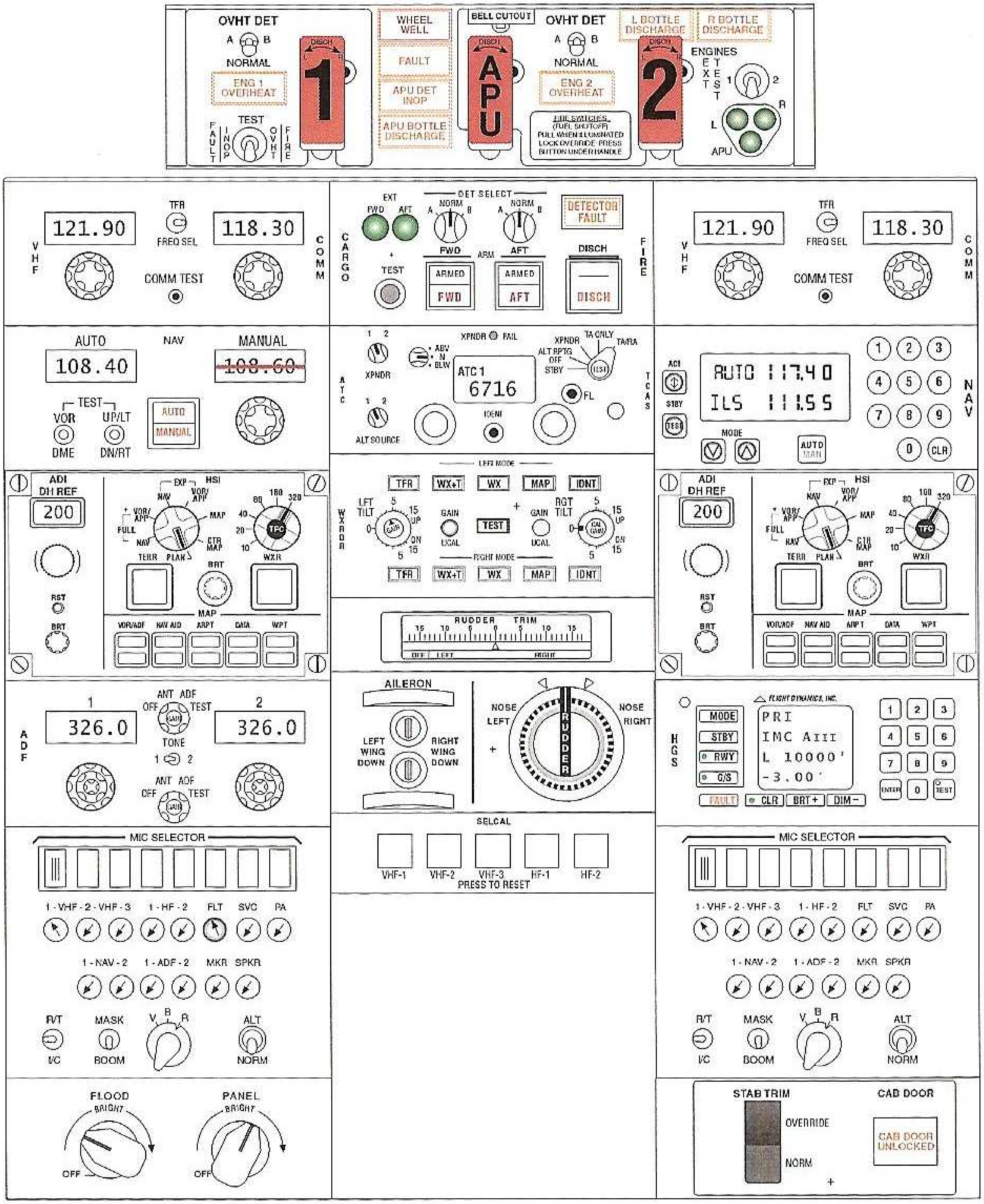
Trim System Notes

- control column cutout switch stops the stabilizer trim actuator when the pilot moves the control column in a direction opposite to the trim direction (out of the neutral range)
  - this can arrest a runaway trim
  - to test, trim in one direction and quickly move control column in opposite direction

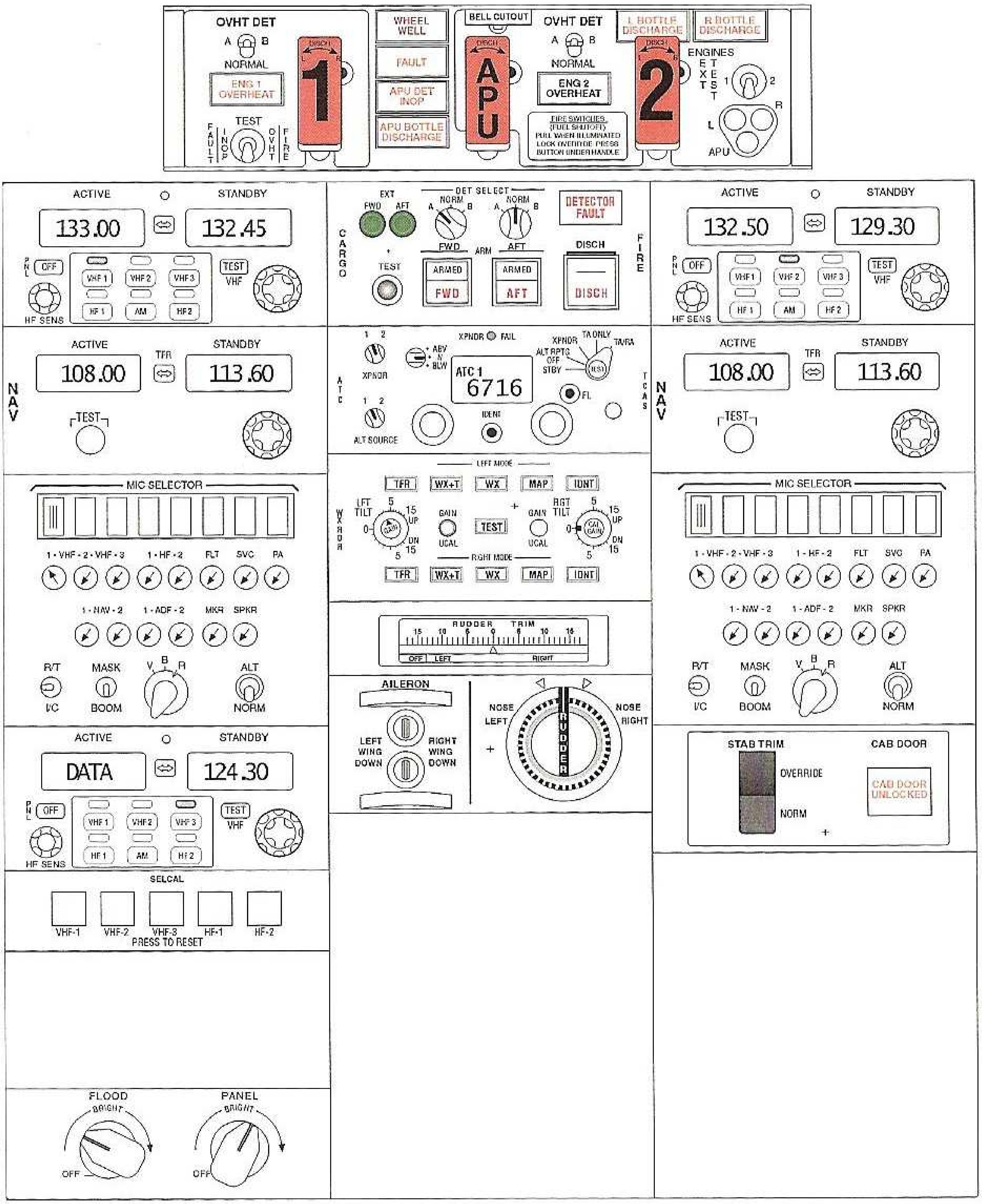
PEDESTAL - non EFIS (3-4-5)



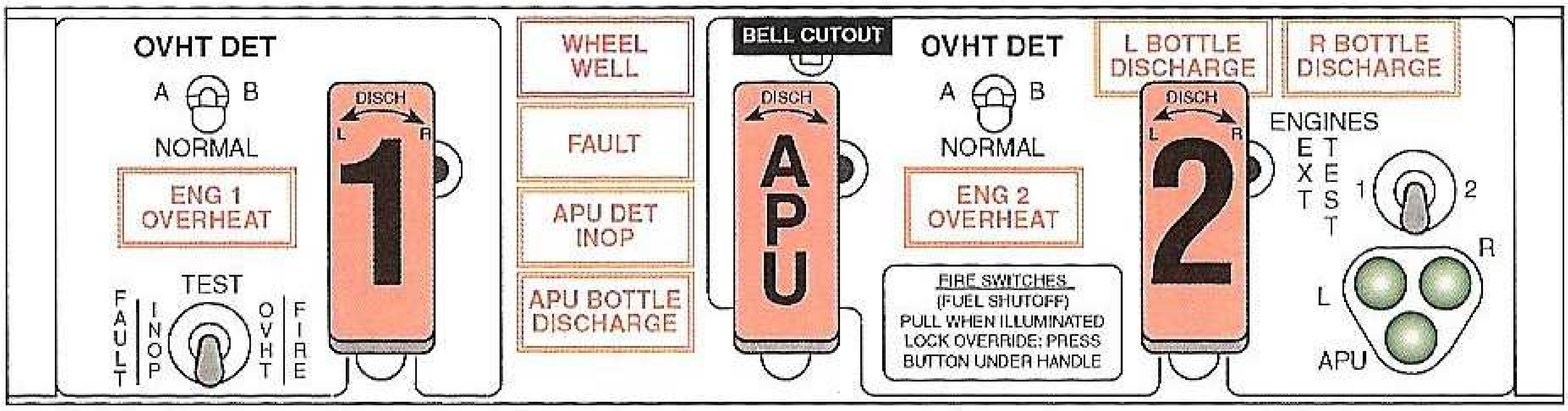
PEDESTAL - EFIS (3-4-5)



PEDESTAL - NG


OVHT DET
NORMAL
ENG 1 OVERHEAT
TEST
FAULT
INOP
OVHT
FIRE
WHEEL WELL
FAULT
APU DET INOP
APU BOTTLE DISCHARGE
BELL CUTOUT
ENG 2 OVERHEAT
L BOTTLE DISCHARGE
R BOTTLE DISCHARGE
ENGINES
EXT TEST
APU
ACTIVE
STANDBY
133.00
132.45
132.50
129.30
HF SENS
NAV
108.00
113.60
MIC SELECTOR
CARGO
DET SELECT
DETECTOR FAULT
ARMED
FWD
AFT
DISCH
ATC 1
6716
ALT SOURCE
IDENT
LEFT MODE
RIGHT MODE
TFR
WX+T
WX
MAP
IDNT
RUDDER TRIM
AILERON
LEFT WING DOWN
RIGHT WING DOWN
NOSE LEFT
NOSE RIGHT
RUDDER
STAB TRIM
OVERRIDE
NORM
CAB DOOR
CAB DOOR UNLOCKED
DATA
124.30
SELCAL
VHF-1
VHF-2
VHF-3
HF-1
HF-2
PRESS TO RESET
FLOOD
PANEL
BRIGHT
OFF

FIRE / OVERHEAT PANEL



OVERHEAT DETECTOR switch

- permits selection of 3 different modes of operation

NORMAL - both the A loop AND the B loop must sense (agree) an overheat or fire condition before a warning is activated

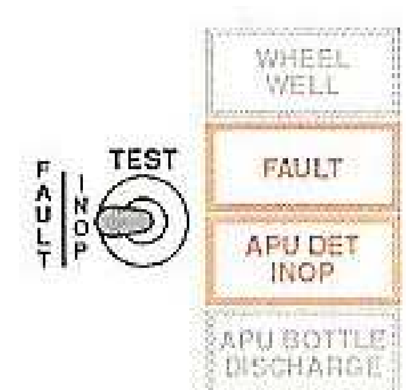
A or B - only the selected detector loop initiates an overheat or fire warning
- other is disabled

ENG OVERHEAT light (amber)

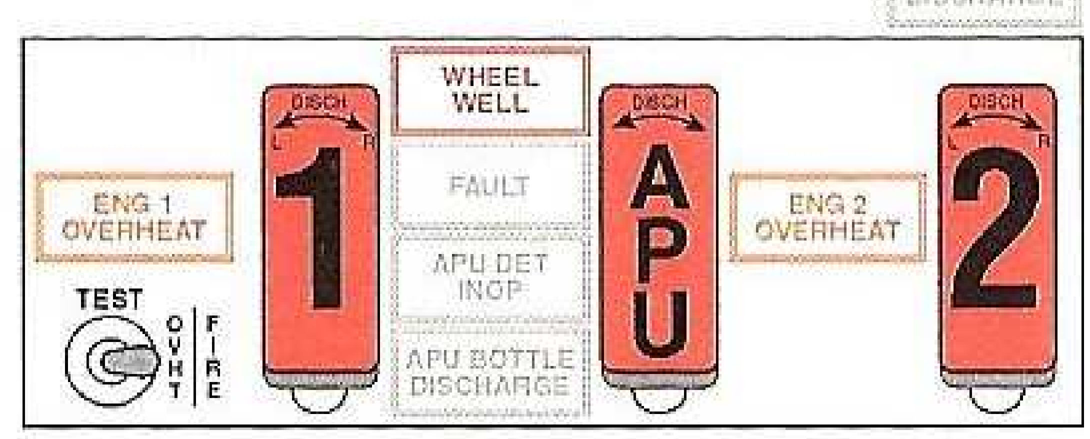
- illuminated = indicates an overheat on the associated engine
- must sense an overheat/overheat, overheat/fire, or overheat/fault
- MASTER CAUTION and OVHT/DET annunciator illuminates

FAULT / INOP switch

TEST switch lets you to do two tests.
- One test is for the fault detection circuits; the other is for the fire detector loops



FAULT / INOP TEST
- does a check of the engine and APU module fault detection circuitry and related flight compartment indications
- indications of a good test are the MASTER CAUTION, OVHT/DET annunciator, FAULT, and APU DET INOP lights illuminate (5 yellow lights)

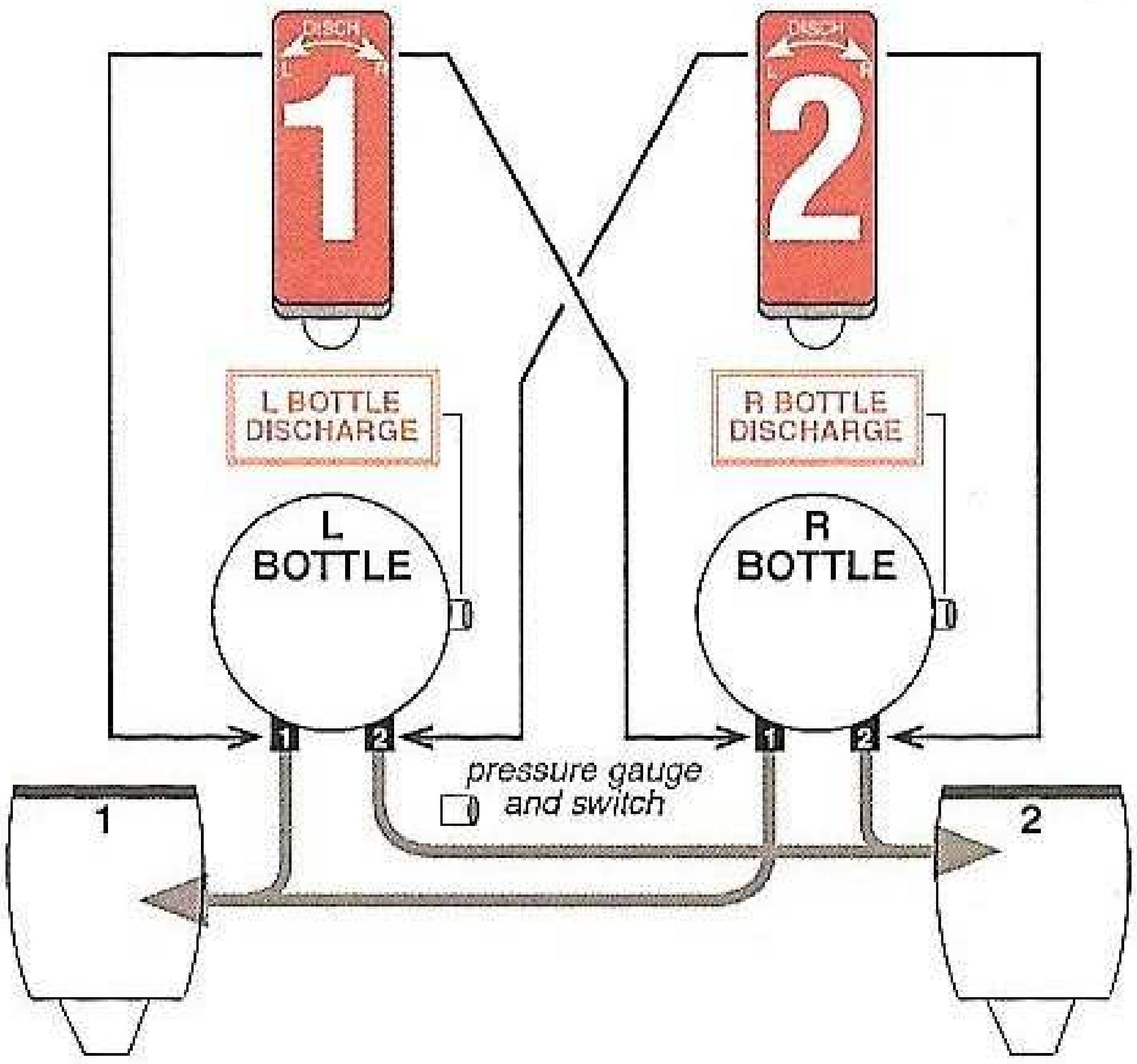


OVHT / FIRE TEST switch

OVERHEAT / FIRE TEST
- does a check of the engine and APU module overheat and fire detection circuitry and related flight compartment indications
- tests the overheat and fire detector loops on both engines and the APU, and the fire detector in the wheel well
- indications of a good test are: master FIRE WARN, MASTER CAUTION, OVHT/DET annunciator, ENG 1, 2, and APU fire warning lights (handles), ENG 1 and 2 OVERHEAT lights and the WHEEL WELL light (if AC power) (10 or 11 lights, red and yellow, and the bell)
- the alarm bell sounds in the cockpit; the APU horn sounds in the wheel well and the APU fire warning light in the wheel well illuminates flashing
- does not shut down APU, if it is running

ENGINE FIRE WARNING light in the handle (red)

- illuminated = the respective fire detector circuits sense a fire input
- dual loop needs fire/fire or fire/fault signal
- the master FIRE WARN lights illuminate and the fire bell sounds
- pressing either FIRE WARN light silences the fire alarm bell and extinguishes the FIRE WARN lights



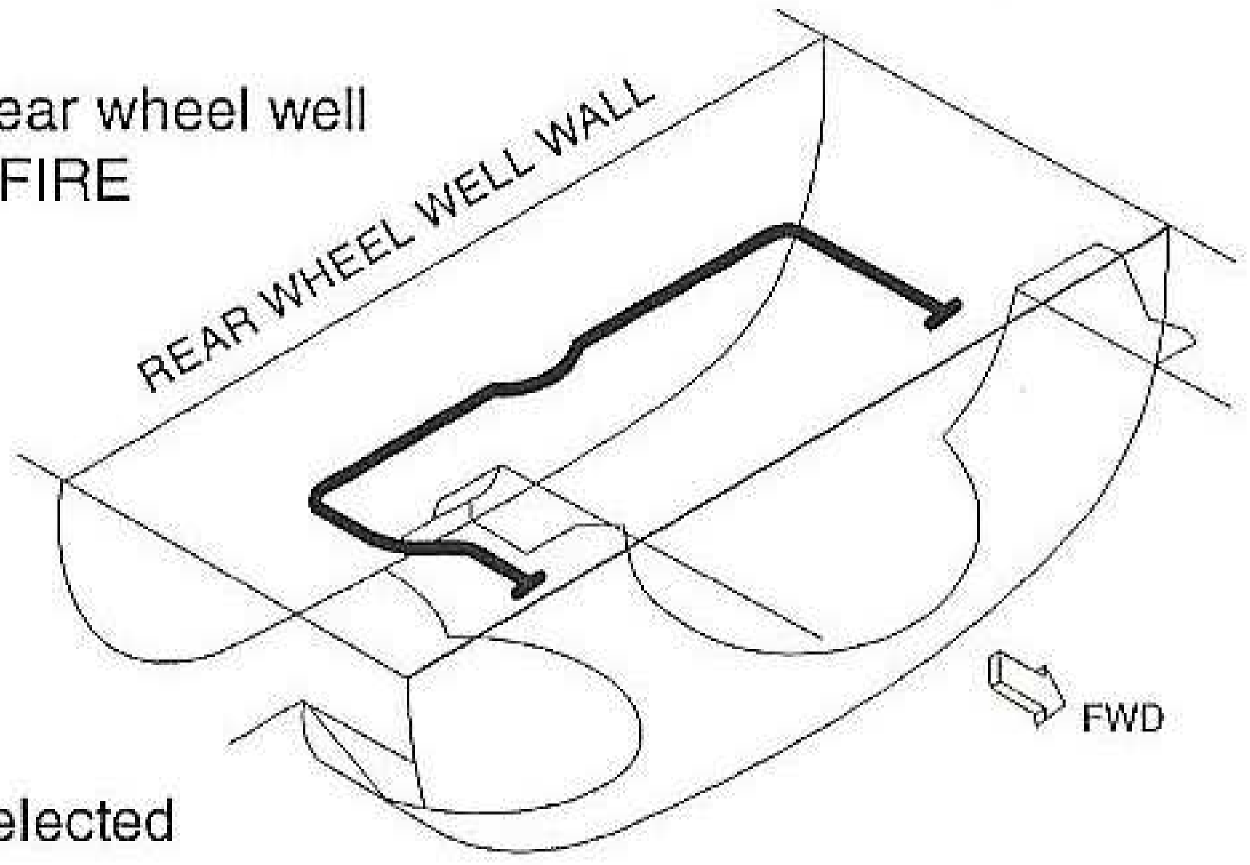
ENGINE FIRE WARNING handle

- the fire handle is locked down until the engine overheat / fire warning circuit detects an overheat / fire condition; the handle is then unlocked
- can override with button under handle, or OVHT/FIRE TEST switch unlocks the handle
- if the EDP runs for 5 minutes with the fire handle pulled, case drain filter must be inspected

PULL UP
- arms one discharge squib on each engine fire extinguisher
- closes the spar fuel valve, the bleed valve, and engine driven hydraulic pump SOV
  - damage to the EDP can occur if engine windmills for extended period of time
  - if the EDP runs for 5 minutes with the fire handle pulled, the case drain filter must be inspected
- thrust reverser control power goes off
- generator trips off
- deactivates engine driven hydraulic LOW PRESSURE light
- gouge is "3 valves close and BAT"
  - generator Breaker, Arms squibb, Thrust reverser

(NG) closes both the spar fuel valve and the high pressure fuel valve in the HMU

ROTATE (left or right) - clockwise, 28v dc goes to the right bottle dual squib
- releases halon to engine; hold until you see the discharge light
- turn the same handle counter-clockwise, 28v dc goes to the left bottle dual squib



WHEEL WELL light warning (red)
- illuminated = indicates a fire in the main gear wheel well
- the fire alarm bell sounds and the master FIRE WARNING lights illuminate
- requires normal AC power

FAULT light (amber)
- illuminated during FAULT / INOP TEST if the detector circuits are OK
- illuminated during OVHT / FIRE TEST if
  - one loop is inop in either engine, or
  - the detector circuit of the single loop "selected A or B" has failed
- illuminates if both loops in any circuit have failed
  - fire detection in one or both engines is inop; consider landing as soon as possible
- will not cause MASTER CAUTION or fire handle lights to illuminate

APU DET INOP light (amber)
- illuminated indicates a malfunction in the APU fire detection loop
- the MASTER CAUTION light and OVHT/DET annunciator illuminates

(QRH) APU DET INOP
- place APU switch to OFF. Do not operate the APU
- an APU fire would not be detected and the APU would continue to run

(MEL) APU DET INOP light - ATA 26
- if the APU DET INOP light fails to illuminate during the FAULT/INOP test, but the red APU fire warning handle illuminates during the OVHT/FIRE test, the APU Fire Detection system is operating normally, and the APU may be used provided the OVHT/FIRE fire warning test is successfully conducted before each APU start

APU BOTTLE DISCHARGE light (amber)
- illuminated = APU bottle has discharged; actually it is actuated by bottle pressure
  - if you had a small leak, you could get the light, and (3-4-5) still have discs
- (3-4-5) lose yellow disc for intentional discharge; red one for thermal discharge

FIRE WARNING BELL CUTOUT switch
- PRESS
  - silences the fire alarm bell and cancels the master FIRE WARN lights
  - silences the APU horn in the main wheel well
  - causes the flashing APU fire warning light in the main wheel well to turn steady

APU FIRE WARNING handle
- the handle is locked down until the APU fire detector circuit senses a fire input
  - the handle is then unlocked. Can override with button under handle

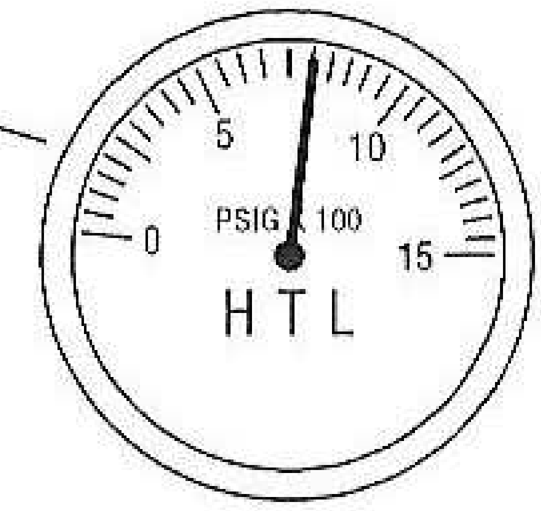
PULL UP - gouge is 2 SOVs and the word "BAD"
  - closes fuel and bleed air SOVs
  - trips generator Breaker, Arms discharge squibbs, closes inlet Door

ROTATE - left or right to discharge the single APU fire bottle (halon)
  - hold until you see APU BOTTLE DISCHARGE light
    - rotate right, so you can see discharge light easier

(QRH) APU FIRE INFLIGHT

FIRE WARNING SWITCH.................................PULL, ROTATE AND HOLD
- rotate to stop and hold until APU BOTTLE DISCHARGE light illuminates. To manually unlock the APU fire handle, press the override button under the handle and pull
- place APU switch to off. If light remains illuminated land at the nearest suitable airport

L/R BOTTLE DISCHARGE lights (amber)
- illuminated = indicates the associated engine fire bottle has low pressure; either by intentional discharge or thermal discharge
- you can check the two bottle pressure indicators in wheel well

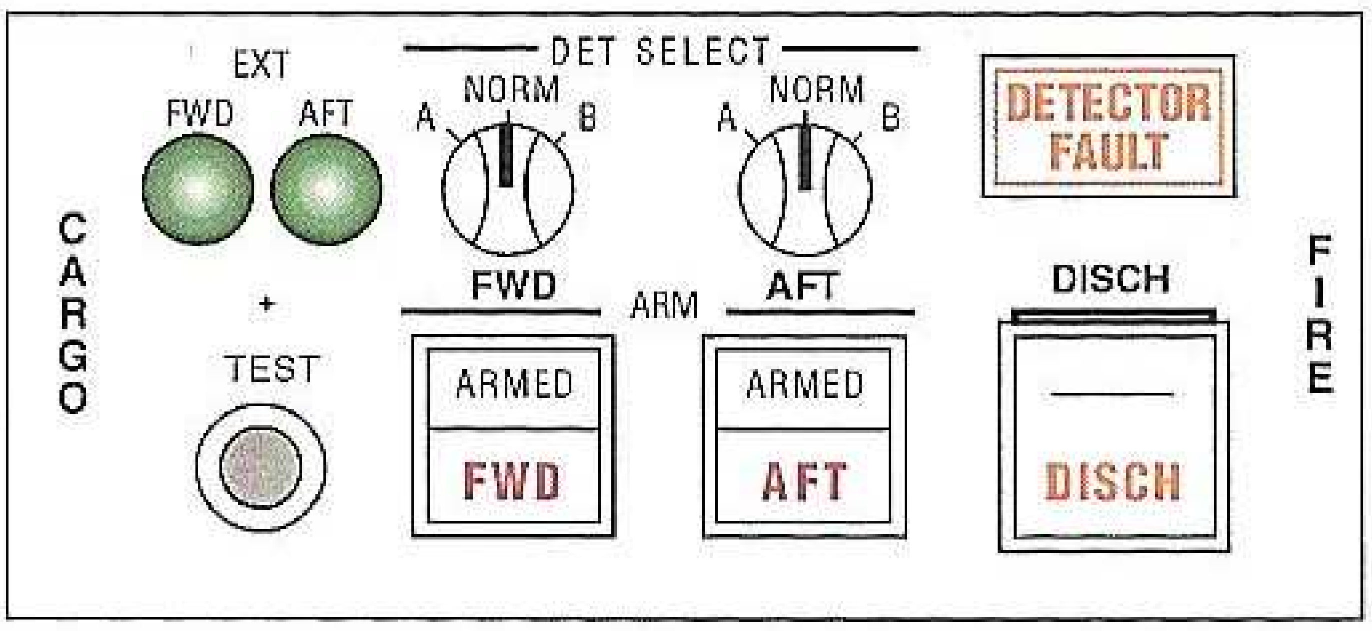


EXTINGUISHER TEST switch
- 1 tests the left and right squib for bottle #1, and APU squib
- 2 tests the left and right squib for bottle #2, and APU squib
- you test the same APU squib with the switch in the 1 or two position

EXTINGUISHER TEST lights (green)
- illuminated = the discharge circuits are normal

(L/OP) Fire Warning, Bottle Pressure
- engine fire bottles (two) 800 psi @ 70°F, located in left wheel well

CARGO FIRE DETECTOR



TEST

- test signal sent to the forward and aft cargo fire detector loops and squib circuits
- fire bell sounds, both master FIRE WARN (glareshield) illuminate
- red DISCH light illuminates, and green EXT FWD and AFT squib lights illuminate
- red FWD and AFT lights illuminate when all detectors in selected loops respond to fire test
  - if a FWD or AFT light fails to illuminate, one or more detection loops for the associated cargo compartment is inop
  - to determine the specific inop loop(s), position DET SELECT switch(es) A or B, as required and do the test again

> To operate the cargo compartment fire extinguishing system you push the related cargo fire warning switchlight (FWD or AFT), lift the guard to the DISCH switchlight and push the DISCH switchlight.

EXT FWD / AFT lights (green)

- illuminate during test to verify good circuit between the panel and the forward and aft squibs on the cargo fire extinguisher bottle(s)

DET SELECT switches (3 position)

NORM = detection loops A and B are selected (dual loop system similar to ovht/fire loops)
- when the DET SEL switch is set to NORM, smoke must be detected by a detector in loop A and loop B (any detector in both loops, they do not have to be a pair) before the alarm will occur
- if one has failed, other will operate

A = detection loop A is selected

B = detection loop B is selected
- when the DET SEL switch is set to A, and any detector in loop A detects smoke, an alarm will occur. Similarly, when the DET SEL switch is set to B, and the B loop detects smoke, the alarm will occur

(MEL) FWD/AFT Detection Loops - ATA 26

- one loop (A or B) may be inop in each compartment provided other (A or B) works ok
- if A and B loops are inop in same compartment, that compartment must remain empty

ARMED window (white)

- extinguisher(s) are armed by pushing the appropriate armed switch, FWD or AFT
- a shutter mechanically opens displaying ARMED

FWD / AFT Fire Warn lights (red)

- at least one detector in each loop has detected a fire in the respective cargo compartment (DET SELECT switches in NORM)
- at least one detector in the selected loop has detected a fire in the respective cargo compartment (DET SELECT switch(es) in A or B)
- FIRE WARN illuminates and fire bell sounds

(MEL) FWD/AFT Detection Loops - ATA 26

- one loop (A or B) may be inop in each compartment provided opposite loop is normal
- if Fwd *and* Aft loops are inop, cargo compartment must remain empty

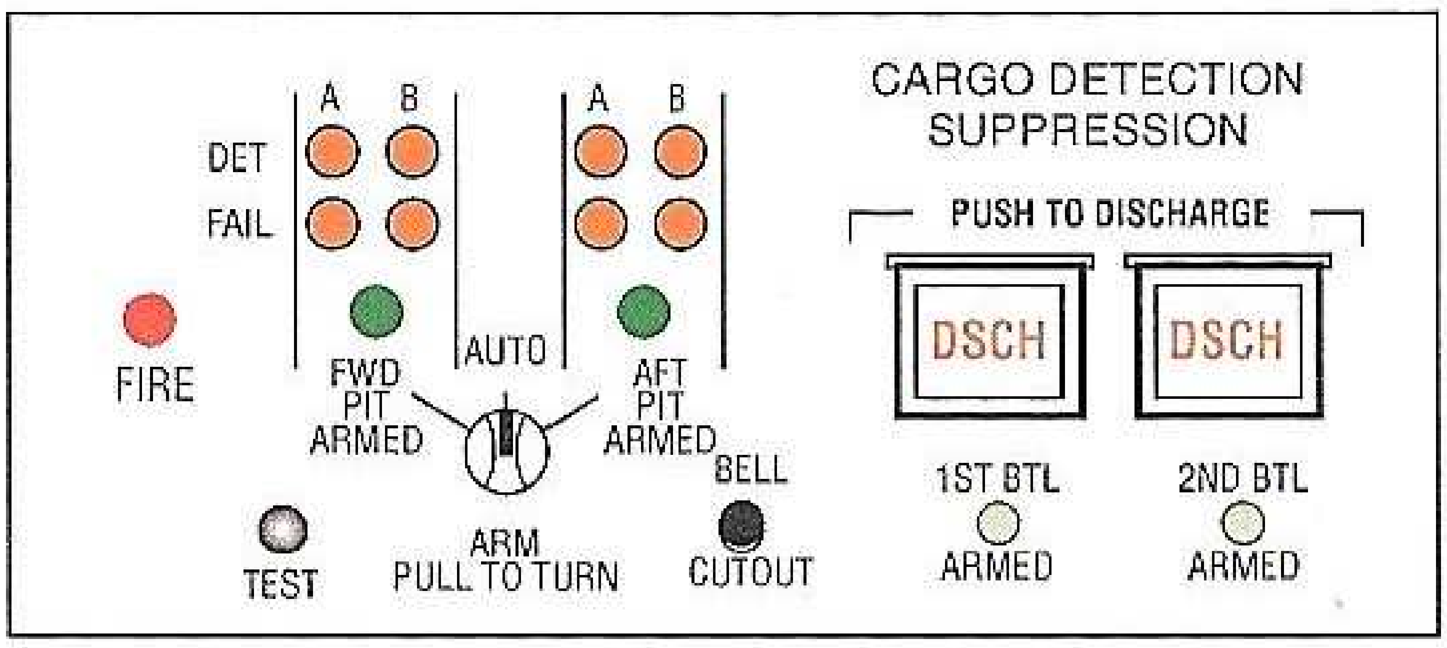
DISCH switch (amber)
- if armed, pressing this switch will discharge halon 1301 (pressurized with nitrogen)
- DISCH light illuminates when the bottle is discharged (less than 250 psi)
  - may take up to 30 seconds to illuminate
- a timer is set for 60 minutes to discharge the second bottle (second bottle is option)

(MEL) Extinguisher Bottle #2 - ATA 26
- may be inop but must remain within 60 min of an adequate airport

DETECTOR FAULT light (amber)
- illuminated during a test, indicates one or more detectors in the loop(s) has failed
  - individual detector faults can only be detected by a manually initiated test
- illuminated for a dual loop failure (DET SELECT switches in NORM)
  - fire detection system in one or both cargo compartments is inop
- illum. indicates one or more detectors in the selected loop has failed (sw. in A or B)

(QRH) Cargo Fire
- arm the appropriate switch (FWD or AFT), lift the protective cover, push the DISCH switch, turn the recirc fan(s) off, and turn the right pack off
  - the DISCH switch illuminates to confirm agent discharge
- land at nearest suitable airport

CARGO FIRE DETECTOR



Cargo Detection Suppression Control Panel (CDSCP)

DET lights (4) (amber)

- illuminate:
  - when a detector in the respective loop senses smoke
  - residual smoke trapped in the compartment will cause fire warning lights to remain on even thought the fire may be extinguished

FAIL lights (4) (amber)

- illuminate when a detector in the respective loop (A or B) has failed
- MASTER CAUTION and OVHT / DET annunciator lights illuminate
- when one detector in a unit fails, the system automatically operates that detector unit in a single loop mode

FIRE light (red)

- illuminates when a cargo fire is detected simultaneously within the same pair of A and B smoke detector loops
- a cargo fire warning will also occur when any loop A detector plus any loop B detector in the same bay detects smoke
- bell, MASTER CAUTION, FIRE WARN, and OVHT / DET annunciator light; on the CDSCP, FIRE warning, A and B DET lights for the affected bay, FWD and AFT squib lights – for affected bay – and BTL 1 and BTL 2 squib lights
- if only one smoke detector senses smoke, its respective loop's DET light will illuminate instead of the FIRE WARN and FIRE warning lights
  - to arm the fire suppression for discharge when only one DET light is on for the affected compartment, move the ARM selector switch from AUTO to the affected compartment positon (FWD or AFT)

TEST

- press for 3 seconds to test integrity of detector loops and suppression systems
  - if held for less than 3 sec, FAIL lights illuminate and test does not occur
- all functions and lights on the panel except the DSCH annunciators are tested
  - on CDSCP, FIRE, FAIL, and DET lights illuminate
  - FIRE WARN, MASTER CAUTION and OVHT / DET illuminate and bell sounds
- if a DET loop has failed, the system will automatically turn off the faulty detector, turn on the respective FAIL light, and switch the unit to single loop mode
  - ARM switch must be in AUTO when conducting a test in order for the system to switch from dual to single loop mode in case of failure
  - when operating in the single loop mode, a cargo fire warning will occur if the operating detector in the affected unit detects smoke

Squib lights (green)

FWD PIT ARMED and AFT PIT ARMED lights

- illuminate:
  - during a system test
  - when the system is armed to show the status of the squibs
- an illuminated squib light indicates the respective squib has not been fired and is ready
- after a squib is fired, its respective squib light will not illuminate

FWD or AFT - shows status of squibs on the diverter valve

1ST BTL or 2ND BTL - shows status of squibs for halon bottles 1 and 2¥

ARM switch

- controls arming of the four discharge control squibs (must pull to turn)

AUTO - a cargo fire warning will automatically arm the diverter valve squib for the appropriate bay – FWD or AFT – and arm both the BTL 1 and BTL 2 squibs
- the respective squib lights will illuminate

FWD PIT ARMED or AFT PIT ARMED - manually arms the diverter valve squib for the selected bay and both the 1ST BTL and 2ND BTL squibs (cargo fire warning is not required)
- respective squib lights will illumianate

DSCH switch

- not powered until armed
- armed automatically if Arm switch is in AUTO and a cargo fire is detected
- when the Arm switch is in the FWD or AFT position, the DSCH switches are armed irregardless of a cargo fire warning
- when armed, pressing the 1ST BTL DSCG switch fires two squibs; one squib releases halon from bottle 1, and the other squib directs the halon to the appropriate cargo bay through the diverter valve
- 15 minutes later, press 2ND BTL DSCG switch. This fires a squib releasing halon from bottle 2 through a restrictor into the same bay as bottle 1
  - the restrictor sustains the discharge of halon for approximately 45 minutes for a total protection time of 1 hour

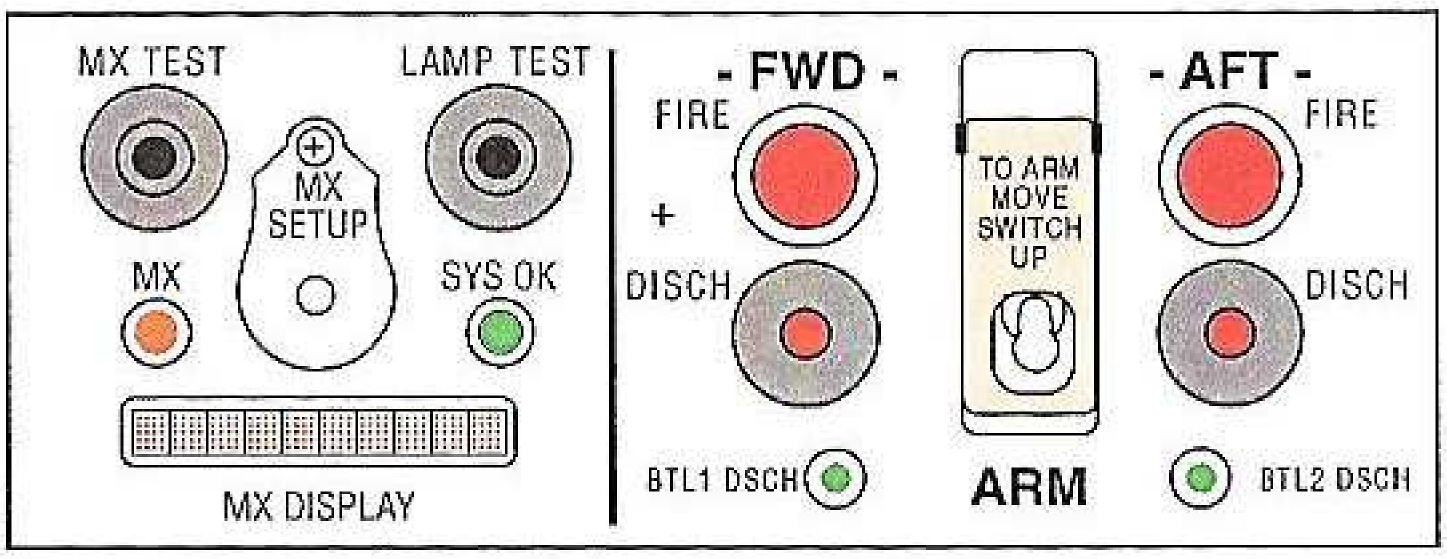
DSCH light (amber)

- indicate status of halon bottles 1 and 2
- illuminate when pressure for their respective bottle is low (intentional discharge or leak)
- tested through LIGHTS TEST switch on center panel

BELL CUTOUT

- silences the fire bell and extinguishes FIRE WARN light

Cargo Bay Smoke Detection and Fire Suppression Control Display Unit



Lamp test button
- push and hold
  - illuminates all lamps on CDU
  - illuminates all pixels on alpha-numeric display
  - illuminates master FIRE WARN lights and cockpit fire warning bell sounds
- release
  - the SYS OK light extinguishes for 1 second, then illuminates
  - all other CDU lights extinguish

Maintenance test button
- for maintenance use only

Maintenance light (MX)
- illuminates
  - system requires maintenance
    - if SYS OK lamp also illuminated, system will still function
  - both halon bottles have discharged normally, or
  - bottle number 1 fails to discharge within 40 seconds

Maintenance Setup Switch (MX SETUP)
- for maintenance use only

System OK light
- illuminates if system is operating normally

Alpha-numeric display
- displays system status messages

Cargo Bay Fire Warning lights (FWD or AFT FIRE)
- illuminated (red) if a fire is detected in the forward or aft cargo bay

ARM toggle switch
- Down for normal operation
- UP sends an arm signal to the central control unit

Discharge buttons (FWD or AFT DISCH)
- push to send a discharge signal to the central control unit
- if an arm signal has been received by the central control unit, bottle #1 will be commanded to discharge into the related cargo bay

Bottle Discharge lights (BTL 1 and BTL 2)
- illuminated
  - steady = the related halon bottle has been discharged
  - blinking = the related halon bottle is discharging or has failed to discharge

(QRH) Cargo Bay Fire

ARM TOGGLE SWITCH ....ARM (UP)
- verify alpha-numeric display reads SYS ARMED

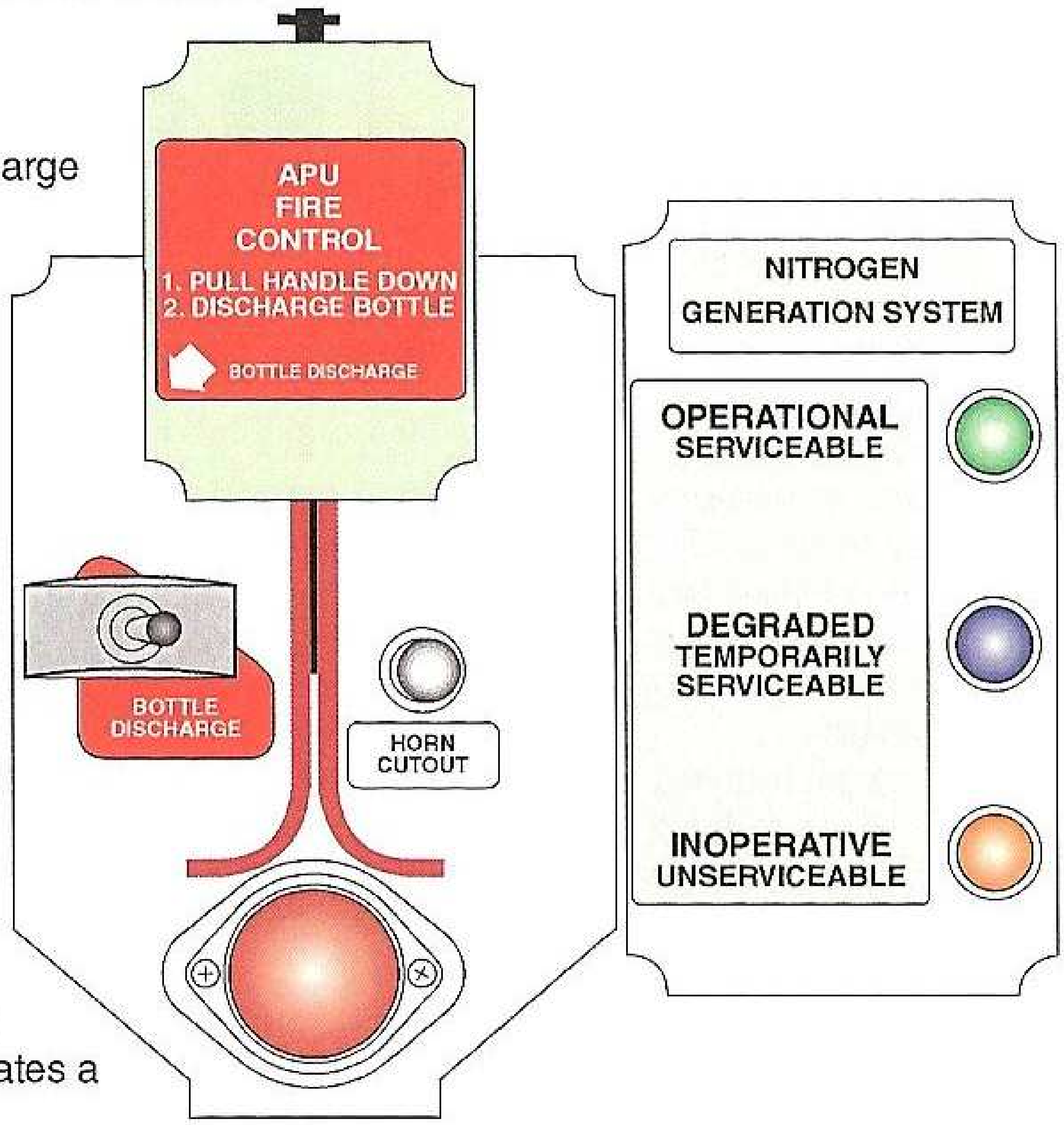
FWD OR AFT DISCHARGE BUTTON (AS APPROPRIATE)................PRESS
- the green BTL 1 DISCH light will blink until discharge is complete then illuminate steady
- the alpha-numeric display will indicate BTL 1 DISCH until discharge is complete

RECIRC FAN..OFF

RIGHT PACK SWITCH..OFF
- these two actions help prevent smoke from entering the cabin

LAND IMMEDIATELY AT THE NEAREST SUITABLE AIRPORT

APU FIRE GROUND CONTROL PANEL (P28)
- located in right main wheel well on aft bulkhead



APU FIRE CONTROL HANDLE
- when pulled:
  - arms the APU bottle discharge switch on this panel only
  - closes the APU fuel shutoff valve, bleed air valve, and APU inlet door. The generator control relay and generator breaker trip
    - no discharge light in wheel well

APU BOTTLE DISCHARGE switch
- armed if the APU fire control handle is pulled
- activate to discharge the APU extinguisher

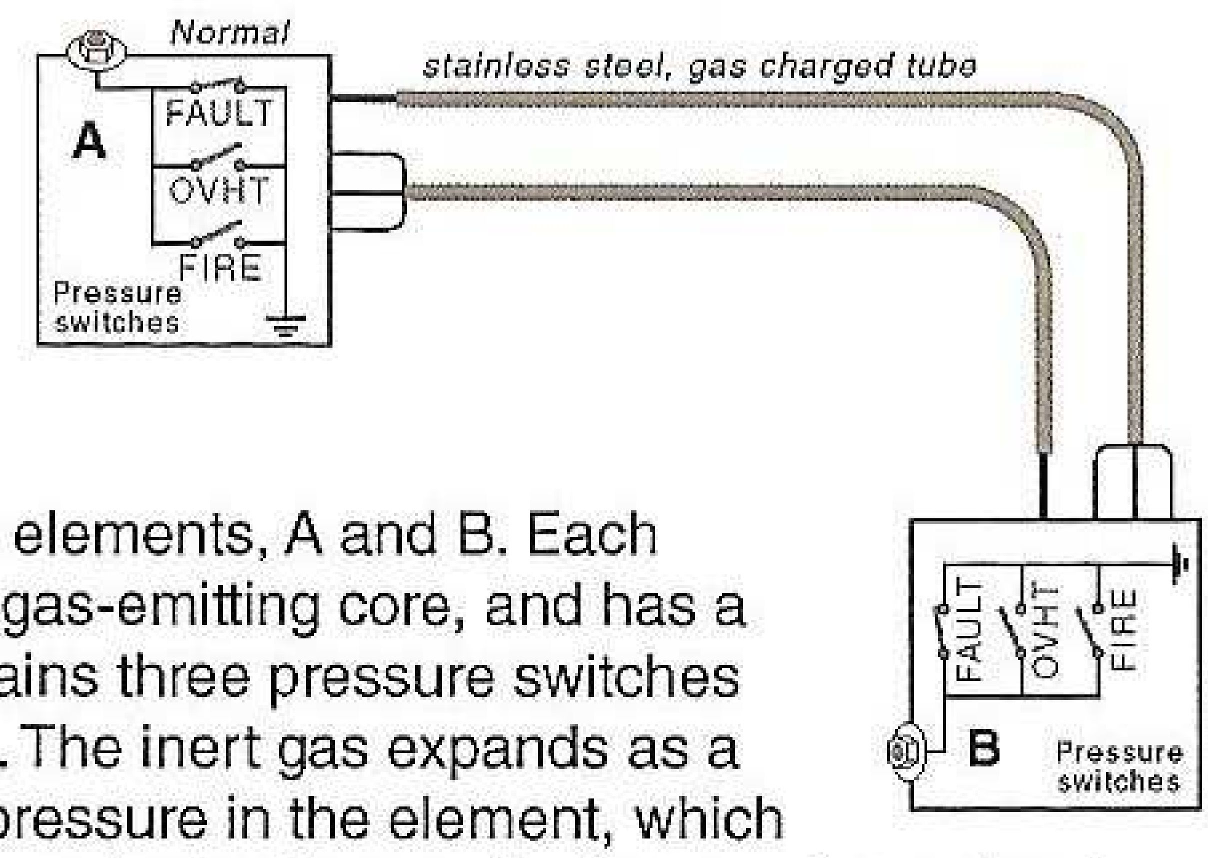
APU FIRE WARNING light (red)
- illuminated (flashing) = indicates a fire in the APU
- FIRE WARN lights illuminate, the fire alarm bell in the cockpit rings, the APU horn in the main wheel well sounds

APU HORN CUTOUT BUTTON
- will silence the APU fire warning horn and cause the APU fire warning light to stop flashing but will remain on steady
- cancels FIRE WARN and bell in cockpit
- APU fire horn is disabled in flight

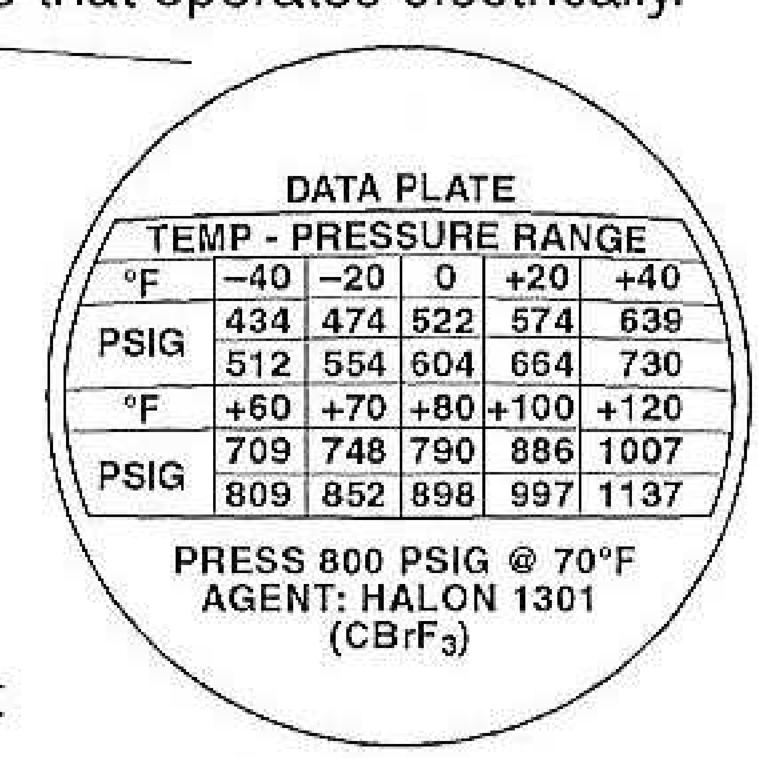
NGS OPERABILITY INDICATOR (as installed)
- operability Indicator provides a visual check of the condition of the Nitrogen Generation System (NGS) using 3 lights, green, blue, and amber
  - Note: No lights illuminated also indicates the NGS is inoperative
- the NGS gets bleed air from the left side of the pneumatic manifold to generate nitrogen-enriched air (NEA) using an air separation module and supplies this NEA to the center tank to displace normal O2 content air
  - reduces the oxygen concentration in the center fuel tank to a level which will not support combustion
- operation of the NGS is transparent to the crew; it does not require any crew action to operate the system, nor are there any flight deck indications
- automatically starts operating after takeoff and runs continuously through landing and for a short period, during taxi
- shuts down after a specified period of time or when bleed pressure is no longer available
- automatically shuts down during the following non-normal flight conditions
  - an engine is not running, fire or smoke detection in the cargo or main deck areas, left air conditioning pack overheat, or center tank refueling valve is open

(MEL) NGS System Inop
- the fuel tanks are primarily protected by precluding ignition sources; hence dispatch with the NGS inoperative is acceptable under MEL procedures

Fire Protection System Notes



1. Engines
   - detection from battery bus
   - extinguishers from hot battery bus
     - overhead panels painted in a lighter color contain major components affected by the fire handle
   - a detector consists of two identical sensing elements, A and B. Each sensing element contains an inert gas and gas-emitting core, and has a responder on one end. The responder contains three pressure switches for sensing integrity (fault), overheat, or fire. The inert gas expands as a function of temperature and increases the pressure in the element, which causes an alarm pressure switch in the responder to close, activating an alarm signal.
     - both actions are completely reversible - as the temperature decreases, the pressure decreases, and the alarm switch deactivates.
     - gas pressure in the tube holds the fault pressure switch in the closed position. When a sensing element is damaged allowing the inert gas to leak, the integrity pressure switch opens and the fault signal is sent to the fire control panel.
     - the other two pressure switches close when the gas pressure increases because of an overheat or fire condition. The overheat or fire signal is sent to the cockpit.
     - at the overheat temperature set point, the gas expands in the detector and closes the overheat pressure switch. This decreases the resistance of the detector. The engine or APU fire detection module uses this decrease in resistance to set the overheat warning. If the temperature increases to the fire temperature set point, the gas expands more to close the fire pressure switch in the detector. This decreases the resistance further setting the fire warning.
   - if an engine overheat/fire detector fails to operate, the engine and APU fire detection module automatically changes to single loop operation In the single loop mode, only one loop must detect an overheat or fire condition for the engine and APU fire detection module to give the alarm condition. There is no indication in the flight compartment of single loop operation until you do the OVHT/FIRE test.
   - two bottles with pressure indicators are in the left wheel well
     - each fire extinguisher bottle has two squibs, controlled by the fire handles 1 and 2
     - squib #1 on each bottle sends halon to engine 1 and squib #2 on each bottle sends halon to engine 2
     - engine 1 fire handle controls both #1 squibs and handle 2 controls both #2 squibs
     - the purpose of the squib is to break the diaphragm seal and start the release of the halon gas from the bottle. The squib is an explosive device that operates electrically.
   - data plate on bottle says it's charged to 800 psig @ 70°F



2. APU
   - fire detection from battery bus (28v DC)
     - fire signal automatically shuts down APU
     - shuts fuel SOV at the APU
     - fuel SOV at wing spar still open until fire handle pulled
   - fire protection (extinguishers) from hot battery bus
   - single loop for detection for fire (no overheat light for APU)
   - single bottle - has no pressure indicator
     - located in 48 horizontal stabilizer accessory compartment
       - yellow blowout disc indicates intentional discharge
       - red blowout disc indicates thermal discharge (bottle exceeded 1800 psi or 266°F)
3. Wheel well warning
   - single loop detection system (no extinguishing system)
   - power source is #1 transfer bus for the classic and #2 transfer bus for the NG
   - light will go out when loop cools
     - wait at least 20 minutes after light goes out, before putting gear back up

- The OVHT/FIRE test position checks the continuity of the sensing element. If the element has continuity, the indications are the same as during a real alarm. If the element does not have continuity, there are no indications in the cockpit. There is no difference between a real alarm and a short circuit.
- The sensing element is a thermistor type with resistance inversely proportional to temperature. As the temperature increases, the resistance decreases. If any portion of the sensing element is above the alarm temperature (400F, 205C), the element resistance decreases sharply. The single wire in the center is the power lead and the outside tube is electrically grounded. The insulating resistance of the core material decreases suddenly at the alarm temperature. Current flows through the core material to ground when alarm temperature is sensed. When the overheat condition is removed, the temperature and sensing element resistance values return to normal. The overheat signal will be removed and the wheel well overheat indicating components will go off.

4. troubleshooting engine and APU fire controls
   - assume the ENG #1 fire handle and ENG 1 OVERHEAT light did not come on when you did the test; you would move the #1 ENG OVHT DET switch to A. If this was the failed loop the related fire handle and engine overheat light will not illuminate. Conversely, moving the OVHT DET switch to B would allow for a successful retest (fire handle #1 would illuminate)
5. lavatory extinguishers
   - temp indicator placard is on inside of door, black dots indicates discharge
   - nozzle discharge tips, normally flat black, turns gray when discharged
     - there is no cockpit indication if these have discharged
     - must remove trash bin to get to these nozzles
6. lavatory smoke detector under sink or on ceiling
   - sink model series of chimes sound and has red alarm indicator outside the lav
   - ceiling model has its own siren and built in red light
   - deactivate by disconnecting cannon plug under the sink
     - later type can be deactivated by cycling the CB for 5 seconds or depressing recessed interrupt switch
     - pulling CB PASS & CREW CALL / SMOKE DET (P18-4 A1) deactivates all detectors and call sys
   - press interrupt button (with stick) for 3 to 5 seconds to stop siren
   - (NG) preflight check requires green light (power indicator) be on
   - lavatory fire extinguishing system: maintenance required if discharged (black placard dots, or nozzle tip aluminum color)
7. cargo compartment fire protection (class C)
   - gives warnings in the flight deck if there is smoke (photoelectric cell) or overheat (more than 230F / 110C) in a lower forward or aft cargo compartment
   - single bottle installation provides 60 minute fire supression protection

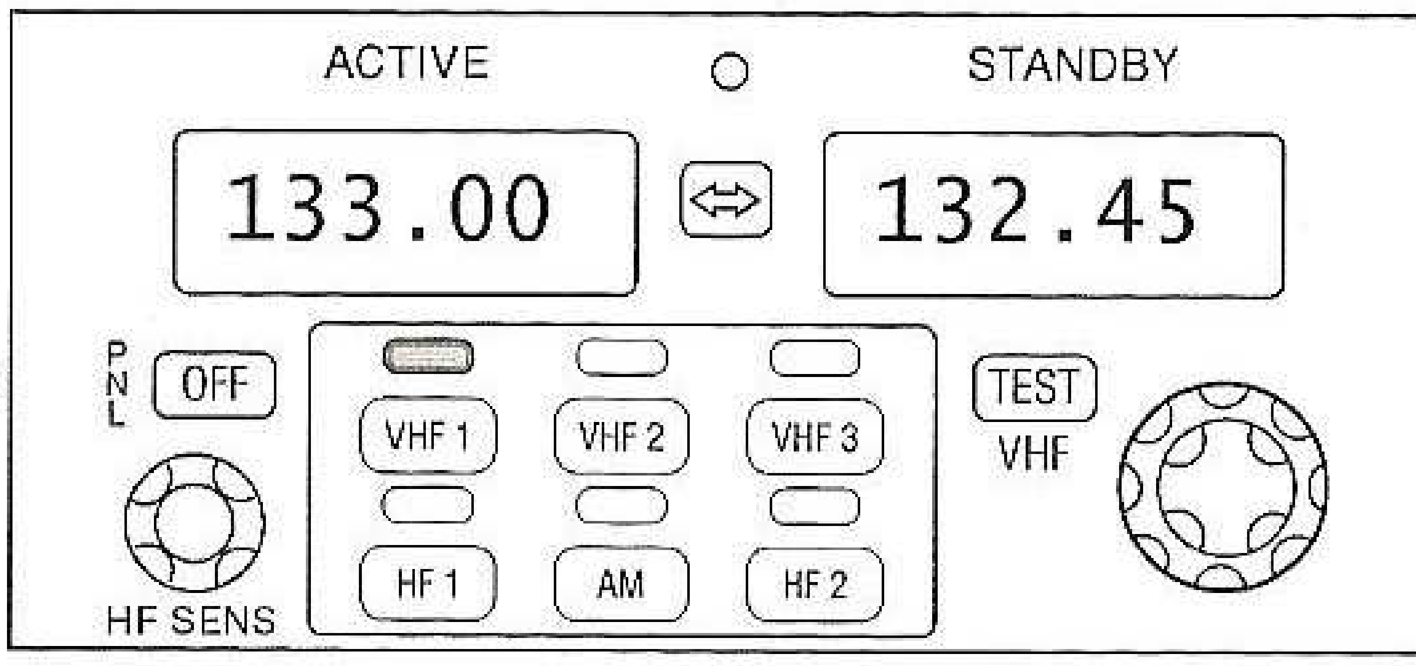
   CAUTION: fire may erupt as soon as the cargo compartment ~~door~~ is opened

   (3-5) complete system from Hot Battery Bus
   - two pairs of smoke detectors installed in the fwd compartment ceiling, three in the aft
   - each unit contains one Loop A and one Loop B detector, for a total of 4 detectors in the forward and 6 in the aft
   - each individual detector is continuously performing a self-test using its BIT capability
   - first bottle discharged results in total discharge ("knockdown")
   - after 15 minutes, the suppresson control unit (SCU) will fire bottle #2
     - second bottle is metered to distribute for approximately 60 minutes ("sustained")
     - BTL 2 DISCH will blink during the discharge then illuminate steady
     - the alpha-numeric display will indicate BTL 2 DISCH then blank when discharge is complete; when both bottles have discharged the sys ok light goes out and the MX light will illuminate

   (NG) detection powered from DC 1 and DC 2; extinguishers from Hot Battery Bus
   - forward and aft cargo compartments each have smoke detectors in a dual loop configuration (4 fwd - 6 aft in ceiling)
     - normally both detection loops must sense smoke/overheat to cause an alert
     - these loops function the same as the engine overheat/fire detection loops

AFT ELECTRONICS PANEL

COMMUNICATION RADIOS PANEL



Radio Tuning Panel (NG)

- allows each of the 3 panels to tune any of the available radios, VHF1, VHF2, VHF3, HF1, or HF2 (option)
- select the desired radio with one of the five pushbuttons
- technique; leave #1 radio in VHF1, #2 in VHF2, and #3 in VHF3 (power up settings)
  - if you use #3 for datalink (ACARS), keep DATA in the ACTIVE window
  - DATA is between 118.xx and 136.xx
    - it defaults to STBY window at power down
- #1 panel is also #1HF; #2 panel is #2HF (if installed) "hi sun, hi frequency"
- AM sets the Amplitude Modulation (AM) or Upper Side Band (USB) for selected HF
  - AM light illuminated = HF AM is selected. Extinguished = HF USB is selected

FREQUENCY SELECTORS (NG)

- controls the standby frequency of the VHF transceiver
- rotation of the outer selector knob changes the 3 left digits
- rotation of inner changes the 2 rt digits if 25 kHz spacing (3 digits if 8.33 kHz spacing)

(L/OP) VHF Comm Radios

- do not use VHF 2 or 3 on 120.00 MHz as primary means of comm

Offside Tuning light (NG)

- illuminated (white) = the radio normally associated with this panel is being tuned by another radio tuning panel, or the radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel
- two RTPs are controlling one radio

VHF TRANSFER switch (NG)

- selects the STANDBY frequency to the ACTIVE position
- #1 antenna is on top of fuselage; #2 and #3 on bottom

COMMUNICATION TEST switch (NG)

- removes the automatic squelch feature, permitting reception of background noise and thereby verifying receiver operation (providing a confidence test)
- reception range is increased and improves reception of weak signals

Radio Tuning Panel Off switch (NG)

- turns the radio tuning panel off or on (press for 2 sec to turn off)

HF Sensitivity Control (NG)

- adjusts the sensitivity of the on-side HF receiver (after contact decrease to fine tune)
- SEN 00 to 100 displays in STANDBY window when knob is turned ("high sun, high freq")

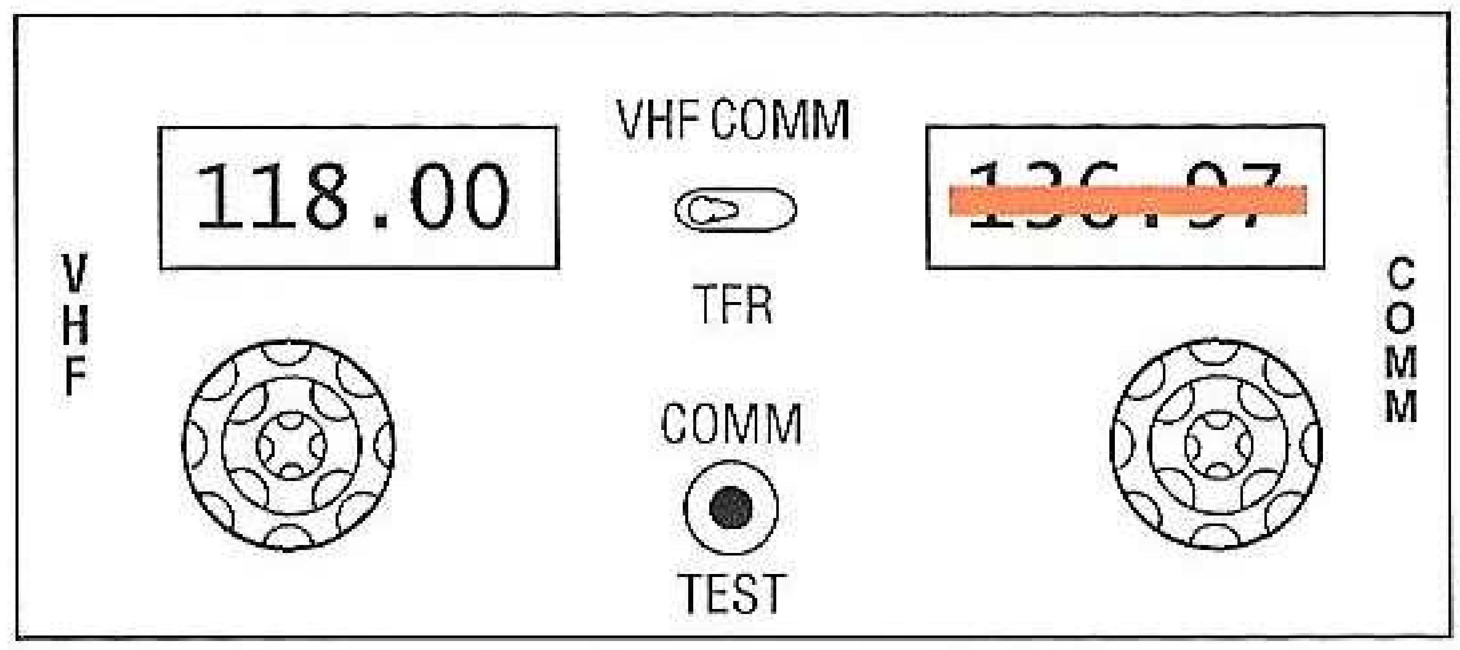
Radio Tuning Panel Fail Modes (NG)

- dashes indicate the selected radio has failed or has been disconnected
- PANEL FAIL indicates the respective radio tuning panel has failed

(FIX) RTP

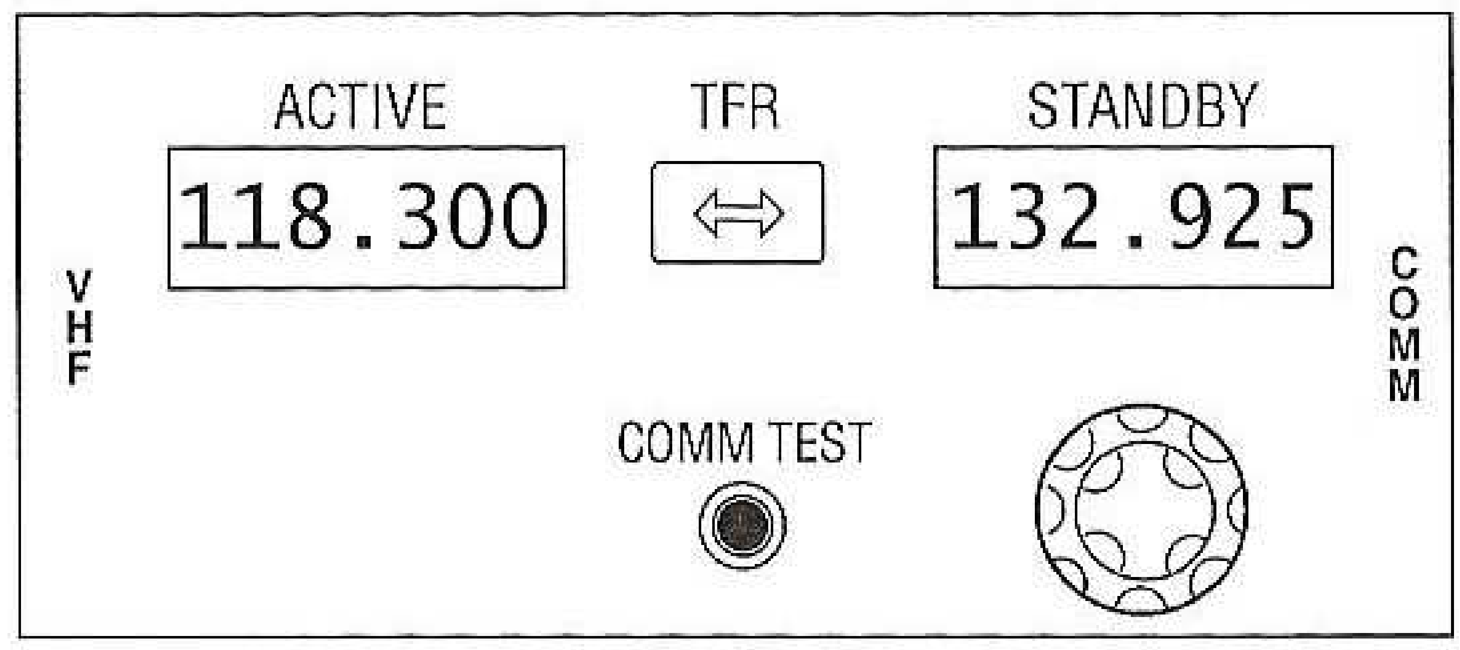
- if DATA is not between 118 and 136, cycle VHF 3 circuit breaker P18-2 C12
- if this does not work, pull ACARS and VHF 3 CBs
  - INOP will appear in the RTP window (depowers the RTP)
  - at the same time, push the transfer switch and the failed comm source (3) switch, and reset the CB

TRANSFER switch
- selects the STANDBY frequency to the ACTIVE position



FREQUENCY indicator
- indicates selected frequency

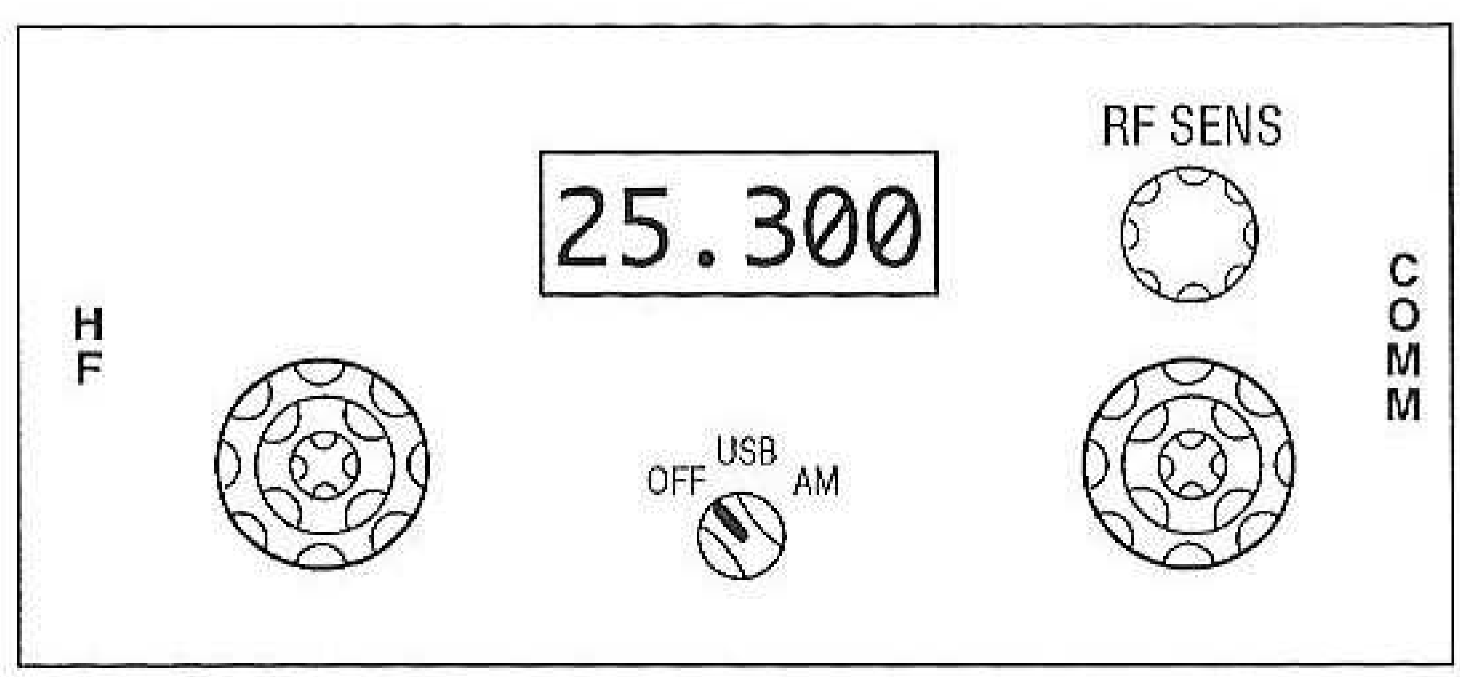
FREQUENCY selector
- rotate to select frequency in related indicator
  - outer selector changes three left digits
  - inner selector changes right digits
    - 2 digits if 25 kHz spacing
    - 3 digits if 8.33 Khz spacing



(option)

COMM test
- removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation
- improves reception of weak signals

HF COMM PANEL



FREQUENCY indicator
- displays tuned frequency
- range from 2.000 to 29.999 megahertz

FREQUENCY selector
- rotate to select desired frequency

RF Sens
- rotate to control sensitivity of receiver
- clockwise increases sensitivity of weak or distant stations
- counterclockwise decreases sensitivity to reduce noise or static

MODE selector

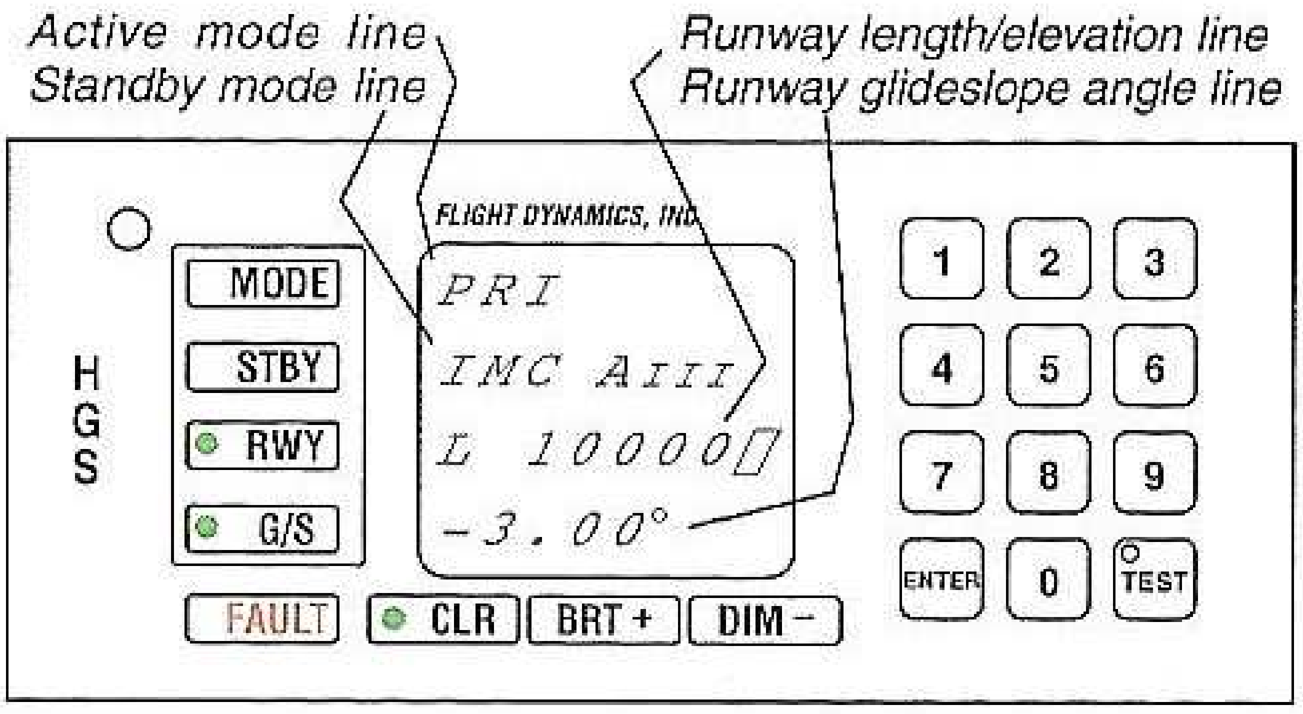
OFF
- removes power to transceiver

USB
- Uper Sideband transmits and receives on the higher side of the frequency

AM
- Amplitude Modification transmits and receives on the selected frequency, accompanied by a carrier wave

HUD CONTROL PANEL

- select and display modes of operation, display values, and enter data
- mx can start system BITE



Mode / Function keys

MODE
- selects desired mode from available modes on the standby display line

STBY
- push to cycle through available standby modes
- push the MODE key to make the new mode active

RWY
- use the keyboard to enter runway length / elevation or to toggle between values
- select once to enter runway length
- select again to enter runway elevation
- use the DIM– (minus) key to enter negative values

G/S
- use the keyboard to enter the glideslope angle for the landing runway

MODE	FLIGHT OPERATION	GUIDANCE SOURCE
PRI	Takeoff, climb enroute, descent, approach, landing	DFCS
PRI	Low visibility takeoff	HUD
AIII	Cat II or IIIA approach and landing	HUD
IMC	DFCS autopilot / FD approach and landing	DFCS
VMC	Visual approac and landing	None

Control Panel display

- displays information entered using the mode / function keys

FAULT light
- illuminated (amber) = HUD BITE fault

CLR
- used to clear all symbology from the combiner display
- symbology can be re-displayed by selecting CLR again, changing modes, or entering TEST
- CLR can also be used as a backspace key during data entry and TEST operations

BRT+ used to manually increase control panel display intensity

DIM – used to manually decrease control panel display intensity

Note: Display brightness is adjusted automatically based on ambient light measured by a sensor located in the upper left corner of the control panel

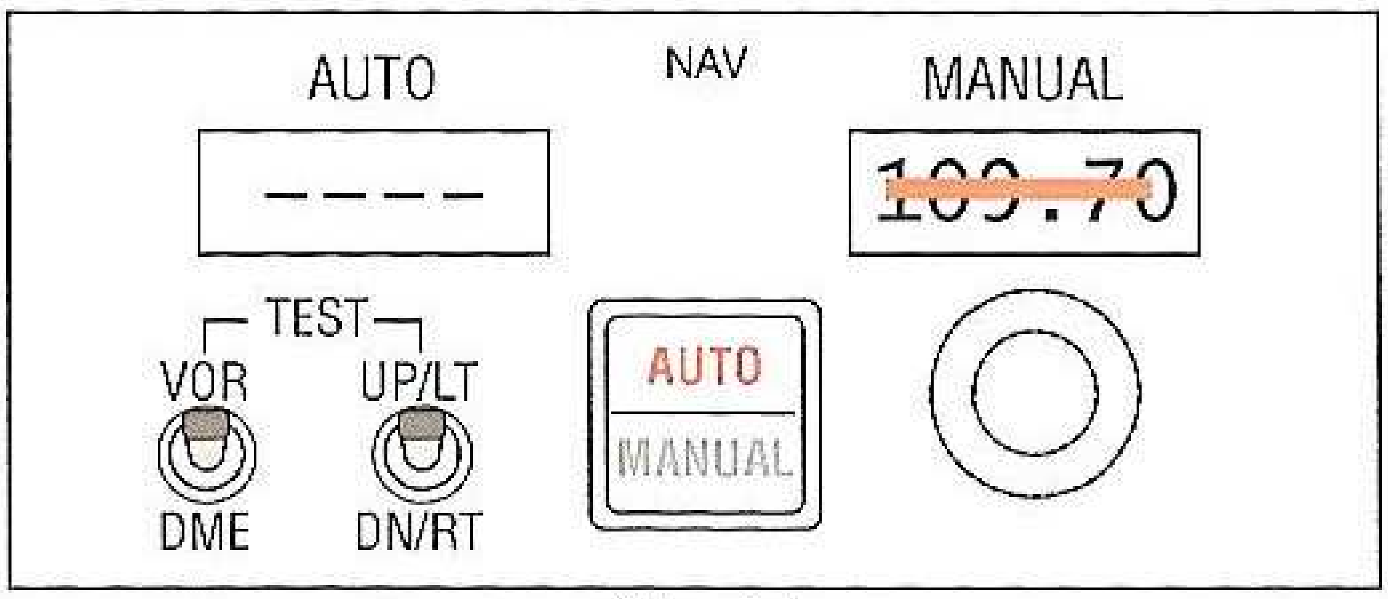
Numeric keys

0 through 9 puts selected number in display

ENTER used to enter selected values

TEST used by maintenance for system tests and troubleshooting while on the ground

VHF NAVIGATION RADIOS PANEL



(classic)

AUTO FREQUENCY INDICATOR

- indicates frequency tuned by the FMC
- display is blank when MANUAL tuning has been selected
- displays dashes during agility tuning; (only when one radio is in AUTO)
- agility tuning does not degrade the FMC position

MANUAL FREQUENCY INDICATOR

- indicates the frequency which has been selected by rotating the frequency selector
- a bar appears over this frequency when AUTO tuning is selected

AUTO-MANUAL switch (alternate action switch)

(NG) this switch has been removed. FMC uses dual scanning DME, now standard equipment whereas before scanning DME was optional

- dual scanning DME consists of 2 DME interrogators, each of which rapidly alternates between the manually tuned frequency (VOR/ILS) and an automatically tuned frequency for radio position updating

AUTO (illuminated white)

- tuning is accomplished by the FMC
- (3-4-5) Non EFIS - the HSI switch must be positioned to NAV
- pressing the switch will change the function from AUTO to MANUAL

MANUAL (illuminated white)

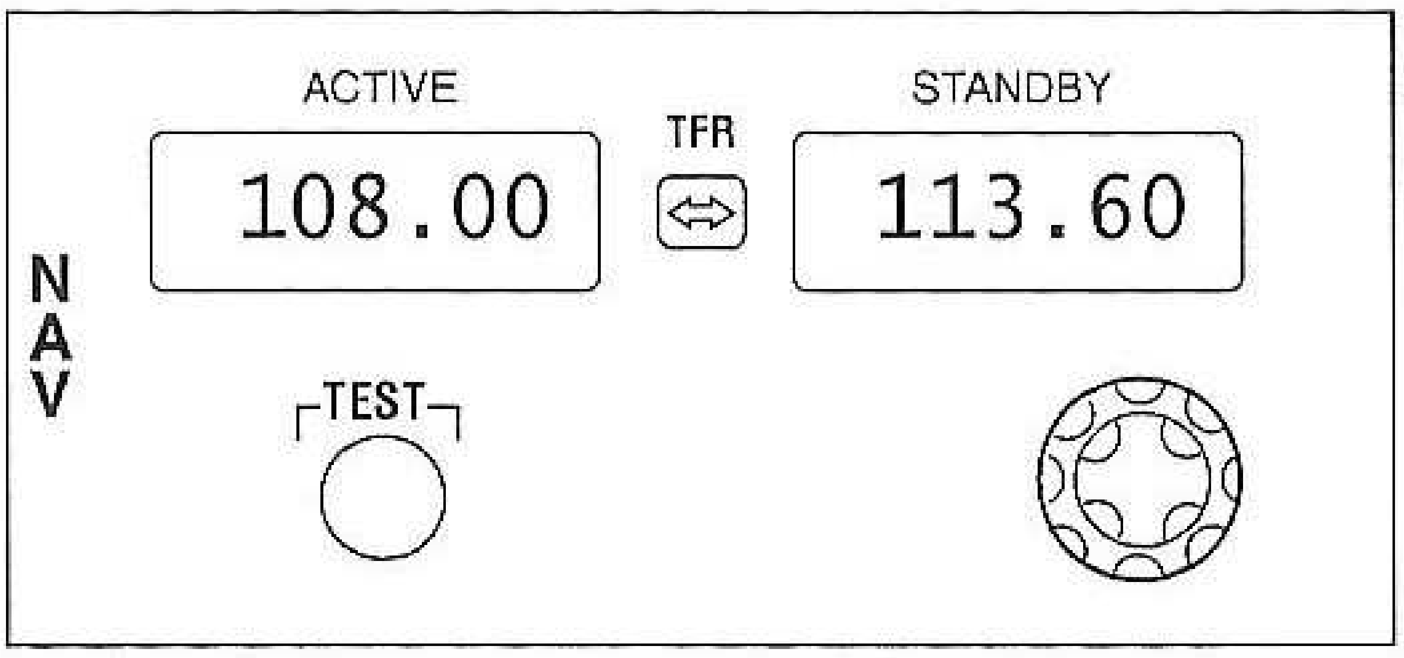
- tuning must be accomplished manually by rotating the frequency selector

Non EFIS - when the HSI switch is positioned to VOR/ILS the nav head switches automatically to MANUAL. You must be in VOR/ILS to arm APP or VOR/LOC

- on EFIS series aircraft:
  - ILS Approaches: the VHF NAV does not automatically switch from AUTO to MANUAL when the EFIS mode selector is switched to VOR/ILS (FULL or EXP). This must be done manually on the Nav control head. You must ensure the Nav radio is properly tuned and in MANUAL, and the final approach course selected for all ILS, LOC, LOC BC, LDA, SDF, and VOR approaches or you will fly through the final approach course!
  - NDB approaches: both pilots may be on a MAP mode provided raw data is being monitored (RDMI).
  - RNAV/FMS approaches: the approach must be in the Jepp's and stored in the nav database. May use MAP with approved FMS departures. One radio must be in AUTO to allow for radio updating (no IRS NAV ONLY message).

FREQUENCY SELECTOR

- controls the active and inactive frequency
- rotation of the outer selector changes the three left digits
- rotation of the inner selector changes the two right digits
- tuned frequency displayed in the standby window / display
  - TFR switch moves standby frequency to active frequency
  - if you want to get rid of the green dashed line on the EFIS Map, manually tune 108.00 in the active window
- tuned (ACTIVE) station also displayed on the standby RDMI



VOR / DME TEST switch

VOR - with a VOR frequency tuned and a course of 000 selected:

(3-4-5) non EFIS

the course deviation bar centers

the VOR bearing pointer indicates 180°

the TO / FROM ambiguity indicates FROM

(3-4-5) EFIS

the course deviation bar and TO/FROM indicator disappears

the course bar then centers and TO/FROM indicates FROM

on RMI, flag appears momentarily then needle points to 180°

(NG)

VOR fail flag appears first, then FT (functional test) appears in outboard display, upper outboard corner

course deviation bar, scale, and TO/FROM indicator biases out of view

course deviation bar, scale and TO/FROM indicator re-appears

DME

(3-4-5)

the DME warning flag (*slashes*) appears for 1 sec, then *dashes* appear for 1 sec, then all *zeroes (not to exceed 00.5) appear until the test switch is released*

ILS TEST switch

(3-4-5)

UP / LT - with an ILS frequency selected, the glide slope indicates one dot up and the LOC indicates one dot left

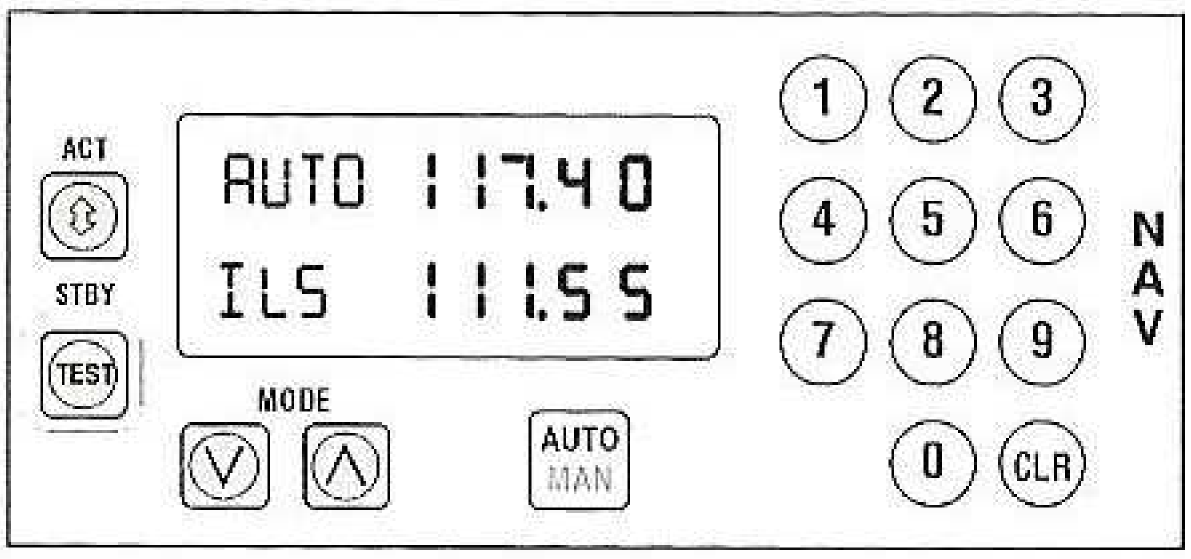
DN / RT - with an ILS frequency selected, the glide slope indicates one dot down and the LOC indicates one dot right

(NG)

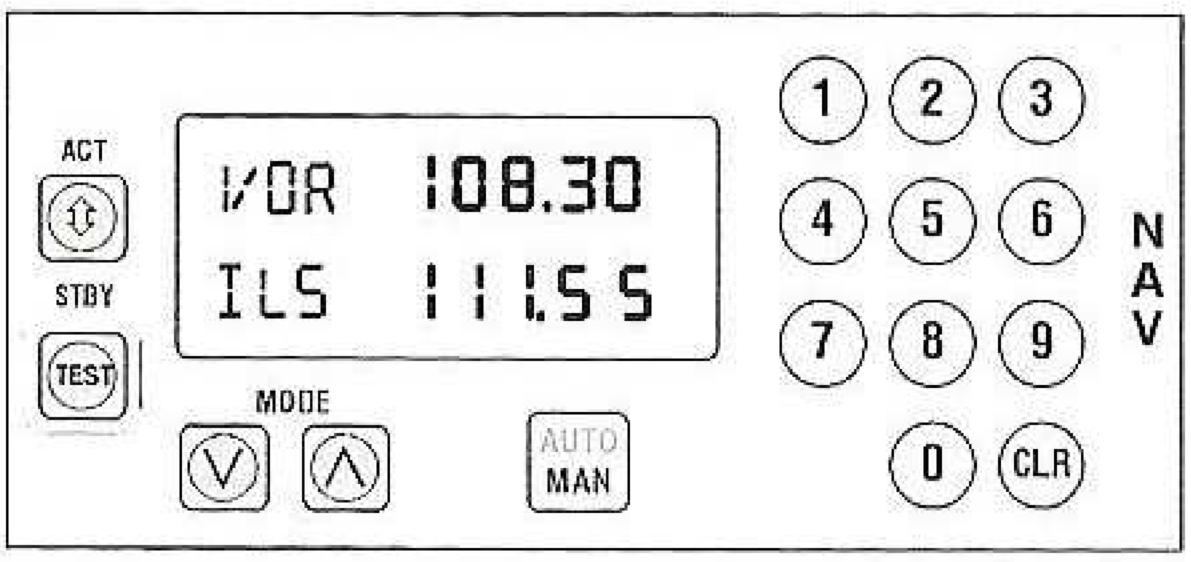
with ILS frequecy tuned and a course within 90 degrees of airplane heading

- G/S and LOC fail flags appear
- the glide slope indicates one dot up and the LOC indicates one dot left
- pointers then display one dot low and one dot right
- pointers then return to normal display

GABLES NAV TUNING PANEL



- top frequency is active, bottom is standby
- transfer arrow/key only works if MAN key is pressed
- MODE select keys are used to pre-select VOR or ILS
- tuning from the AUTO position
  - use the MODE key to select ILS or VOR
  - type in the desired frequency using buttons on right side of panel
  - press AUTO key to move the entered frequency to the active line
  - MAN will illuminate
- tuning from the MAN position (MAN illuminated)
  - use mode key to select ILS or VOR
  - type in the desired frequency
  - press transfer arrow to move the frequency to the active line



- for VOR frequency selection, trailing zeros are optional after the first 3 characters are entered
- the CLR key is used as a backspace or to clear the entire frequency value in the STBY line. Pressing the CLR key for less than 1 sec will clear the last digit. Holding the CLR key for more than 1 sec will clear the entire frequency

ADF FREQUENCY SELECTOR

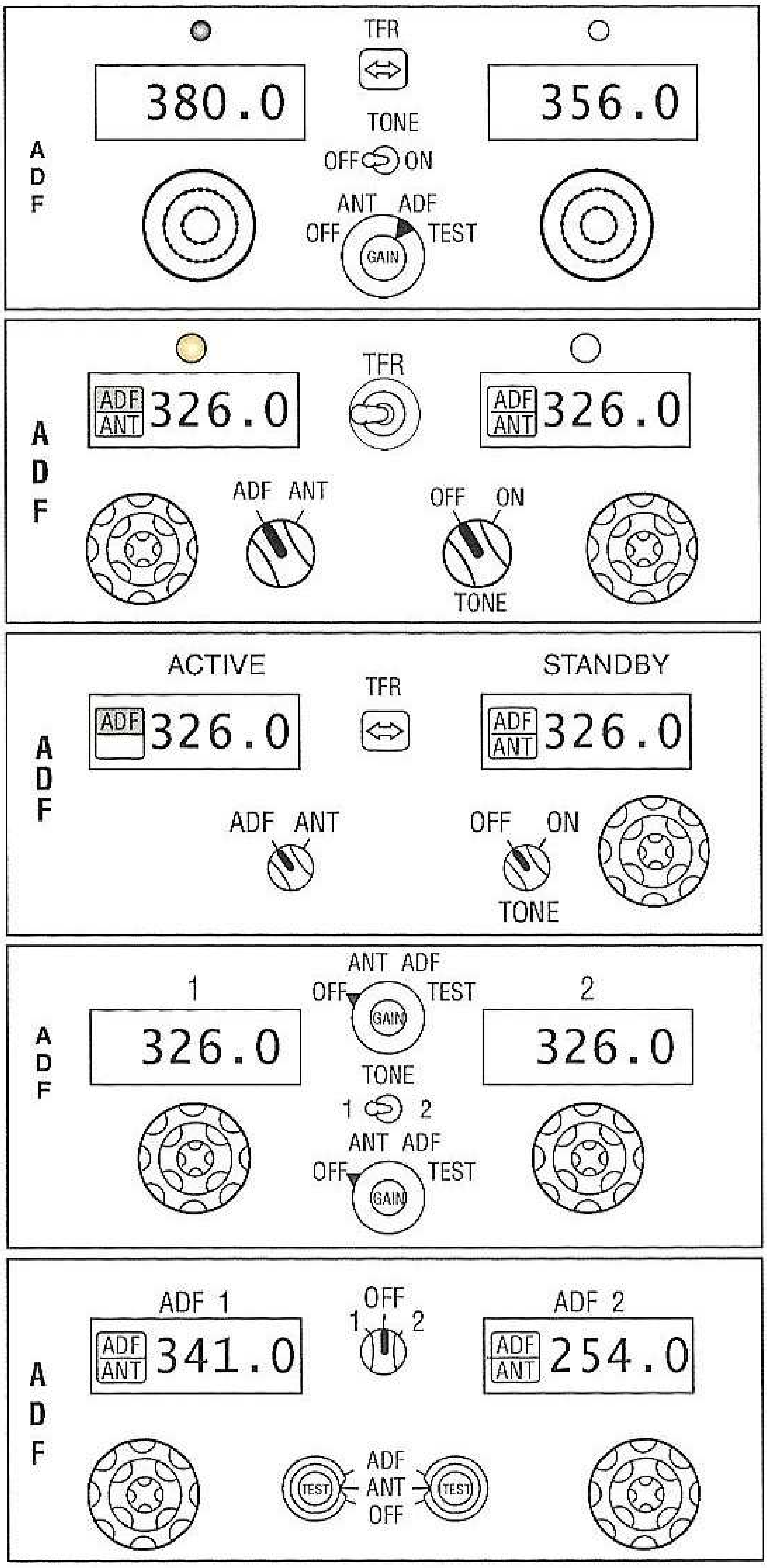
- enters frequency into respective window

ADF #1 and #2 MODE SELECTORS
- OFF - no electrical power to receiver
- ANT - audio reception optimized; no ADF bearing data available
- ADF - audio reception is possible; ADF bearing sent to RDMIs (normal position)
- TEST - respective (#1 or #2) ADF bearing pointer indicates 45° left of lubber line for valid test

GAIN CONTROL #1 and #2 - adjusts receiver gain

TONE switch
- 1 adds tone to ADF receiver #1 audio
- 2 - adds tone to ADF receiver #2 audio
- ON adds tone to selected ADF receiver audio
- CENTER/OFF
  - disables tones

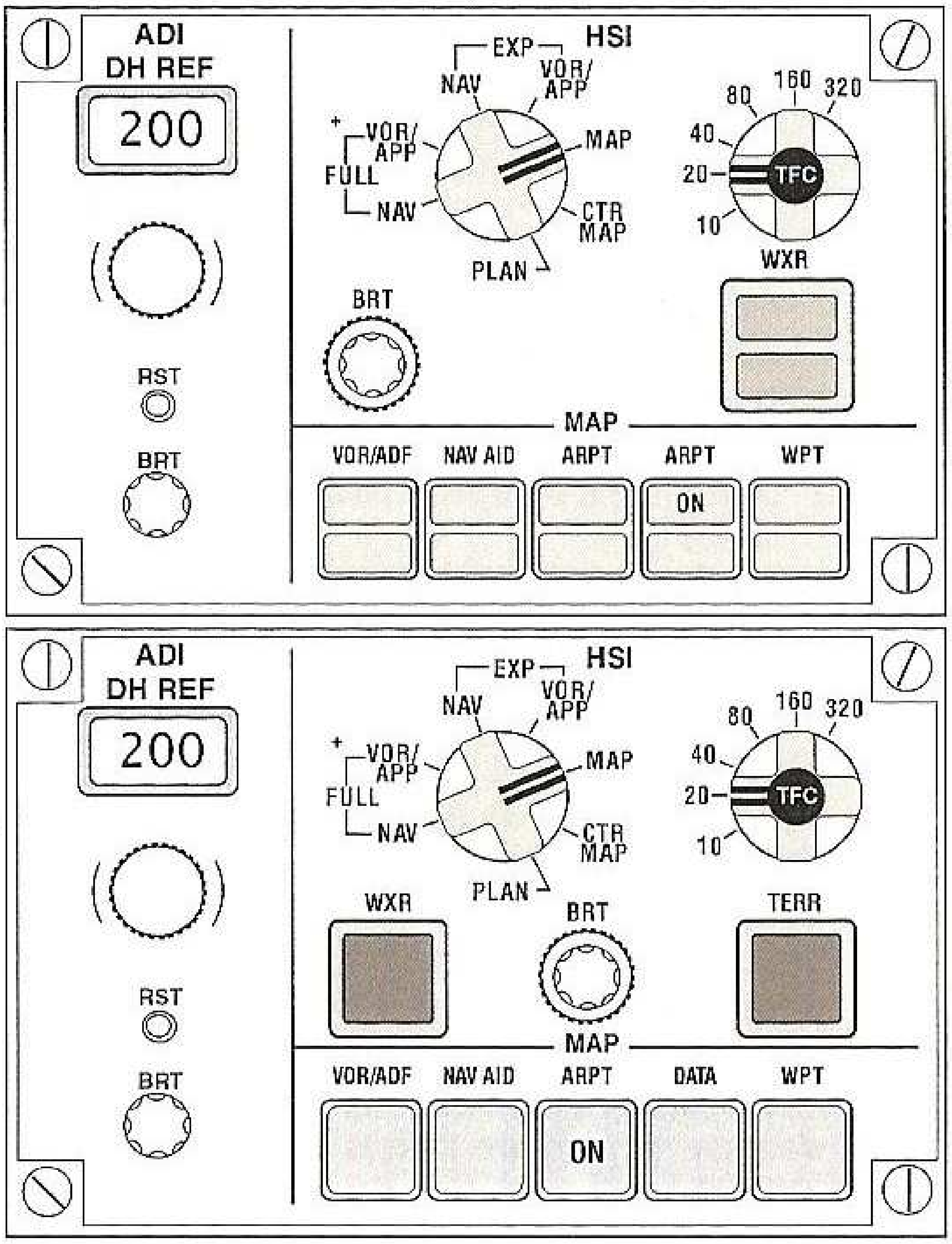
Note:
- #1 drives narrow needles in RMDIs; #2 drives wide needles in RMDIs



ANTENNA LOCATION (typical)

- ADF loop - belly
- ADF sense - belly
- DME 1 - forward belly
- DME 2 - belly
- Glideslope - nose cone
- GPS - forward top
- HF - leading edge of the vertical stabilizer
- Localizer (fwd) - nose cone
- Marker beacon - belly
- Radio Altimeter - forward belly
- TCAS - forward belly
- TCAS - forward top
- TXP - forward top
- VHF 1 - forward top
- VHF 2 - belly
- VHF 3 (ACARS) - aft belly
- VOR LOC - top of vertical stabilizer
- Weather radar - nose cone

EFIS CONTROL PANEL (3-4-5)



DH REF (DECISION HEIGHT REFERENCE INDICATOR)
- displays selected decision height (also displays on EADI)
- display on ADI blanks when a negative decision height is selected
- resets to 200 at power interruption

DECISION HEIGHT SELECTOR
- continuous-turn control sets desired decision height for alerting
- the range for decision height is -20 to +999 feet
- decision height starts at 200 as a baseline when power is applied
- two speeds of response are achieved by software

RST switch
- pressing resets the DH alert on the associated ADI after the airplane has passed through the selected decision height
- changes RA display from yellow to white

EADI BRIGHTNESS CONTROL
- used to adjust the brightness of the ADI display to the desired level; used in conjunction with light sensors on glare shield

EHSI MODE SELECTOR
- selects the type of data symbols displayed on the EHSI

FULL NAV displays same data as expanded navigation mode with the following exceptions:
- weather radar displays are not available
- a full compass rose is shown in place of the expanded compass rose
- alternate symbols are used for airplane symbol and course pointer

FULL VOR / ILS (make sure Nav radios are in "manual"):
- with a VOR frequency selected, displays the same data as the expanded VOR mode with the following exceptions:
- weather radar displays are not available
- a full compass rose is shown in place of the expanded compass rose
- DRIFT ANGLE POINTER (Track indicator) replaces the track line
- TO/FROM pointer is shown in addition to the TO/FROM annunciation
- alternate symbols are used for airplane symbol and course pointer
- with an ILS LOC frequency selected, displays the same data as the expanded ILS mode with the following exceptions:
- same as above except for #4

EXP NAV displays lateral and vertical navigation guidance information similar to a conventional HSI but is oriented to airplane track. The FMC is the source of the guidance data
- Weather Radar return data is displayed when the WXR switch is ON
- on the ground, if distance marker is displayed, TCAS switch is ON

EXP VOR / ILS
- (3-4-5) make sure Nav radios are in MANUAL
- with a VOR frequency selected:
  - displays VOR navigation data oriented to the airplane heading
  - displays the source of navigation data as VOR 1 or VOR 2 in the lower left corner of the EHSI
  - displays TO/FROM annunciation and the navigation source frequency in the lower right corner of the EHSI
  - weather radar return data is displayed when the WXR switch is ON
- with an ILS LOC frequency selected:
  - displays ILS frequency data oriented to the airplane heading
  - displays the source of navigation data as ILS 1 or ILS 2 in the lower left corner of the EHSI
  - displays the navigation source frequency in the lower right corner of the EHSI
  - weather radar return data is displayed when the WXR switch is ON
- on the ground, if distance marker is displayed, TCAS switch is ON

(NG)

APP is the same as EXP ILS
VOR is the same as EXP VOR

MAP (3-4-5)
- displays a fixed aircraft symbol superimposed on a moving map background. The basic map background data includes origin/destination airports, flight plan route, and display of navaids in use. Optional background data includes off-route navigation aids, airports and named waypoints; tuned VOR/ADF relative bearing radials; and flight plan route waypoint ETAs and altitude constraints
- weather radar return data is displayed when the WXR switch is on

CTR MAP (3-4-5)
- displays the same data and symbols as the MAP mode, but the airplane symbol is placed in the center of the map so the MAP information behind the airplane is displayed. Can change range settings

PLAN (3-4-5)
- displays a static map which is oriented to true north. The top portion of the EHSI remains the same as in the MAP mode
- allows the pilot to review the planned route by using the respective Capt or F/O LEGS page CENTER STEP line select key
- weather radar display data and TCAS display are inhibited
- Heading Bug has no stem (——)

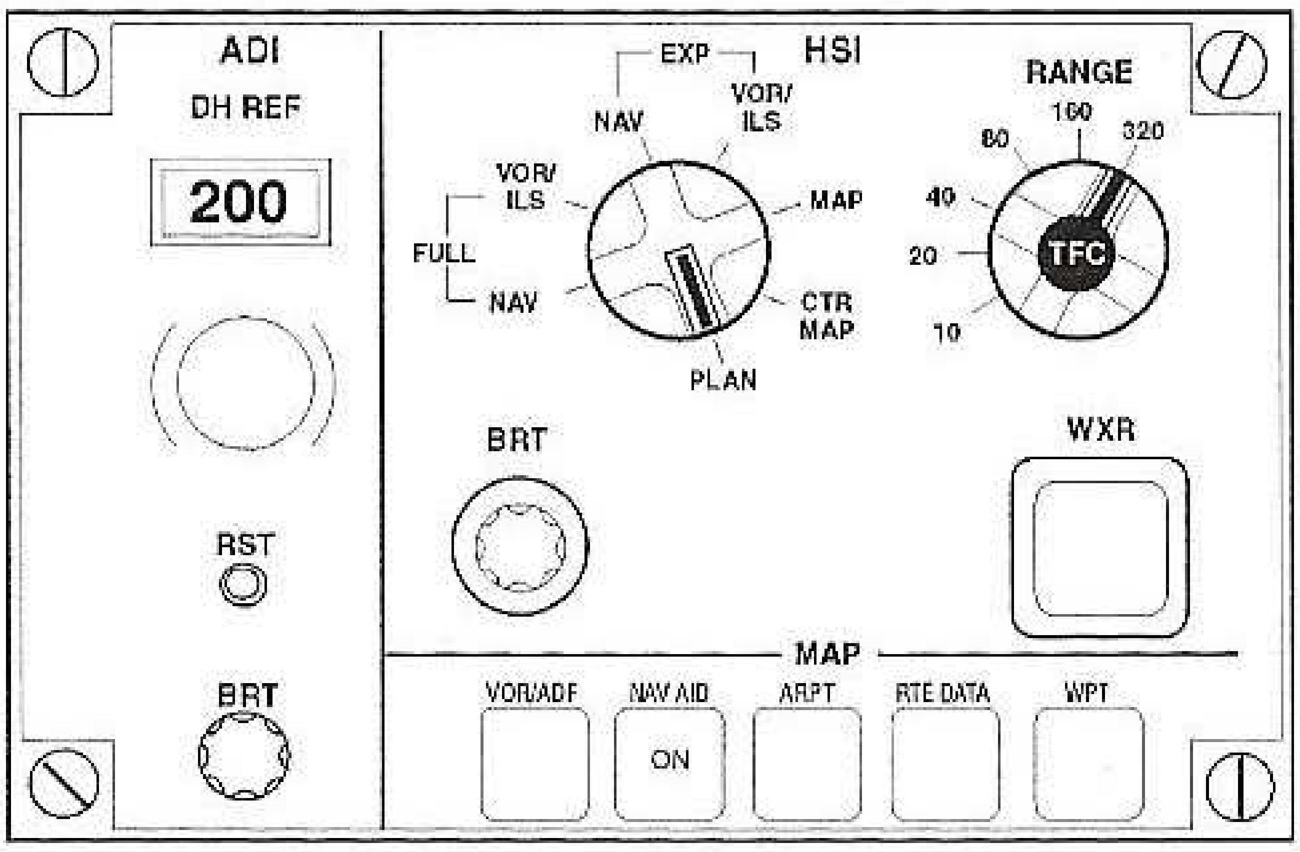
EHSI RANGE SELECTOR
- selects desired nautical mile range for MAP, CTR MAP, PLAN and weather radar displays. Button on knob cycles TCAS display on or off
- if the range switch fails, or the range data becomes invalid, the EFIS will show the range that is received from the weather radar system

EHSI BRIGHTNESS CONTROLS
- OUTER control: adjust brightness of HSI display
- INNER control: adjusts brightness of weather radar display

(QRH) EFIS Control Panel Inop (3-4-5)
- if an EFIS Control Panel fails
  - map mode reverts to EXP VOR ILS
  - if WX Radar was ON, it continues to operate with current range display
  - if WX radar was OFF, it fails on that side and there is no range display
  - TCAS fails on that side

EFI TRANSER SWITCH..BOTH ON 1 / 2
- COMP flag is displayed (ATT comparator function fail)

MAP switches (alternate action)



- add background data/symbols to EHSI when selected
- multiple options can be selected simultaneously
- EXCESS DATA message appears when there is too much symbology for the SG to handle. Flight plan wpts are drawn with priority
- ON (white) when pressed:
  WXR map switch
    - Weather radar return data is displayed on the EHSI when the EHSI Mode Selector is in EXP NAV, EXP VOR/ILS, MAP or MAP CTR positions (ON light does not illuminate on above panel)

  TERR map switch (ON light does not illuminate on above panel)
    - displays information associated with the Enhanced Ground Proximity Warning System database (EGPWS) in MAP, CTR MAP, expanded VOR/APP and NAV
    - deselects weather radar display if on
    - terrain and weather radar cannot be displayed simultaneously on an individual display; however, the captain's and first officer's map displays are independent, so weather can be selected on one display while terrain is displayed on the other

  VOR ADF map switch
    - displays VOR and/or ADF relative bearing radials if the VOR/ADF receiver(s) are tuned to usable stations and valid data is being received

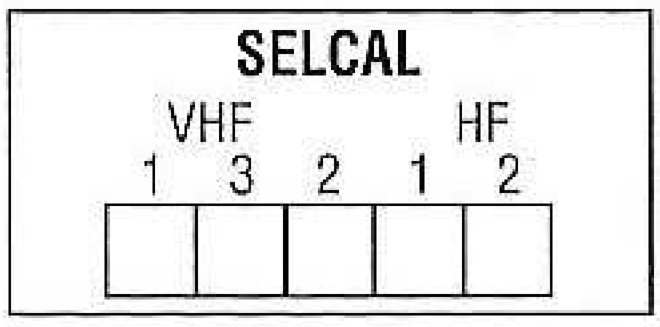
  NAV AID map switch (Navigation Aids)
    - displays FMC data base high altitude navigation aids on map scales 80, 160, or 320 NM
    - displays all FMC data base navigation aids if on map scales 10, 20, or 40 NM

  ARPT map switch (Airports)
    - displays all airports which are stored in the FMC data base and which are within viewable map area of the EHSI

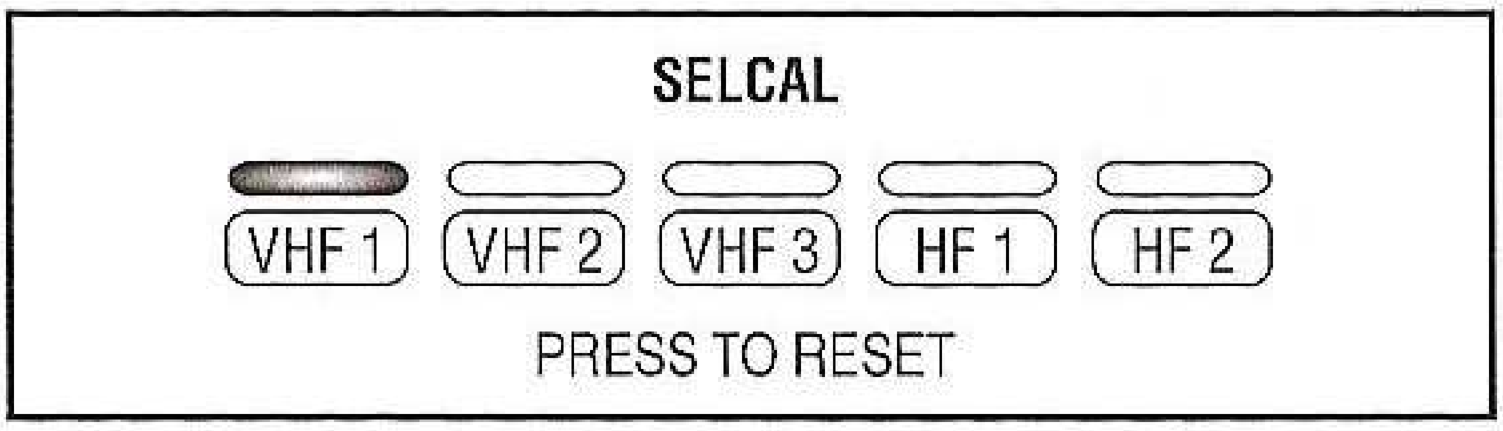
  RTE DATA map switch (Route Data)
    - displays altitude constraint (if applicable) and estimated time of arrival (ETA) for each ACT RTE waypoint

  WPT map switch (Waypoints)
    - displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 NM or less

SELCAL

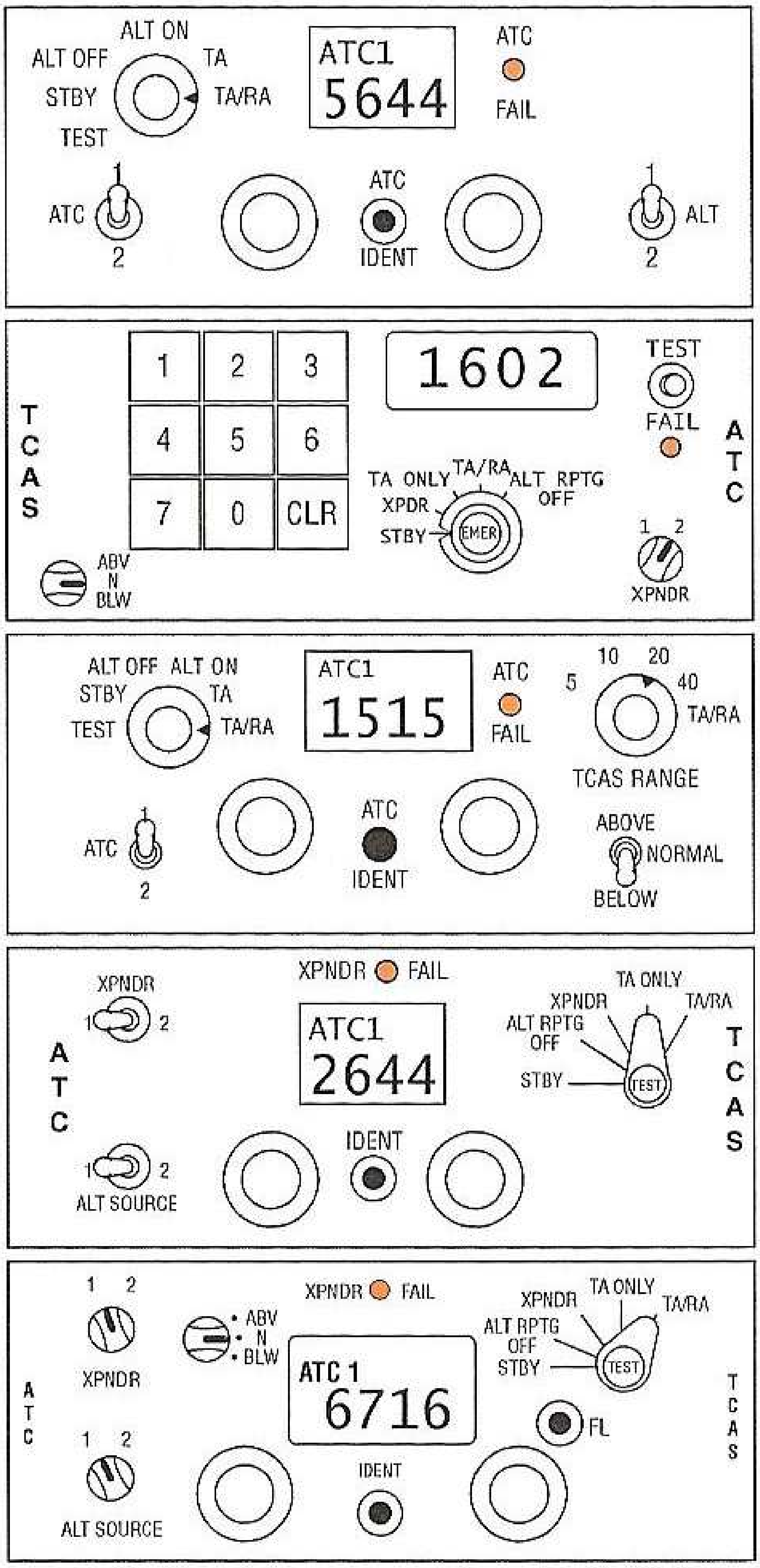


- a ground station desiring to communicate with the crew can use the SELCAL system
- each airplane is assigned a unique four-letter SELCAL code
- SELective CALling (SELCAL) monitors selected frequencies on VHF and HF radios



- SELCAL decoder receives audio signals from the VHF and HF comm systems
- SELCAL indications are a two tone chime and a call light
- a white light illuminates to alert the crew to an incoming communication on indicated radio
- the call light can be on the SELCAL control panel or the audio control panel (option)
- when the crew pushes the applicable switch on the SELCAL control panel or the audio control panel, the light goes out and the system resets

TRANSPONDER



TRANSPONDER selector

1 or 2 - selects desired transponder

XPNDR FAIL light

- illuminated indicates the selected transponder, antenna, altitude, or control data has failed or in test
- TCAS has failed

ATC CODE INDICATOR

- displays code selected by ATC code selector

Controls

STBY - disables both transponder modes

ALT RPTG OFF / ALT OFF - transponder responds to ATC interrogation but the reply does not contain altitude report

XPNDR / ALT ON - transponder operates with altitude reporting

TA or TA ONLY - enables display of Traffic Advisory targets (no RA function)

TA/RA - enables display of Traffic Advisory and Resolution Advisory TCAS targets

TEST

- tests TCAS system. Symbols appear on Map if TCAS switch is on
- PASS appears in window
- XPNDR FAIL light illuminates to indicate the selected transponder is operational
- IRS must be aligned

(3-4-5) Non EFIS TCAS RANGE

ABOVE = range + 8700' to - 2700' (use for takeoff / climb phase)

NORMAL = range ± 2700' (use for cruise phase)

BELOW = -8700' to + 2700' (use for descent / landing phase)

FL = displays Flight Level of target for 15 seconds

ALT SOURCE

1 or 2 - selects desired air data computer for altitude reporting

- Captain's altimeter on #1 ADC, FO altimeter on #2 ADC

ATC CODE SELECTORS

- rotating sets code in the ATC code indicator and both transponders

REPLY LIGHT (green)

- illuminated - transponder is replying to ground interrogation or test switch is pressed

ATC IDENT switch

- PRESS, transponder adds a special position identification (SPI) pulse to the interrogation reply for the next 15 seconds

TCAS (Traffic Alert and Collision Avoidance)

- the level of protection provided by TCAS equipment depends on the type of transponder the target aircraft is carrying - no protection against aircraft without a transponder
- TCAS I (mode A) provides traffic advisories (TA) and proximity warning of nearby a/c
- TCAS II (mode C or S) provides TA and resolution advisories (RA) - recommended escape maneuver, in the vertical dimension and takes precedence over ATC instruction
- symbols display on Map and, if threatening, provides alerts and vertical maneuvering resolution advisory (RA) and functions independently of grond-based system
- two systems: a surveillance system and a collision avoidance system (CAS)
- CAS predicts the time-to and separation-at the intruder's CPA using range, closure rate, altitude, and vertical speed
- surveillance airspace is 15-40 nm forward, 5-15 nm aft, and 10-20 nm on sides
- never disobey a RA unless you are absolutely certain you have traffic in sight

Traffic

- 7.0 software certified in early 2000, complies with ICAO SARPs for ACAS II and required for RVSM
  - reduces unnecessary alerts when 1,000 ft separation is applied above FL290

Unfilled diamond
  - non-threat traffic 1,500 ft below (-15) and climbing (arrow up)

Filled diamond (proximate traffic)
  - intruder moves to within 6 nm and/or ±1,200 ft of your altitude

Yellow circle
  - indicates an intruder is within 20-48 sec of Closest Point of Approach (CPA)
  - TCAS will issue a Traffic Advisory (TA)
  - aural alert "*Traffic, Traffic*" annunciates

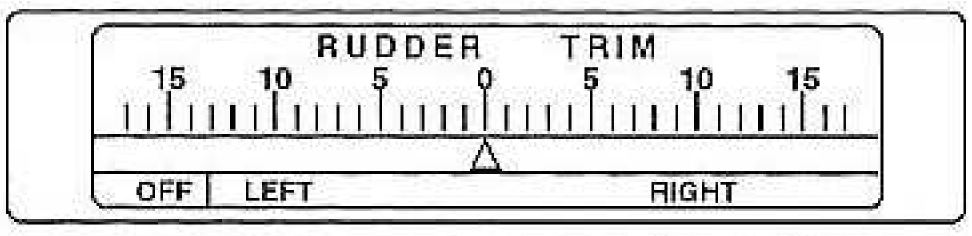
Red square
  - indicates a nearby threat is within approximately 15-35 seconds
  - TCAS will issue a Resolution Advisory (RA) - evasive action is necessary
  - symbol turns to solid red square and a vertical maneuver command is annunciated
  - respond within 5 seconds with a vertical maneuver at 1.25G
  - use same heading, and climb or descend to ±1000' at 1500 fpm
  - properly done, the RA maneuver does not require large or abrupt control movements
  - the ADI will display a red pitch command bar to fly to
  - Increase, Reversal within 2.5 seconds at 1.35G
  - do not maneuver in opposite direction
  - "*Clear of Conflict*" (usually within 600')
    - resume ATC clearance
  - Inform ATC and fill out Irregularity Report (CO) if deviated from ATC clearance
    - declaring emergency not necessary

Altitude Tags:
  + (plus) intruder is above your altitude, – (minus) intruder is below your altitude
  trend arrow appears when the intruder's vertical rate is 500 ft/min or greater

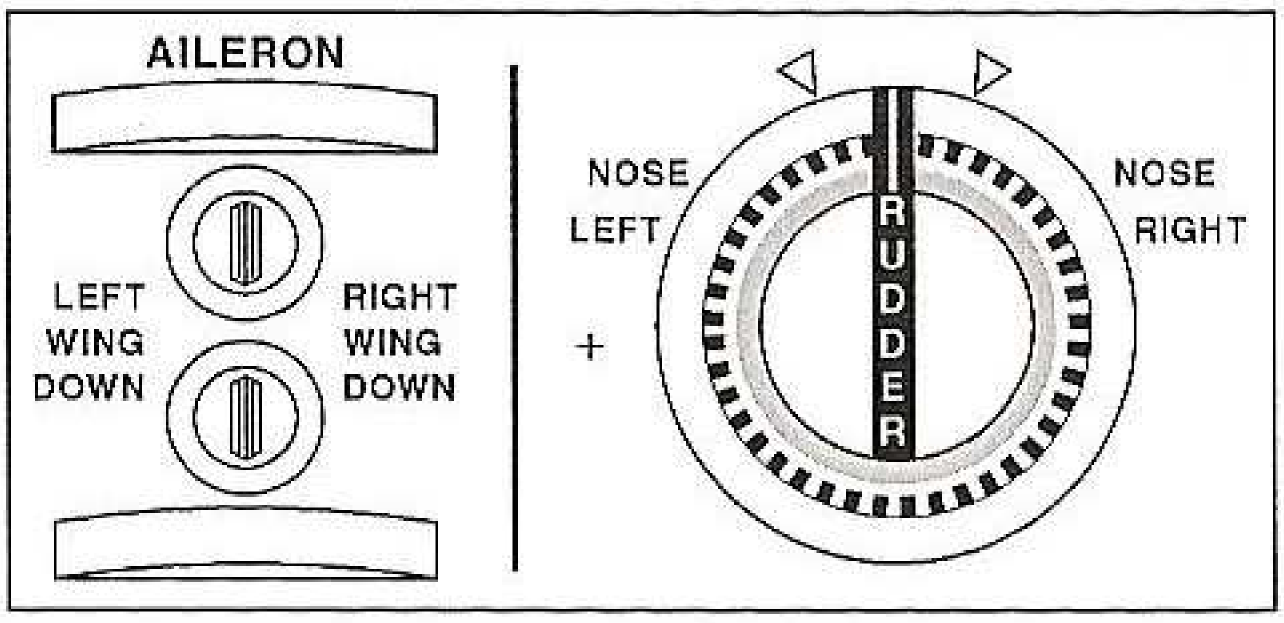
TCAS System Notes

- during preflight, determine if TCAS display is turned on by selecting any VOR/ILS mode; if on, range marks will appear; if off, no range marks.
- when you get a TA, turn all lights on and try to make visual contact with traffic before evasive action is required
- comply with an RA even if you think you have the target in sight
  - you may be looking at the wrong target
- if TFC is not selected and annunciated, targets will not be displayed
  - A TA or RA will display only the word, TRAFFIC in amber or red respectively
- authorized to deviate from ATC clearance to comply with an RA
- "Increase Descent" RAs inhibited below 1450' AGL; "Descend" RAs below 1100' AGL; all RAs below 1000 ft AGL (±100)

RUDDER & AILERON TRIM

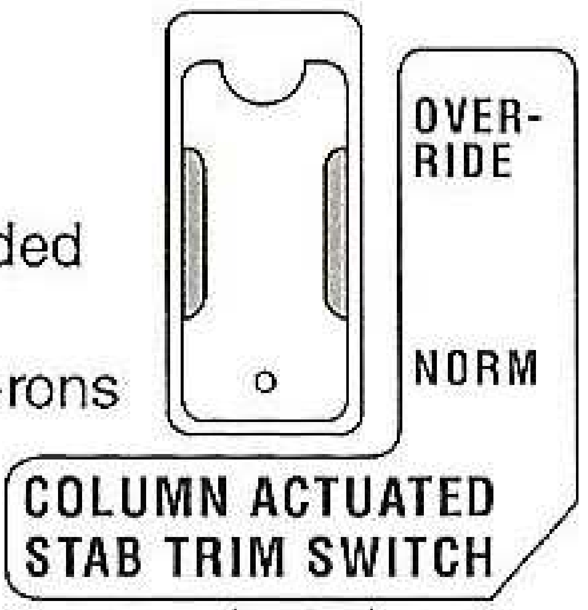


- an AC motor repositions the neutral point of the rudder feel and centering device
  - rudder is deflected from the faired position
- changes rudder trim indicator units, left or right of neutral
- if no normal AC power, you will see OFF on the left side of the indicator tape
- CAUTION: when you check the ops make sure the knob returns to neutral
- rotate trim left and right, making sure the arrow moves and indicator "tape" shows movement and correct indication



AILERON TRIM switches

- repositions neutral point of aileron feel/center unit; knob spring-loaded to neutral
- movement of both switches changes the neutral position of the ailerons
- yoke will move to align the trim scale units
- use of aileron trim with the autopilot engaged is prohibited



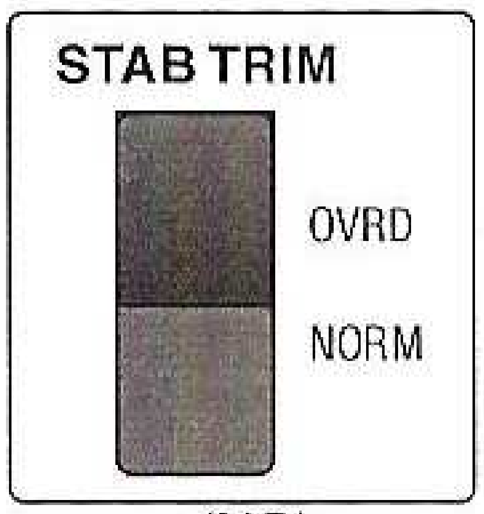
(3-4-5)

STAB TRIM OVERRIDE SWITCH

NORMAL = normally guarded to ensure normal operation of the column actuated cutout switch

OVERRIDE - bypasses the control column cutout switch assembly

- when this switch is placed in override, the main electric trim will operate when commanded regardless of control column position
- Note: normally a runaway trim can be stopped by moving the control column in the opposite direction. This override switch will bypass the control column cutout switch if either switch fails
- if stab is jammed you may be up against control column cutout switch (opposite force).
- operational test: while trimming with column trim, oppose trim by moving column in opposite direction; trim cutout switch should engage. Move STAB TRIM OVRD switch to OVRD; trim should resume



(NG)

HANDSET (NG)

- sends chimes to the remote electronics unit (REU)
- the REU amplifies the audio and sends it back to the handsets

  2 PILOT (cabin to cockpit)
  - single high chime and blue CALL light in cockpit
  - pick up handset and talk - it's "hot"

  5 ATTENDANT (cockpit to cabin)
  - high / low chime sounds and pink light on Master call panel in cabin crew station illuminates
  - no need to press ATTEND call button on overhead
  - pick up handset and talk - it's "hot"

  8 PA - press PUSH TO TALK to make announcement

  222 EMERGENCY / ALERT
  - any cabin handset; each time a "2" is pressed, a chime sounds
  - in the cabin, high / low chimes sound, pink light on Master call panel illuminates
  - in the cockpit, single high chime sounds, blue CALL light illuminates
- RESET
  - you can switch modes (i.e., ATTENDANT to PA) by using RESET

MISCELLANEOUS INFO

SINGLE ENGINE TAXI (saves gas on long taxi or for delays)
- two things to be very careful of:
  - don't use excessive thrust to break-away, damaging something behind you
  - start the other engine in plenty of time before takeoff; don't rush your FO
- in hot weather, start #2. Use APU for left pack and #2 engine for right pack
- don't "single-engine taxi" on hot asphault. New York LaGuardia is the worst
- the condition of the tarmac is the big factor, not weight
- you can single engine taxi a heavy 737 on concrete, but avoid turning into #2
- normally, 40% N1 will provide break-away thrust; extreme caution over 50% N1
- you can also cross-bleed start an engine as you're doing a single-engine taxi at 40%

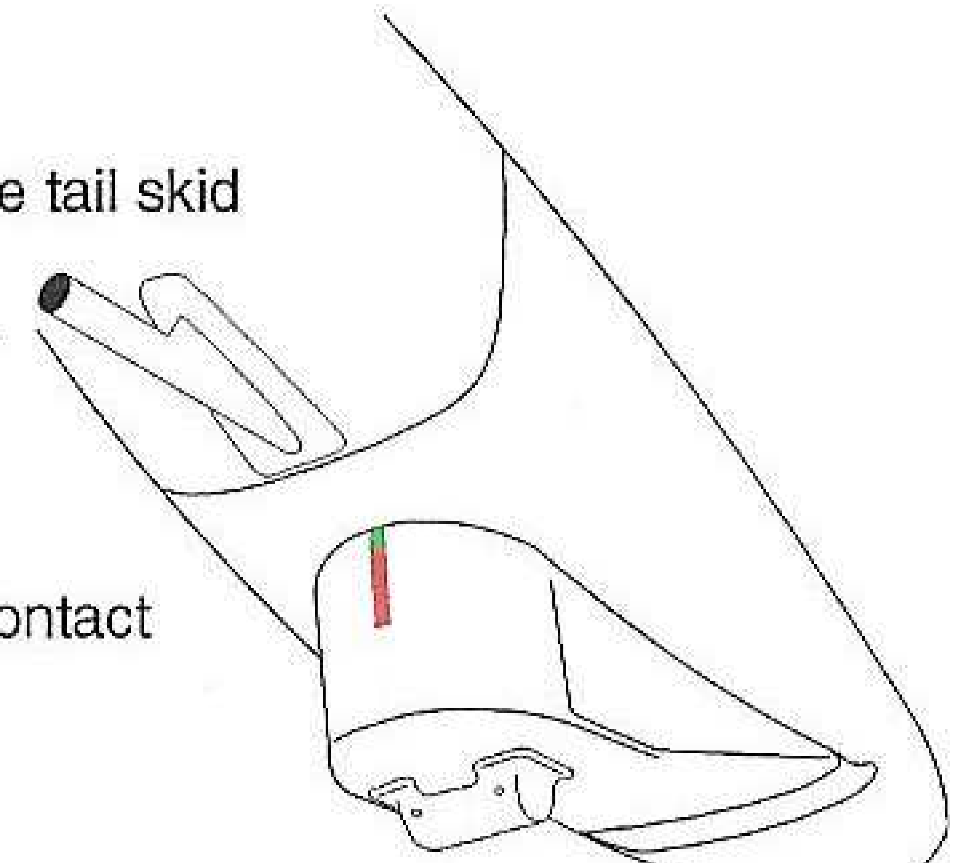
COCKPIT DOOR
- lower 2 panels for depressurization will blow into the cockpit
- upper 2 panels can be pulled inward for EMERGENCY exits ("pull" emergency handle)
- need electricity to "lock" the door (use CAB DOOR LOCK button)

EMERGENCY EQUIPMENT
- life vests (back of seats), smoke goggles, crash ax, escape rope, megaphone (in cabin; squeeze trigger or insert pin if anti theft siren!), flashlights (at least one flash per 10 seconds)
- all four slides automatically inflate if not, pull "Manual" releases. Older models have "girt bar retainer velcro straps" must be attached properly
- FO window has external emergency open lever

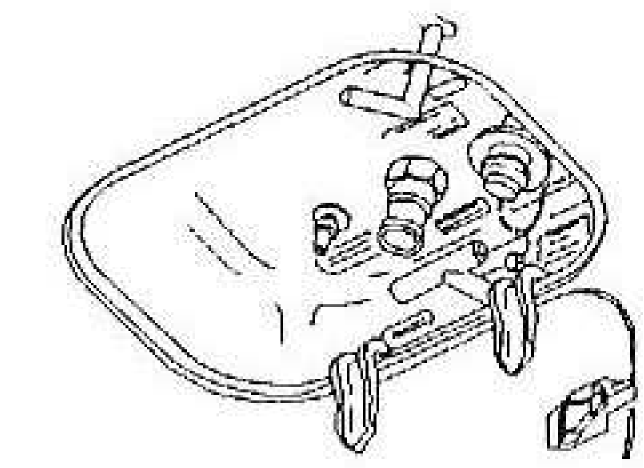
FIRE EXTINGUISHERS
- Halon - pull pin use only for electrical or grease fires and Water (twist handle use only for combustible fires) fire extinguishers in cabin; one Halon extinguisher in cockpit (be sure to wear O2 masks at 100%; halon evacuates all oxygen from area!)

CARGO COMPARTMENTS
- each have pressurization equalization valve and blowout panels
- master caution and door lights if "not locked"
- compartments are class C if fire suppression system is installed, otherwise class D
- animals: ok in both bins

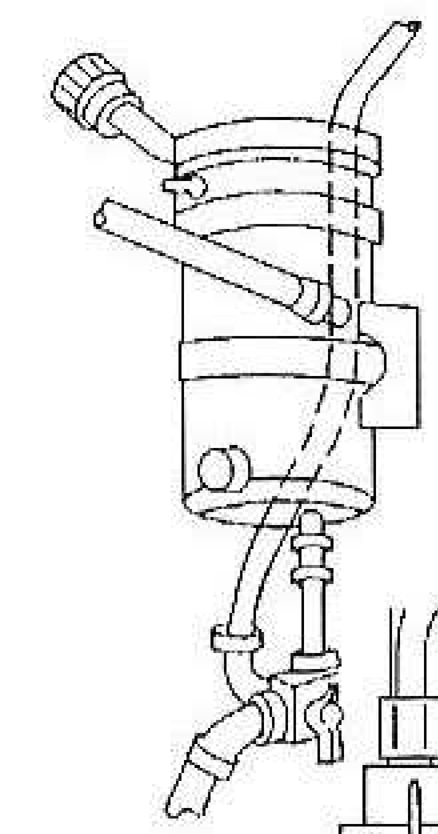
TAIL SKID (-4-8-9-B2)
- provides protection for aft fuselage only during takeoff, not on landing
  - depending on the geometry at touchdown, the aircraft can suffer tail strike on landing and never touch the tailskid - the fuselage strikes the runway
- primarily an indicator, consisting of a compressible core with a wear shoe at the base
- crushed cartridge warning decal on rear of skirt
  - new cartridge indicates green
  - check on walkaround; if scuffed, tell maintenance
    - if the green portion of the band is out of view, the tail skid cartridge has been compressed beyond limits
  - fully compressed indicates possible fuselage damage
  - when the wear shoe is worn to the level of the dimples, the wear shoe must be replaced
  - the wear shoe is designed to shear under heavy contact with the runway
- -900 tailskid fairing extended by 3"



WATER SYSTEM

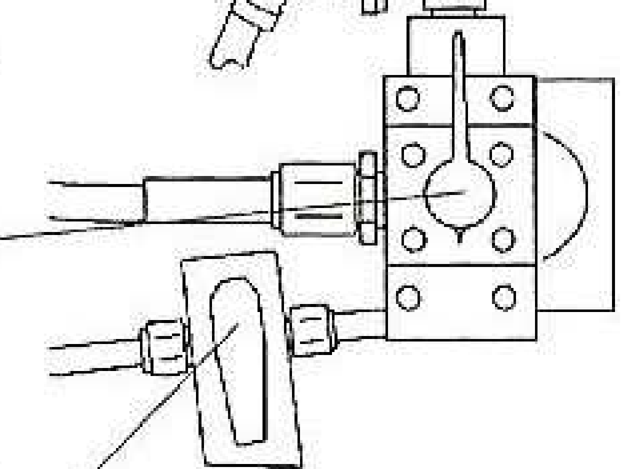


- system pressurized by left engine or the APU (left manifold)
  (NG) if no air pressure available, compressor comes on to keep pressure 30-40 psi (option on 3-4-5)
- water servicing at aft (3-4-5) left side of airplane (NG) right side of airplane
  (NG) opening access door disables compressor
- access door will not close unless the fill/overflow and drain valve handles are in the closed position
- tank behind aft cargo compartment

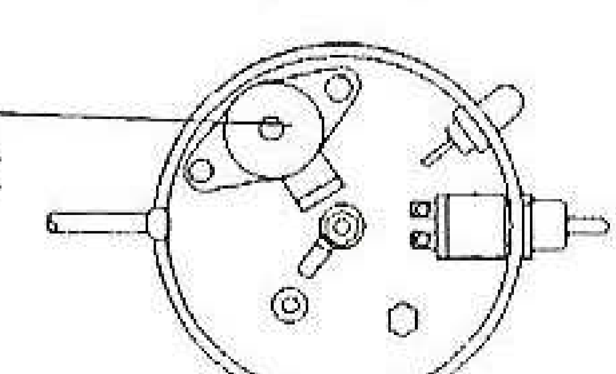


- tank drain valve control handle is accessible on the water service panel and controls draining of the passenger water tank
  (3-4-5) 20 gal capacity
  - water quantity indicator at right aft service door
    - LED lights, all lights illuminated indicates full tank

  (NG) 30, 40, 50, or 60 USgal potable water capacity available
  - potable water quantity indicator
    - located on the aft flight attendant control panel
    - transmits voltage proportional to the level of water in tank
  - the capacitance of the water tank level sensor changes
  - the capacitance of the water tank level sensor is 6,700 picofarads when the tank is full, and 2,500 picofarads when the tank is empty (very important to know this! ;-)



- water supply selector valves in each lav under sink
  - selections such as SUPPLY ON, TOILET ONLY, FAUCET ONLY, DRAIN
- if you park the airplane in freezing conditions with no electric power, drain the water and toilet systems to prevent ice formation
  - pull the circuit breakers for the water tank compressor and water heaters before you drain the potable water system
  - optional lav drain valve located below water supply selector
- to drain the potable water system, open these valves:
  - water tank drain valve
  - forward lavatory drain valve (forward lavatory only)
    - drain forward water supply lines
  - lavatory water supply shutoff valves (one in each lavatory).
  - when you drain the potable water system, the water drains overboard through the forward and aft potable water drain ports
- hot water system
  - hot water temp selector is located at the bottom of the water heater
    - (3-4-5) maintains water temp between 125°F (52°C) and 133°F (56°C)
      - overheat switch opennnnns if the temp reaches approx. 195°F (91°C) and power indicator light extinguishes
    - (NG) and optional on the (3-4-5) selections of LOW (approx. 105°F/40°C), MEDIUM (approx. 115°F/46°C), HIGH (approx. 125°F/52°C)
      - the overheat switch opens if the water temp reaches approx. 170°F (76°C). Power indicator light extinguishes



  - hot water heater reset is on top of tank
  - the power indicator light shows that power is available and that the overheat switch is closed (no overheat).
  - pressure relief valve opens if hot water pressure exceeds 140 psi and closes at approx. 130 psi

TOILET SYSTEM

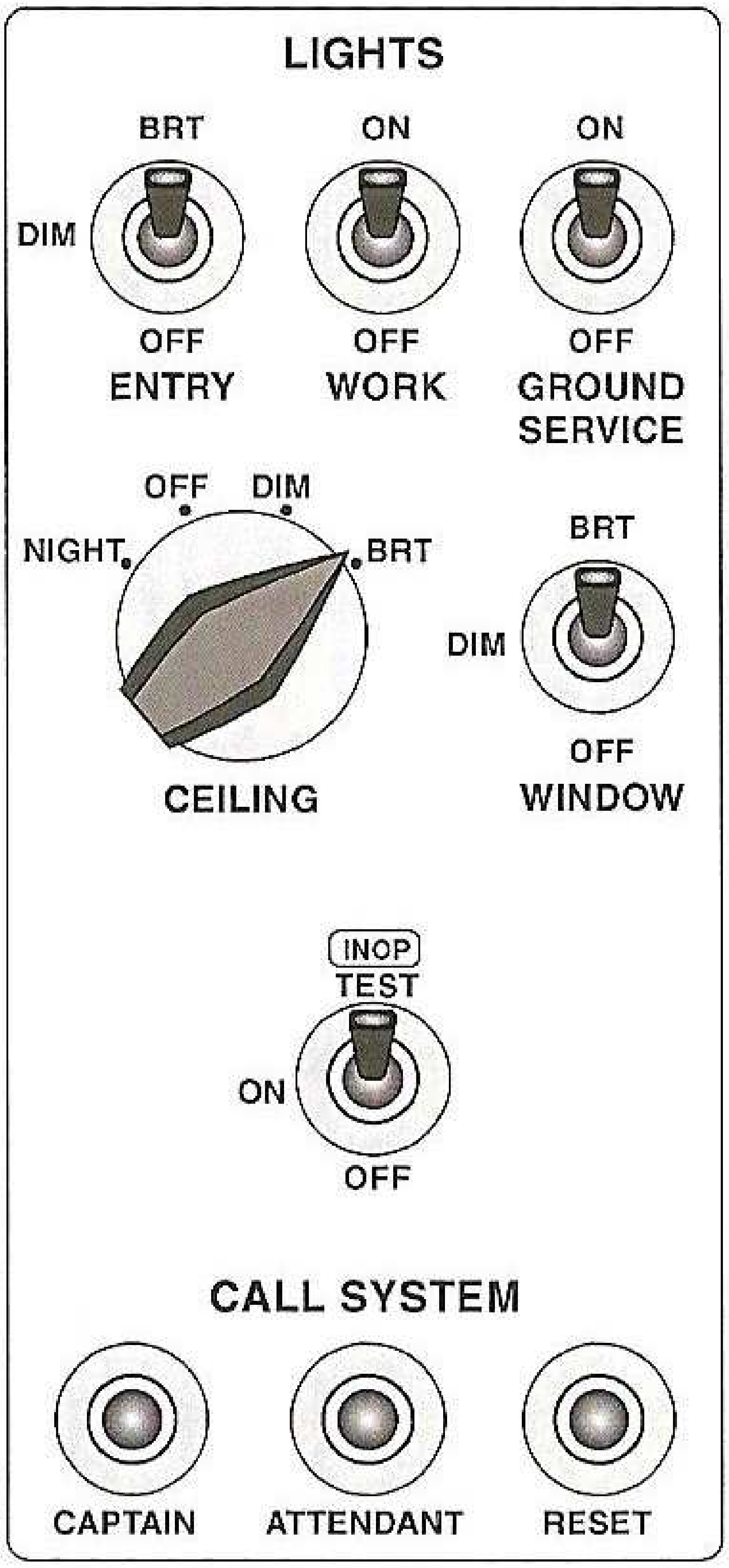
(3-4-5)

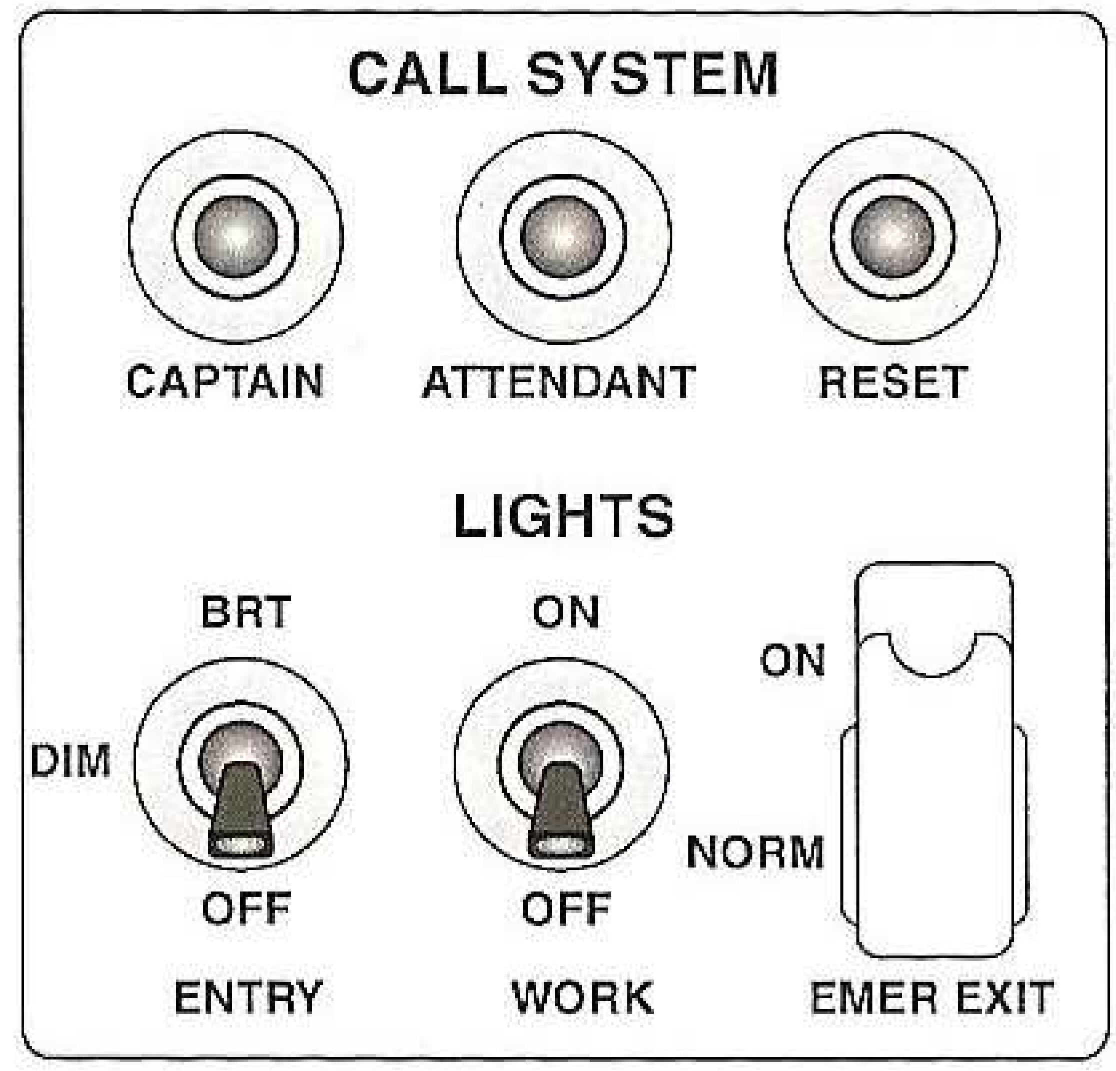
- toilet recycles the blue water

(NG)

- indicators are on the aft flight attendant control panel
- waste system quantity indicator
  - waste sensors in the tank provide input to the gauge
  - gauge shows the amount of waste in the tank, which, when full, automatically deactivates the flush capability of all lavs
  - FA is directed to notify flight deck if a high waste system quantity is indicated prior to departure
- LAVS INOP light
  - if the waste tank becomes full the LAVS INOP light will illuminate and the flush capability of all three toilets will be automatically deactivated
- CLEAN CHECK SENSOR light
  - indicates at least one of two waste sensors has failed or is fouled and requires maintenance
  - if both level sensors are dirty, full tank signal may be generated
- toilet system ops
  - when you push the flush switch, the rinse valve opens for .7 seconds to supply 8 oz of potable water to flush the toilet bowl. Two seconds after the flush cycle starts, the FCU opens the flush valve. The flush valve is open for 4 seconds to drain the toilet waste
  - differential pressure causes the toilet bowl contents to flow to the waste tank. The vacuum blower or cabin differential pressure supplies the differential pressure for the waste tank. A vacuum check valve prevents the pull of ambient air in from the waste tank vent port by the vacuum blower. The vacuum blower will operate if the airplane is below 16,000 ft.
  - the anti-siphon valve prevents backflow of water from the toilet bowl into the potable water system
  - the duty cycle inhibit (started when the flush switch was pushed) prevents another input from the flush switch for the next 15 seconds
  - the toilet will not function if the waste tank is full
  - 3 thermal switches in the vacuum blower stop the motor if the temperature in the vacuum blower is more than 270F (132C). The thermal switches reset when the vacuum blower temperature decreases to less than 270F (132C)
  - the manual shutoff handle closes the flush valve
  - crushed ice should be flushed down the toilets at regular intervals. DO NOT USE ICE CUBES. The crushed ice will help to prevent unwanted material from collecting in the vacuum waste lines
- toilet abnormals
  - if the toilet is making a loud continuous sucking sound, the flush valve may be stuck open by a large object. Close the lid and pull the manual shutoff valve behind a shroud at the base of the toilet. Block the lav until maintenance checks

FLIGHT ATTENDANT PANELS
(3-4-5)

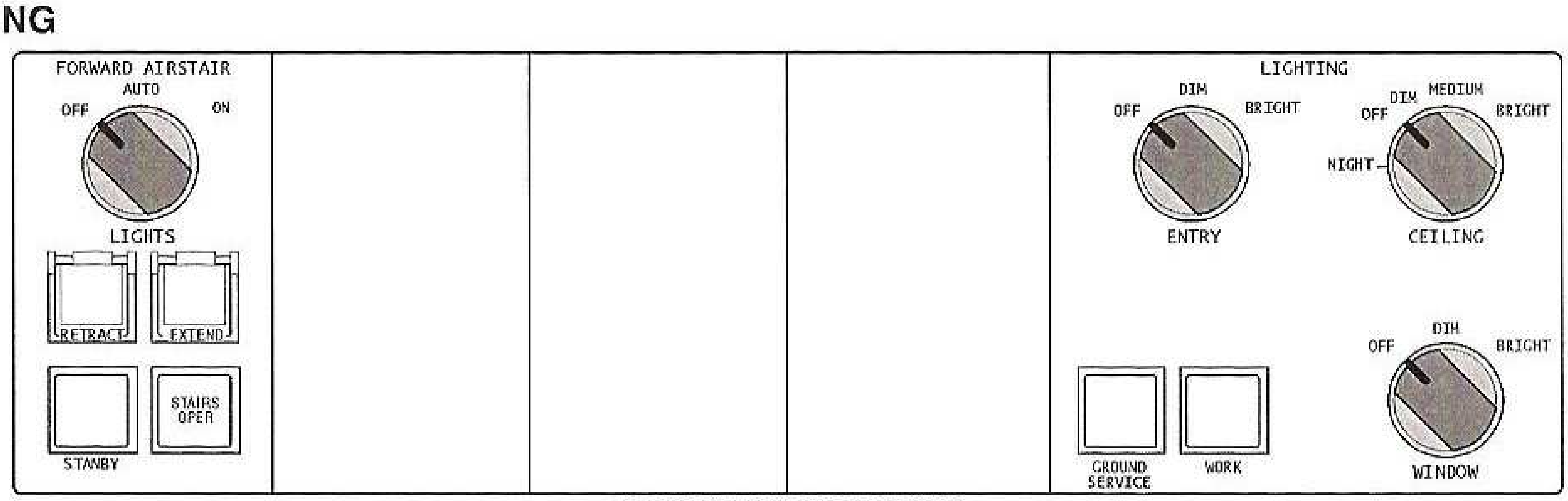




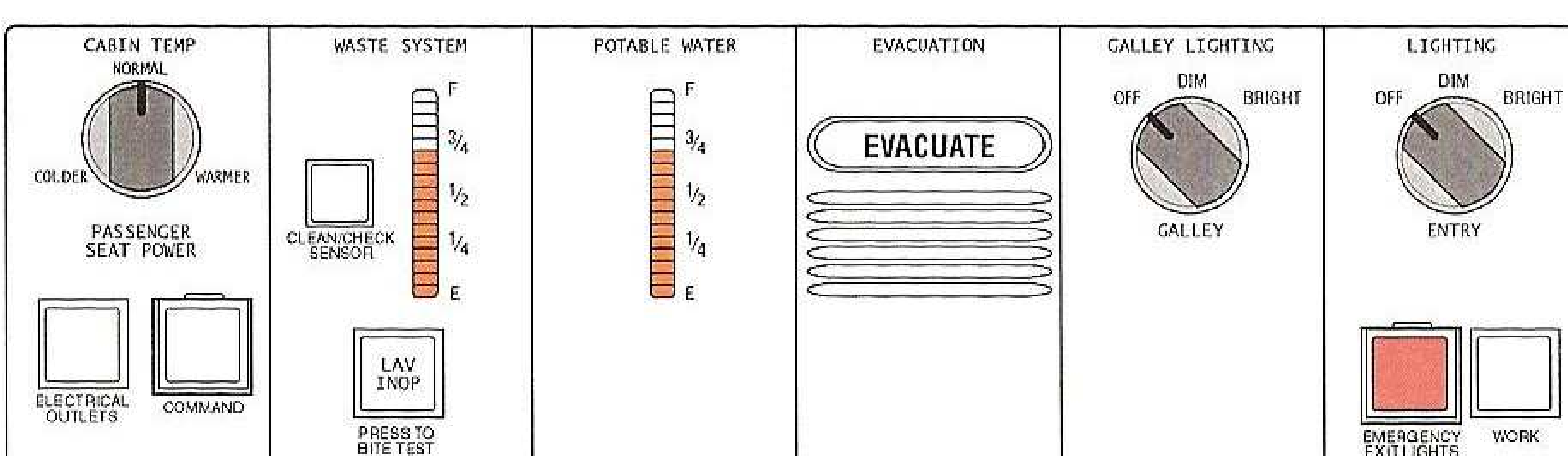
EMERGENCY EXIT LIGHTS switch (guarded)

- press to ON illuminates all emergency lights and bypasses flight deck control
- switch can be located on either the forward or aft FA control panel

NG

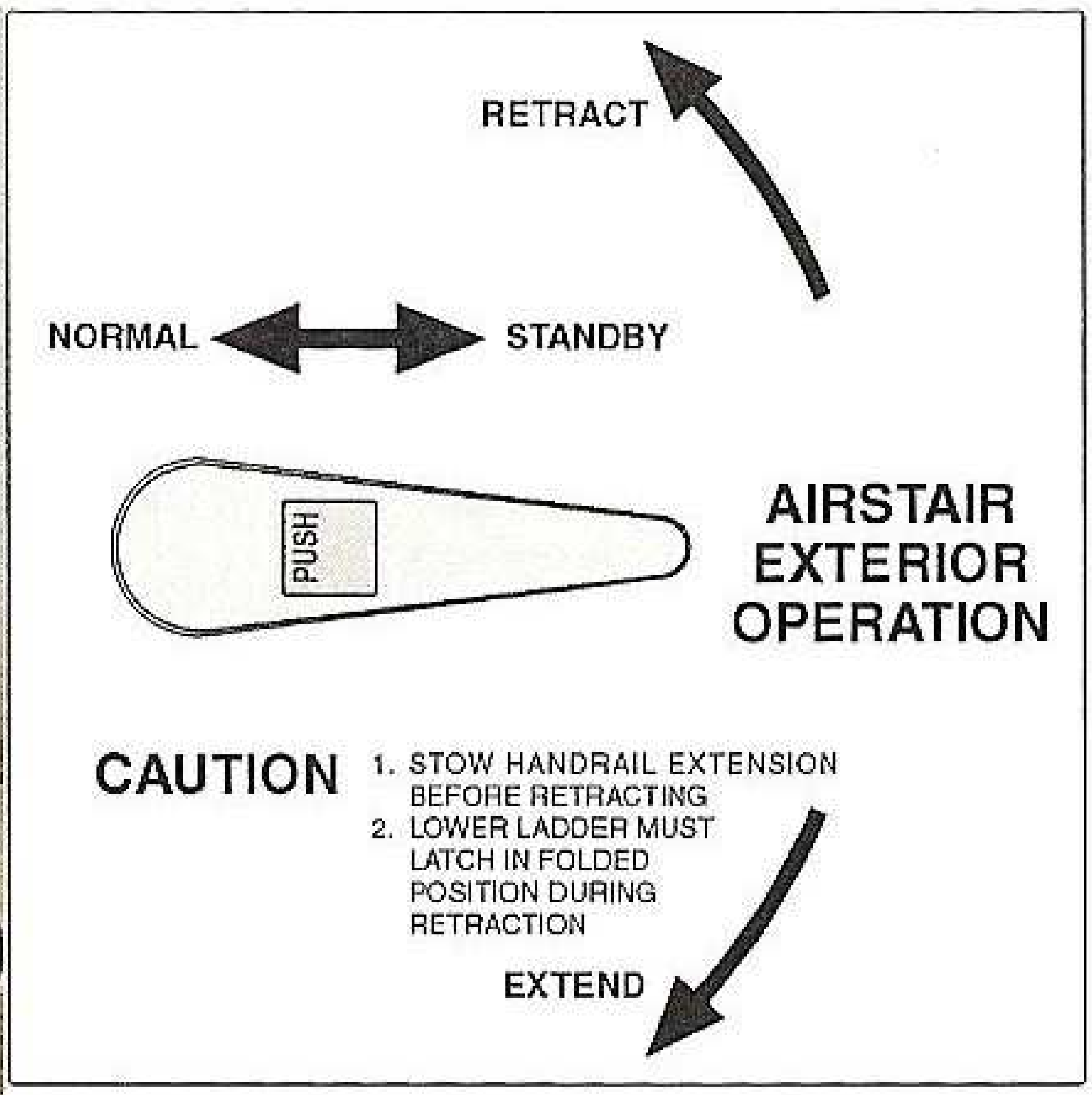


FORWARD ATTENDANT PANEL



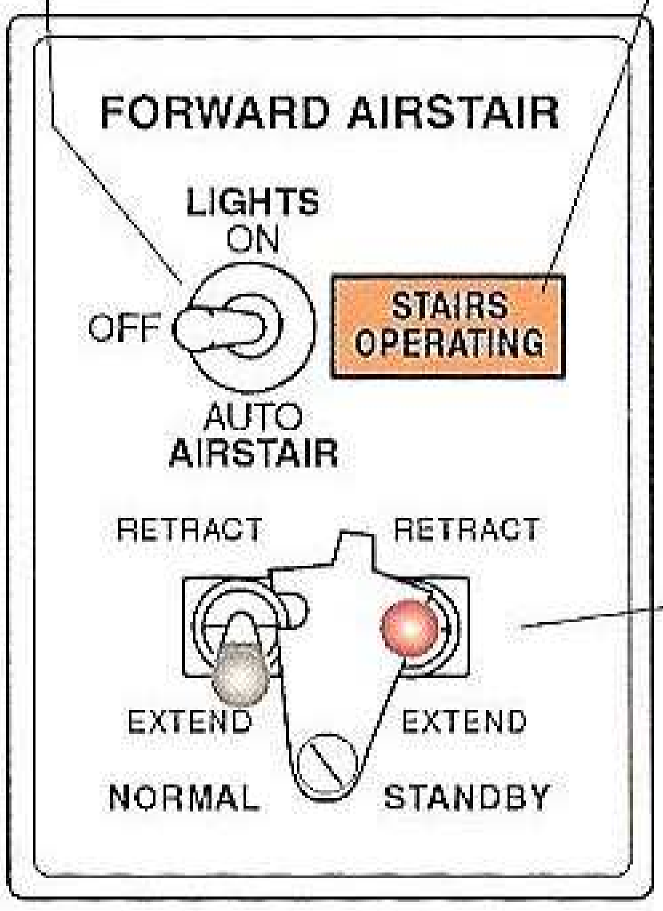
AFT FLIGHT ATTENDANT PANEL

AIRSTAIRS - Kidde



the door warning light on the cockpit overhead door panel illuminates when the airstair door latch pin is retracted or the airstair door is open

LIGHTS
ON turns the tread lights on
AUTO turns the tread lights on when the stair is fully extended

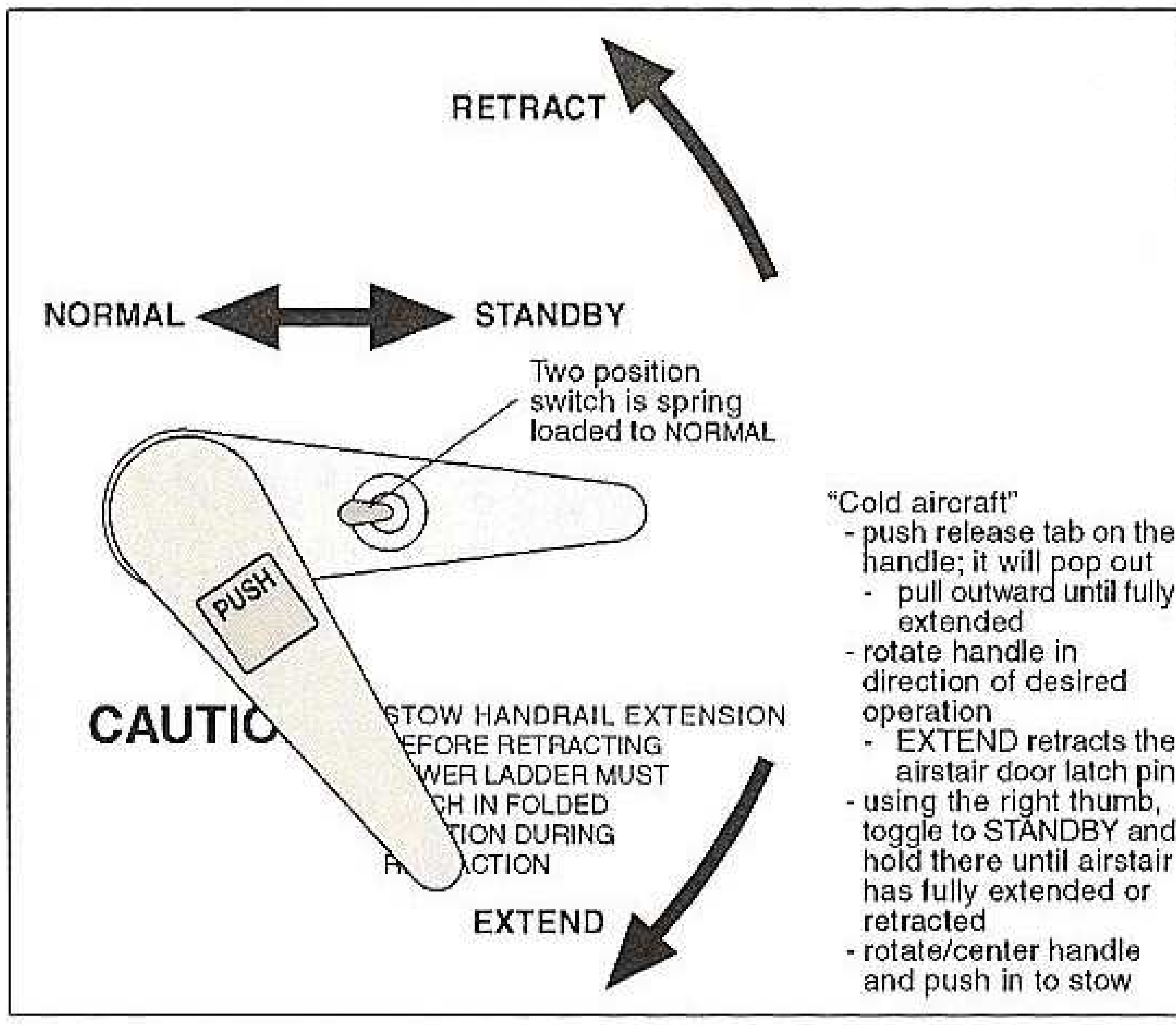


STAIRS OPERATING light
- push to test
- comes on when the airstair door and the stair are in an operating cycle
- will remain on as long as the stair is in any position other than fully extended with the airstair door open, or fully retracted with the airstair door closed
- will operate if DC power is provided by the normal airplane electrical system either in normal or standby mode
- if normal DC power is lost, the battery will provide power for airstair operation, but the STAIRS OPERATING light will not illuminate

- NORMAL and STANDBY positions are spring loaded to center, which is off
- use of **STANDBY** RETRACT can cause damage to equipment if handrail extensions are deployed or not properly stowed for stair retraction

Airstair System Notes

1. the airstair is electromechanically operated and is provided with both normal and standby operating systems
2. the airstair can be controlled from inside or outside
3. inadvertent extension of the airstair in flight is prevented by a latch pin which prevents the airstair door from moving inward from the closed position
   - the latch pin can only be retracted by opening the forward entry door or by operating the airstair exterior control handle
4. normal system (ac and/or dc)
   - the stair door uses normal 115v ac and 28v dc
   - the stair uses normal 3 phase ac power
5. standby system (dc)
   - provided for use if the normal electrical system has failed
   - the door and stair use only dc power, and it can be from the normal aircraft electrical system or the battery
   - the battery is locked out when normal dc is available
   - the handrail stowed limit switches are bypassed
6. operating from the interior control panel
   - the internal control panel requires dc power
   - the forward entry door must be cracked open so the latch pin will retract to unlock the stair door
     - cracking the entry door also powers the interior control panel



- the airstair should only be operated with the entry door at the cocked open position or the fully open and locked position (handrail can contact bottom of a mid-opened door)
- the stair door motor will not be powered while the stair door is still latched

7 extending stairs (normal)
- if the ship has ac power, the airstair will extend faster than if only dc is available
- hold the interior NORMAL toggle to EXTEND or rotate exterior handle to EXTEND
  - stby door motor is energized and if ac is available, the ac door motor is also energized
- when the stair door is fully open, the door motor is de-energized and the stair motors are energized
- just before the upper ladder rollers enter the curved tracks of the carriage, the speed-up switch is released which removes power from the standby stair motor
- as the ladders rotate downward, the standby motor energizes in the retract mode to slow-down the rotation of the ladders
- when the extend cycle is complete, release the interior toggle switch to the center position or move the exterior handle to neutral and push in to the stowed position
- disengage handrail extensions from stowed position by sliding handrail latch release outboard and lifting handrail extension
- extend handrail extensions and latch ends of handrail extensions to the handrail support brackets just inside the door
  - in the NORMAL mode, when the handrail extensions are disengaged from the stowed position on the handrails, the airstair retract relay is disarmed and the stair will not retract to prevent damage to fuselage

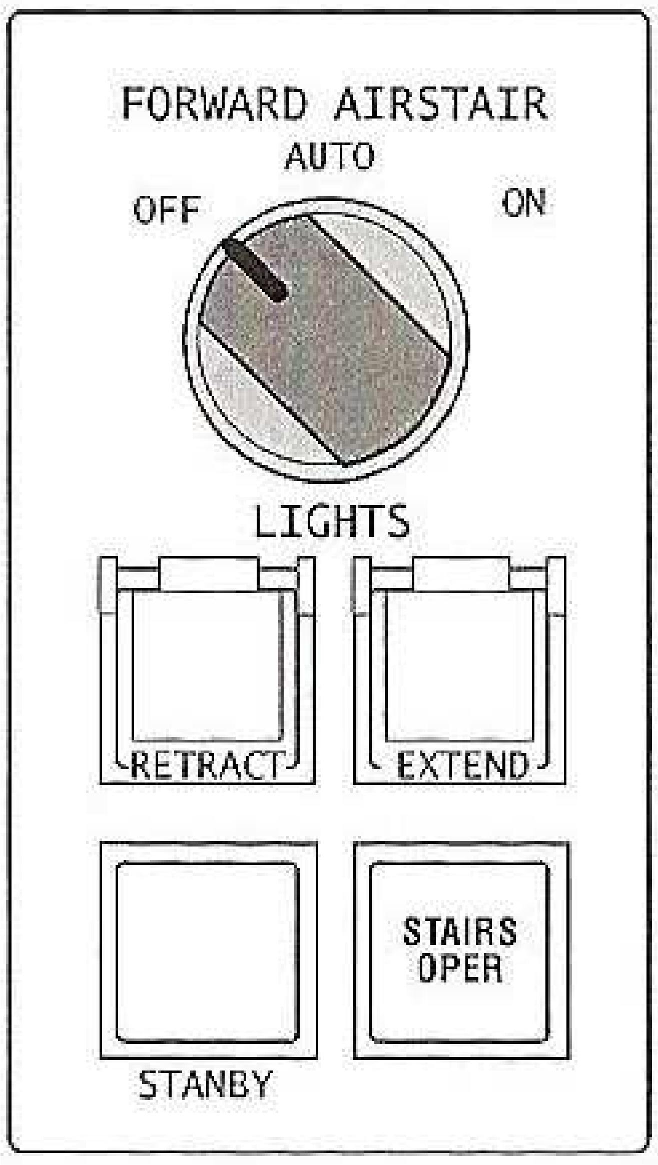
8 retracting stairs (normal)
- stair cannot be retracted until the handrail extensions are locked into their positions
- position interior NORMAL control to RETRACT or rotate exterior handle to RETRACT
- when the retract cycle is complete, release the interior toggle switch to the center position or release the toggle to NORMAL and move the exterior handle to neutral and stow

9 standby system
- CAUTION: no safety switch is provided in the standby system. Ensure that the handrail extensions are retracted and properly stowed or structural damage may occur
- operates on 28v dc power if available or battery power for a "cold" aircraft
- move the safety lock to the left to expose the STANDBY EXTEND/RETRACT switch
- extension/retraction procedure is the same as the normal procedure, however the inside control panel will only operate with normal dc power (not battery)
  - when extension/retraction is complete release the interior toggle switch to the center position or release the toggle to NORMAL and move the exterior handle to neutral and push in to stow. Cabin door is now ready to be locked or fully opened
  - install/stow handrail same as in normal operation

10 airstair may be extended or retracted manually (instructions are on a placard on the stairs)

(L/OP) Airstair Duty Cycle
- do not operate more than 3 consecutive cycles of normal operation in a 20 minute period

(L/OP) Airstair Wind Limit
- do not operate if winds exceed 40 kts



FORWARD AIRSTAIRS (optional controls)

LIGHTS switch (fwd attendant panel)

AUTO - the airstair tread lights illuminate automatically upon airstair ground contact and extinguish upon retraction

ON - illuminates the airstair tread lights

- two operating modes, normal and standby
- normal mode requires the fwd entry door to be partially open

Normal control switch (fwd attendant panel)

- normal AC and DC electrical power must be available

RETRACT- retracts the airstair

- the handrail extensions must be stowed prior to retracting the airstair

EXTEND - extends the airstair

Standby control switch

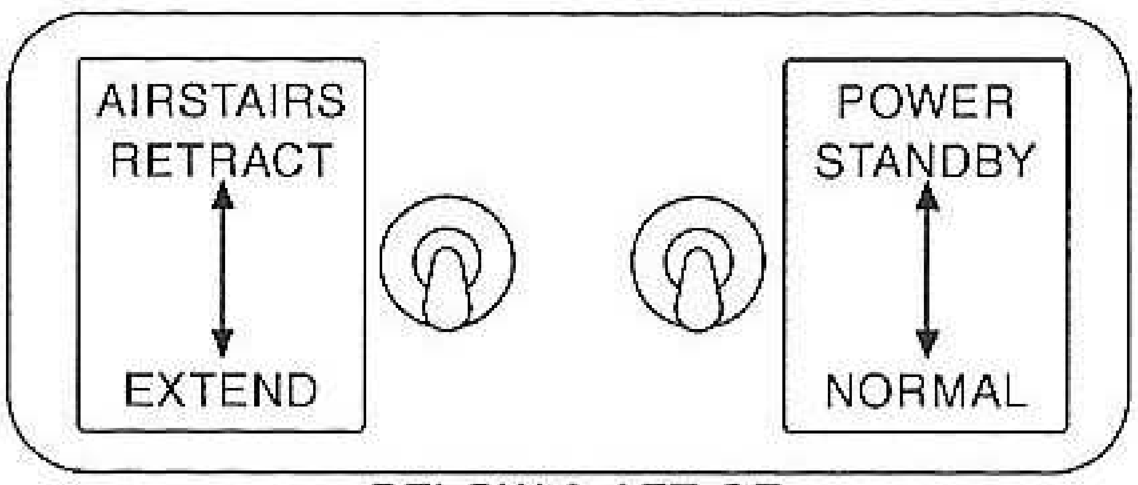
- provides an alternate means of electrical control in the event the normal mode is not available
- only requires BATT switch to be ON (DC power)
- STANDBY switch must be held in while using EXTEND or RETRACT

STAIRS OPER light - illuminated indicates the airstair is in transit

External Airstairs control switch

- outside, below and aft of forward entry door
  - RETRACT retracts the airstair
  - EXTEND extends the airstair
  - NORMAL requires both AC and DC power (spring loaded to NORMAL)
  - STANDBY requires only DC power
    - BATT switch does not need to be ON

Caution: use of the standby switches (FA panel or outside a/c) bypasses all safety circuits. Airstair handrail extensions must be stowed or substantial damage could result



BELOW & AFT OF FORWARD ENTRY DOOR

Airstair Notes

- provides capability of boarding passengers with self-contained stairs
- electrically operated and can be controlled from inside or outside the aircraft
- stowed in a compartment below the forward entry door
  - compartment has a pressure door that automatically opens before the airstair can operate
- upper handrails are attached to support brackets inside the entry door after the airstair is fully extended
- use of interior switches requires (normal or stby) the entry door to be partially open

PERFORMANCE AND PLANNING

FAR Part 25 details the design performance expectations of Transport category jet aircraft. This is a review of a few of the terms and concepts.

V1 (takeoff decision speed).

The speed by which the pilot must decide to reject the takeoff if an engine fails.

Balanced field length

If an engine fails at V1, the aircraft must be capable of stopping in the remaining runway distance or continuing the takeoff and clearing obstructions. The runway length required to do this is known as the accelerate-stop distance. If the decision is made to stop, the aircraft must remain on the runway or stopway using only brakes and ground spoilers; of course the pilot will also select reverse on the good engine(s). If the decision is made to continue the takeoff, the aircraft must be capable of reaching an altitude of at least 35 feet while still above the takeoff surface. This is known as the first segment climb.

V2 (single-engine safety speed)

Engine inop climb performance is based on the aircraft maintaining V2 speed until clear of obstacles. From the time the gear is retracted until the aircraft reaches 400 ft above the takeoff surface, maintaining V2 ensures a 2.4 percent single-engine climb gradient. This is known as the second segment climb.

Within the constraints of balanced field length requirements and various performance speeds, every jet takeoff must also satisfy the most conservative of three performance weight limits.

The *structural limit* weight is the aircraft's certified max takeoff weight.

The *runway limit* weight is the max weight for existing takeoff conditions that still allows the aircraft to meet balanced field length requirements on a particular runway. Factors influencing this value include wind direction and speed, ambient temperature, field elevation, runway slope and length.

The *climb limit* weight relates to that portion of the takeoff profile from 35 ft above the takeoff surface until the aircraft has climbed to 1,500 feet above it. Aircraft weight, altitude, and ambient temperature are the variables that most influence climb ability. FAR Part 25 requires that a jet be able to clear all obstacles in the takeoff flight path when continuing takeoff with a failed engine. Obstacle clearance is based on twinjets maintaining a minimum 1.2 percent single-engine climb gradient when between 400 and 1,500 feet above the takeoff surface. Note that this is only half of the single engine climb gradient required in the climb to 400 feet.

If the *runway length* is the limiting factor, selecting a higher takeoff flap setting will sometimes shorten balanced field length requirement. A higher flap setting typically results in lower V1 and VR speeds, meaning that less physical runway length is required for the takeoff.

But what if the *climb weight limit* is reached first, which is common to the 737. In other words, the physical length of the runway is not the limiting factor. Rather, obstacle clearance criteria along the takeoff path determines the limiting weight. In this case, the extra runway length can be used to permit a higher rotation speed, and a higher takeoff weight. Attaining a faster speed on the runway means the aircraft's energy state is greater once it lifts off. This energy can be used to climb faster, thus better satisfying climb requirements. The takeoff roll will be longer, but balanced field length requirements can still be met.

Another useful technique for increasing allowable takeoff weight is to make a bleeds-off takeoff. Engine bleed air is normally taken from the engine compressor section and used to power air conditioning, anti-ice, and other systems, at the expense of a slight decrease in available engine thrust.

Operation at reduced takeoff thrust based on an assumed temperature higher than the actual ambient temperature is permissible if the airplane meets all applicable performance requirements at the planned takeoff weight and reduced thrust setting. The amount of thrust reduction must not exceed 25% of the full rated or derated takeoff thrust.

This information may not be correct for your SOP

Reduced Thrust Takeoff

- assumed temp method achieves a takeoff thrust less than the full rated takeoff thrust by using an assumed temp that is higher than the actual temperature
- max thrust reduction authorized by the FAA is 25% below any certified rating
- thrust setting parameter (N1) is not considered a limitation
- if conditions are encountered during the takeoff where additional thrust is desired, the crew should not hesitate to manually advance thrust levers to max rated thrust
- do not use reduced thrust takeoff if:
  - PMC/EEC is inop or off; snow, slush, standing water; anti skid inop; or windshear reported or suspected

DerateTakeoff

- uses takeoff thrust less than rated thrust for which complete and independent performance data is provided
- the derate N1 is considered a limitation for takeoff because an increase in thrust following an engine failure could result in a loss of directional control

Improved Climb

- in not field length limited, increased climb limit weight is achieved by using the excess field length to accelerate to higher takeoff and climb speeds to improve climb gradient
- not authorized with: Contaminated runway, Antiskid inop, Reduced power "CAR"

Bleeds-Off Takeoff

- add the following to runway and climb limits
  (3-4-5-6-7) 4,000 lbs, (8-BBJ 2) 5,100 lbs, (9) 5,000 lbs
  - actual gross takeoff weight must be less than both the runway and climb limits

Short Field Landing

- factors affecting landing distance
  - flaps less than 40
  - shallow glide path angle
  - speedbrakes not extended
  - thrust reversers not deployed
  - 10 kts over target speed
  - high over threshold (100' rather than 50')
  - 3 sec float after flare
  - speedbrakes not extended
  - 1/2 brake pressure
- do not "duck under" the VASI or glideslope
- select autobrakes 3 or MAX and don't kick off untill less than 80kts

Crosswind landing

- sideslip only (zero crab) landings are not recommended with crosswinds in excess:

(3-5) flaps 30 = 18 kts @ 1.1 operating empty wt or 22 kts at max landing weight
flaps 40 = 23 kts @ 1.1 operating empty wt or 28 kts at max landing weight
(NG) flaps 30 = 20 kts @ 1.1 operating empty wt or 24 kts at max landing weight
flaps 40 = 22 kts @ 1.1 operating empty wt or 26 kts at max landing weight

- on very slippery runways the crosswind crab angle may be maintained to touchdown
  - this will reduce drift toward the downwind side when touching down
- to maintain adequate control margin and ground clearance margins it may be necessary to combine crab and sideslip technique during strong crosswinds

Exiting the Runway

- after the last airspeed call on the runway transition to the ground speed indicator
  - tail winds will render airspeed indicator unreliable
- do not exit the runway unless the ground speed indicator is down to your minimums
- tailwinds on a rain slick runway (ATL) taught me this lesson the hard way

FLAP MANEUVER SPEED SCHEDULE

	(3-4-5)				(NG)
Flaps	**≤ 117.0***	**> 117.0***	**≤ 117.0****	**> 117.0****	**Speed**
0	210	220	220	230	VREF 40 + 70
1	190	200	200	210	VREF 40 + 50
5	180	190	190	200	VREF 40 + 30
10	170	180	170	180	VREF 40 + 30
15	150	160	150	160	VREF 40 + 20
25	140	150	140	150	VREF 40 + 10

* with Rudder Pressure Reducer (RPR)
** without Rudder Pressure Reducer (RPR) or yaw damper inop

Tailstrike Avoidance

- tail clearance achieved for a given flap setting is a function of airspeed at rotation and rate of rotation
- normal pitch attitude at lift-off is only 3° to 4° less than the attitude at which aft body contact will occur
- smooth continuous rotation (3° per sec) will result in lift-offs of the aircraft at a body attitude of between 7 and 10°, depending on the 737 model flown
- don't use the FD pitch command for rotation
- point of minimum ground clearance occurs slightly after lift-off
- leading cause of tail strikes at takeoff are early rotation and/or an excessive rotation rate

(QRH) Tailstrike On Takeoff

- do not pressurize airplane due to possible structural damage
- set pressurization mode selector to manual and open the outflow valve

AIRCRAFT DIMENSIONS

	300	400	500	600	700	800	900	BBJ	BBJ 2	C-40A
Wingspan	94'9"	94'9"	94'9"	112'7"	112'7" *	112'7" *	112'7"	117'5"	117'5"	112'7"
Length	109'7"	119'7"	97'9"	102'6"	110'4"	129'6"	138'2"	110'4"	129'6"	110'4"
Height	36'6"	36'6"	36'6"	41'3"	41'2"	41'2"	41'2"	41'2"	41'2"	41'2"
Gear Width	17'2"	17'2"	17'2"	18'9"	18'9"	18'9"	18'9"	18'9"	18'9"	18'9"
Wheelbase	40'10"	46'10"	36'4"	36'10"	41'3"	51'2"	51'2"	41'3"	51'2"	41'3"
Wing Area	1135	1135	1135	1345.5	1345.5	1345.5	1345.5	1345.5	1345.5	1345.5
Empty Wt	72.3	76.2	70.4	80.3	83.8	90.6	93.6	94.9	101.9	
MZFW	106.5	116.7	103.0		120.5	138.3	140.3	126.0	138.3	126.0
Max Taxi	135.5	150.0	134.0		155.0	174.7	174.7	171.5	174.7	171.5
MGTOW	138.5	150.0	133.5	143.5	154.5	174.2	174.2	171.0	174.2	171.0
Max Landing	114.0	121.0	110.0	121.5	128.0	146.3	147.3	134.0	146.3	134.0
Aprox LRC "at altitude"	.745	.745	.745	.785	.785	.785	.785	.785	.785	.785

* 117.5" with winglets

Weights are max available from factory

Aft fuselage contact, lift-offs attitudes and minimum tailskid clearances

- rotate at an average pitch rate of 2.5° per second
- don't use the FD for rotation
- because of the short fuselage, aft fuselage contact is unlikely in the -500 / 600
- during takeoff the amount of tail clearance achieved for a given flap setting is a function of the airspeed at rotation and the rate of rotation
- as shown below, the 800 and 900 have the least clearance
  - consider using a larger flap setting for light weight takeoff
- do not pressurize if fuselage runway contact is suspected

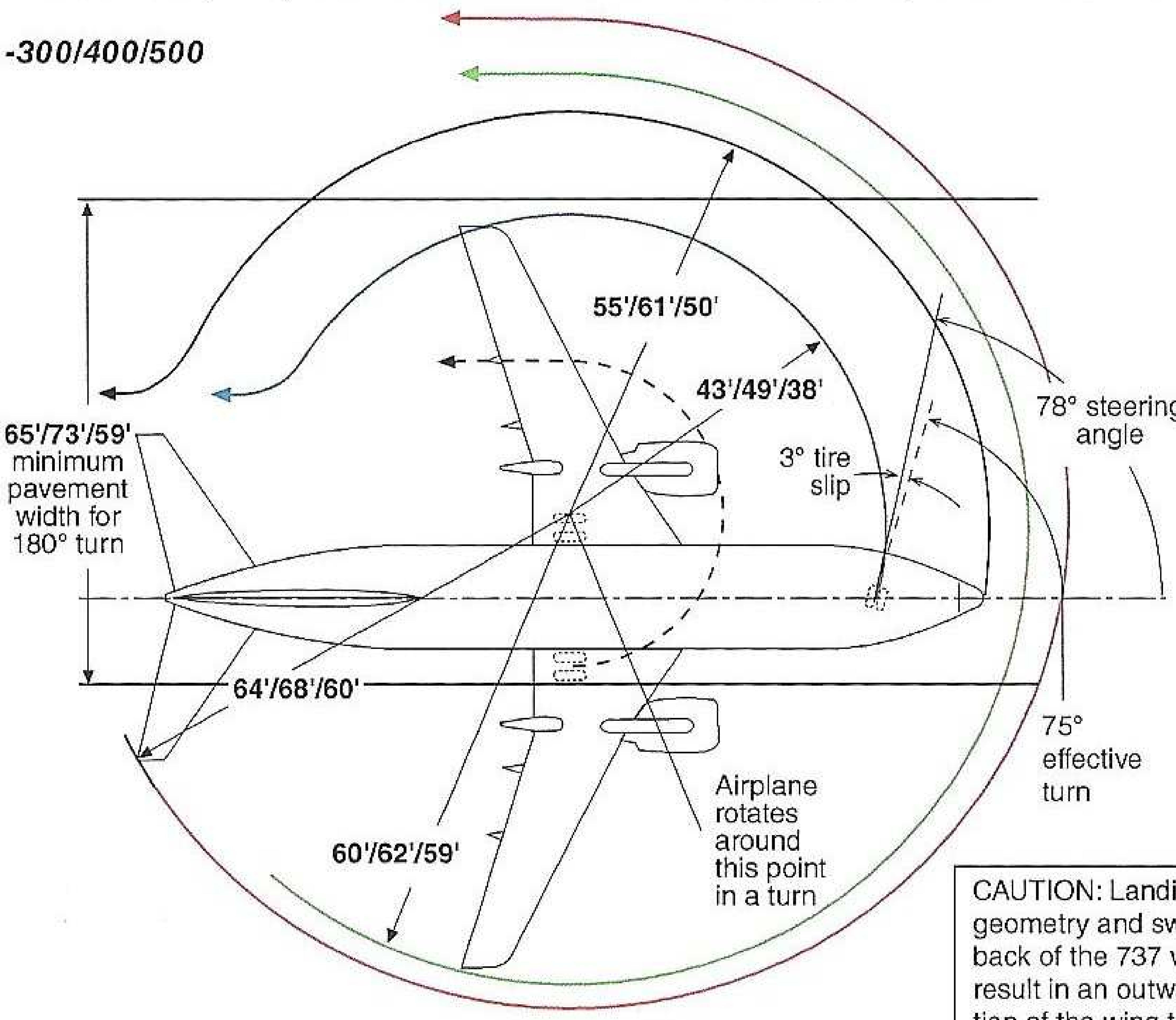
All Engine lift-off attitude	Minimum tail clearance	Aft fuselage contact
-300		
Flaps 1 - 10°	23"	13.4°/11.0° *
Flaps 5 - 9.9°	24"	
Flaps 15 - 8.1°	37"	
Engine Inop lift-off attitude: Minimum tail clearance approximately 12"		
-400		
Flaps 5 - 9.1°	23"	11.4°/- - *
Flaps 15 - 8.5°	29"	
Engine Inop lift-off attitude: Minimum tailskid clearance approximately 10"		
-500		
Flaps 1 - 10.0°	34 "	14.5°/12.0° *
Flaps 5 - 9.9°	35"	
Flaps 15 - 8.1°	47"	
Engine Inop lift-off attitude: Minimum tail clearance approximately 32"		
-600		
Flaps 1 - 9.0°	28"	16.2°/13.8 *
Flaps 5 - 9.0°	28"	
Flaps 15 - 8.7°	30"	
Engine Inop lift-off attitude: Minimum tail clearance approximately 24"		
-700		
Flaps 1 - 9.1°	29"	14.8°/12.2° *
Flaps 5 - 9.1°	29"	
Flaps 15 - 8.7°	31"	
Engine Inop lift-off attitude: Minimum tail clearance approximately 18"		
-800		
Flaps 1 - 8.2°	20"	11.0°/9.2° *
Flaps 5 - 8.2°	20"	
Flaps 15 - 7.8°	23"	
Engine Inop lift-off attitude: Minimum tailskid clearance approximately 10"		
-900		
Flaps 1 - 7.7°	20"	9.2°/8.3° *
Flaps 5 - 7.6°	20"	
Flaps 15 - 7.2°	23"	

* takeoff, struts extended / landing, struts compressed

TURNING RADIUS

- the tail of the 300/400/500 swings the largest arc while turning and determines the minimum obstruction clearance path
- do not attempt to make a turn away from an obstacle within 15 ft (4.6 m) of the wingtip or within 25 ft (7.6 m) of the nose for the -300/500, or 22 ft (6.7 m) of the nose for the -400

-300/400/500

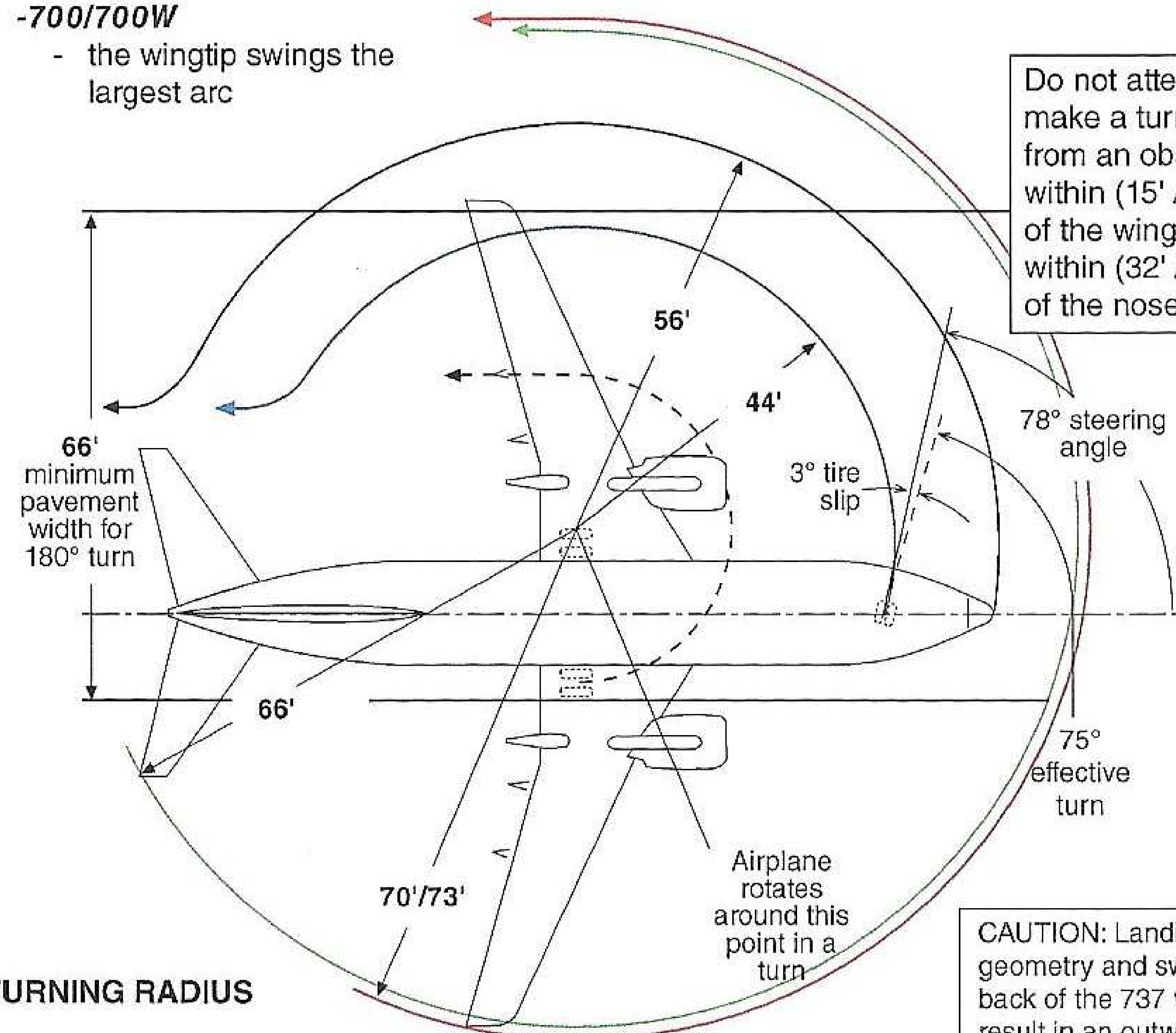


CAUTION: Landing gear geometry and sweep back of the 737 wings result in an outward motion of the wing tips and tail during turns.

TURNING RADIUS

-700/700W

- the wingtip swings the largest arc



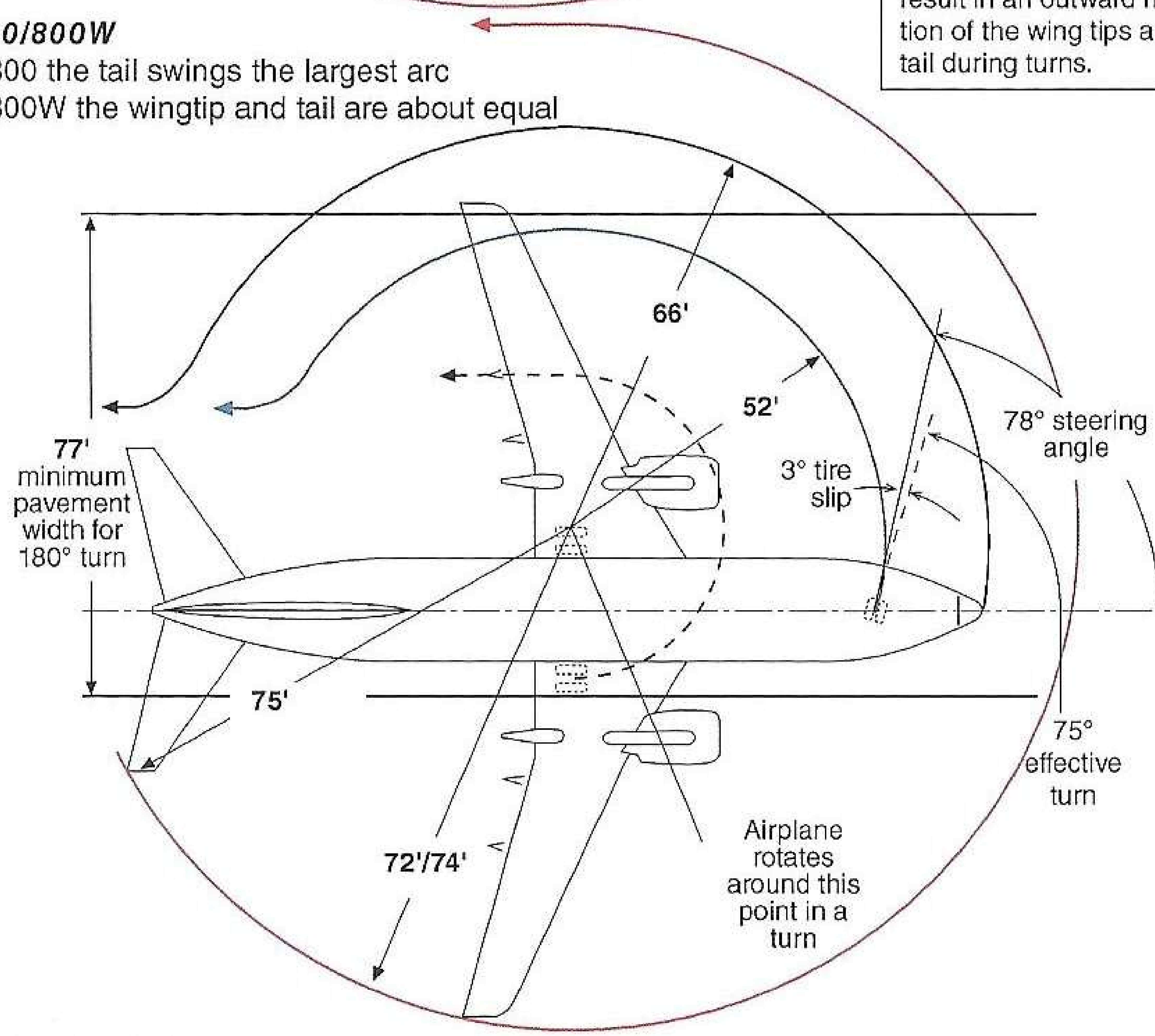
Do not attempt to make a turn away from an obstacle within (15' / 4.6m) of the wing tip or within (32' / 9.8m) of the nose

CAUTION: Landing gear geometry and sweep back of the 737 wings result in an outward motion of the wing tips and tail during turns.

TURNING RADIUS

-800/800W

800 the tail swings the largest arc
800W the wingtip and tail are about equal



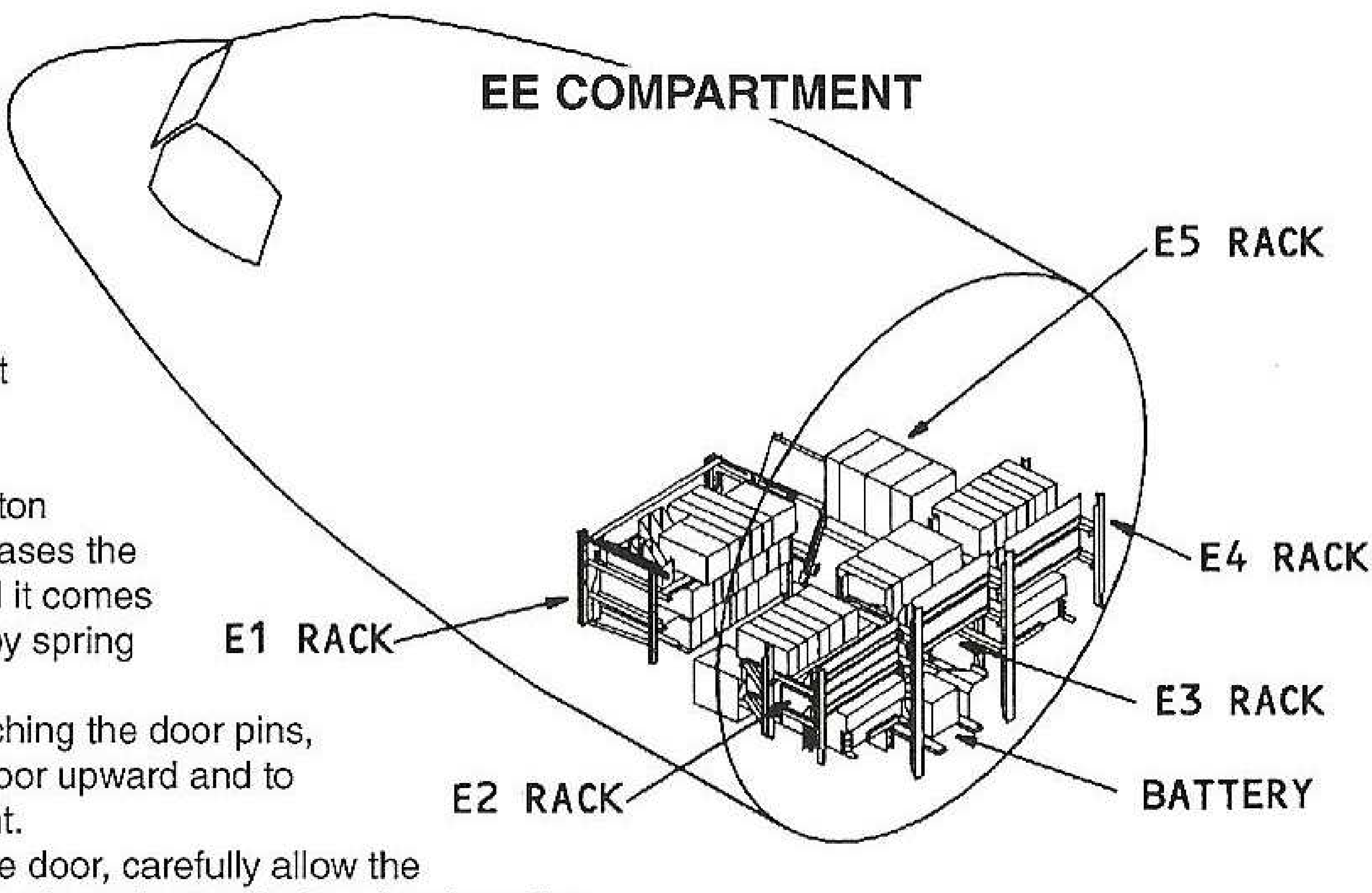
SFP (Short-Field Performance)

- the 737 design enhancements allow operators to fly increased payload in and out of airports with runways less than 5,000 feet long.
- the design enhancements include
  - sealed leading-edge slat on 800-900ER to increase lift during takeoff
    - change does not benefit the -600 and -700
  - Krueger flap (leading edge flap) seal door actuator that opens the door during approach and landing. This increases lift which allows for lower approach speed
  - increased flight spoiler deflection on the ground
    - two stage actuator for the flight spoilers that still limits the deflection to approx. 38° during flight but allows further deflection to approx. 60° after the airplane touches down during landing. This increased deflection reduces lift which increases the weight on the wheels and increases drag which further reduces stopping distances.
  - winglet lift credit that allows use of lower landing-approach speeds
  - (option not chosen by Alaska) a two-position tail skid that reduces approach speeds on 800- 900ER
    - change does not benefit shorter length models, -600 and -700

EE COMPARTMENT

The Electronic Equipment compartment is below the main cabin floor, aft of the nose wheel well. You can enter the EE compartment through an EQUIP door in the bottom of the fuselage.

There are five standard equipment racks.
E1 - front
E2, E3, and E4 on the back starting on aircraft left,
E5 - aircraft right.



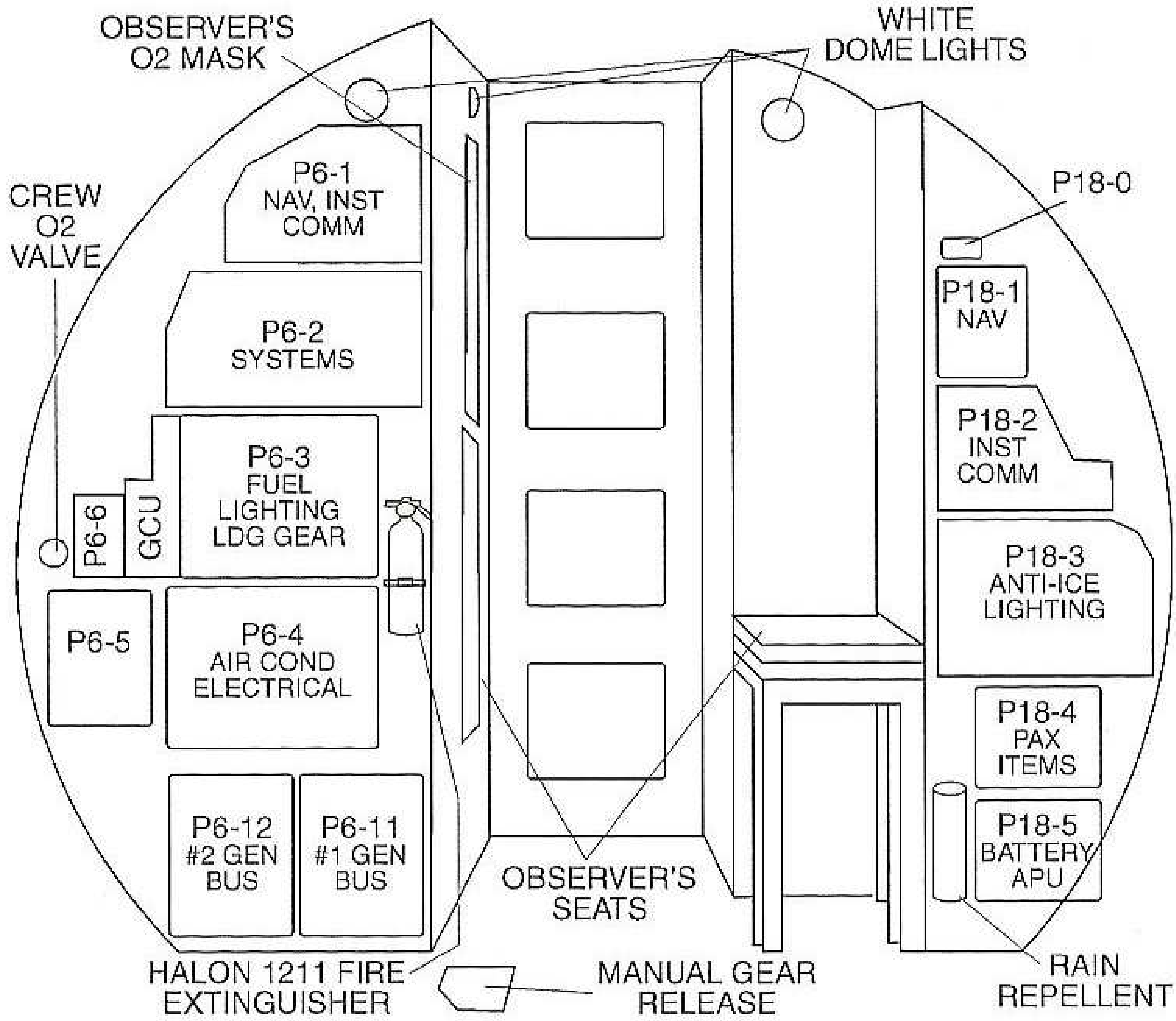
A push-button trigger releases the handle and it comes out of fair by spring force.
After unlatching the door pins, push the door upward and to aircraft right.
To close the door, carefully allow the door to slide down the tracks in a level position.
If you allow the door to gravity fall, the nylon rollers may come out of the tracks. It is very difficult to put back on track. (I had to call maintenance!)
To secure, turn the handle clockwise, then push the door handle back into its recess.

COCKPIT CIRCUIT BREAKERS (3-5)

The circuit breaker legend will vary from one carrier to the next. This is due to airline specific configurations.

Don't reset a fuel pump, lav flush motor, or fuel quantity indicating system circuit breaker.

Before resetting a CB ask yourself:
"How important is that component to the flight?"
"What else is happening that caused the circuit breaker to trip? Phase of flight? Weather conditions?



Preflight:
If a circuit breaker if found tripped during preflight, it may be reset once unless there is reason to believe it has tripped due to an electrical fault.

After block-out:
If a circuit breaker has tripped after block-out, do not reset it. Continue the flight with the CB left out provided the system is not required per the MEL.
One reset of a CB is allowed after a cooling period of 2 minutes if called for in a non-normal checklist or at the discretion of the Captain if the system is necessary for the safe completion of the flight. Do not attempt a second reset.

If a circuit breaker has tripped due to a perceived electrical manfuntion, notify maintenance. Do not reset the breaker.

A Sys Pressure Indicator, Hyd	P6-2	D17	
A Sys, Electric Hyd Pump Cont	P6-2	A15	
A Sys, Electric Hydraulic Pump	P6-12	C2	
A Sys, Hyd Oil Quantity Ind	P6-2	C17	
AC Bus 1, A phase	P6-4	B13	
AC Bus 1, B phase	P6-4	B14	
AC Bus 1, C phase	P6-4	B15	
AC Bus 2, A phase	P6-4	B10	
AC Bus 2, B phase	P6-4	B11	
AC Bus 2, C phase	P6-4	B12	
AC Bus, No 1 Electronics	P18-0	2	
AC Bus, Electronics 2, 3 phase	P6-1	E13	
AC Transfer Indicator	P6-5	D6	
AC Transfer Bus 1, A phase	P6-4	C13	
AC Transfer Bus 1, B phase	P6-4	C14	
AC Transfer Bus 1, C phase	P6-4	C15	
AC Transfer Bus 2, A phase	P6-4	C10	
AC Transfer Bus 2, B phase	P6-4	C11	
ACARS MU (AC)	P18-2	E14	
ACARS MU (DC)	P18-2	E15	hot bat bus
ADF 1	P18-1	B4	
ADF 2	P6-1	B15	
ADI 1	P18-2	B1	
ADI 1, ALTN	P6-1	C8	
ADI 2	P6-1	B8	
ADI 2, ALTN	P18-2	B2	
AFCS, Sys A, FCC (DC)	P18-1	E3	
AFCS, Sys A, Interlock, Engage	P18-1	E4	
AFCS, Sys A, Mach Trim (AC)	P18-1	E6	
AFCS, Sys A, Mach Trim (DC)	P18-1	E7	
AFCS, Sys A, Sensor Exc (AC)	P18-1	E1	
AFCS, Sys A, Warning Light (Bat)	P18-1	E5	bat bus
AFCS, Sys B, FCC (DC)	P6-2	C2	
AFCS, Sys B, Interlock, Engage	P6-2	C3	
AFCS, Sys B, Mach Trim (AC)	P6-2	B2	
AFCS, Sys B, Mach Trim (DC)	P6-2	B1	
AFCS, Sys B, Sensor Exc (AC)	P6-2	C1	
AFCS, Sys B, Warn Light (Bat)	P6-2	C4	bat bus
AFDS Aileron Force Limiter	P18-1	D7	
AFDS MCP (DC)	P18-1	D1	
AFDS MCP Course #2 (DC)	P 6-2	B3	
Aileron Force Limiter, AFDS	P18-1	D7	
Aileron Trim Control	P 6-2	C9	115ac xfr bus 1
Air Conditioning, Ram Air Mod Cont	P6-4	E3	battery bus
Air Conditioning, Ram Air Mod Left	P6-4	E2	115 vac xfr bus 1
Air Conditioning, Ram Air Mod Right	P6-4	E1	
Air Conditioning, Recirc Fan, Cabin (right)	P6-4	E5	115 vac main bus 1
Air Conditioning, Recirc Fan, Control	P6-4	B4	28 vdc bus 2
Air Conditioning, Recirc Fan, Energzd	P6-4	B5	
Air Conditioning, Temp Control, 35° F Left	P6-4	A2	
Air Conditioning, Temp Control, 35° F Right	P6-4	A1	
Air Conditioning, Temp Control, Auto Left	P6-4	A4	
Air Conditioning, Temp Control, Auto Right	P6-4	A3	
Air Conditioning, Temp Control, Manual	P6-4	A5	
Air Conditioning, Temperature Ind	P6-4	D2	
Air Data #1, Auto Transformer	P18-2	A6	

CIRCUIT BREAKERS (CLASSIC)

Air Data #1, Computer (26vac) RD-26 vac elex pwr 1	P18-2	A9	EFIS-26vac stb pwr
Air Data #1, Computer (ac) RD-115 vac elex pwr 1	P18-2	A8	EFIS-115 vac stby pwr
Air Data 1, TAT Indicator	P18-2	A7	
Air Data 2, Altimeter (26V AC)	P6-1	B4	
Air Data 2, Computer (26V AC)	P6-1	B6	26 vac elex bus 2
Air Data 2, Computer (AC)	P6-1	B7	115 vac elex bus 2
Air/Ground Relay & Lights	P6-3	C12	bat bus
Airstair, Actuator (3 phase)	P6-4	B17	
Airstair, Cont	P6-4	A17	
Airstair, Door	P6-4	A16	
Airstair, Stby Door	P6-4	C16	
Airstair, Stby Cont & lwd Ent Door Ind	P6-4	C17	
Airstair, Tread lights	P6-4	A18	
Alpha Vane Heater, Left	P18-3	D5	115 vac xfr bus 1
Alpha Vane Heater, Right	P18-3	D4	115 vac xfr bus 2
Altimeter 1 (26V AC)	P18-2	B8	stby AC
Altimeter 2 (26V AC)	P6-1	B4	26 vac elex bus 2
Altimeter, Radio	P18-1	B5	
Altimeter, Radio 2	P6-1	C15	
Altitude Alert Audio	P18-2	D6	
Altn T.E. Flap Drive (AC)	P6-2	D10	115 vac xfr bus 2
Anti-ice, Master Caution	P6-3	D9	
Anti-skid, Fail Warn & Park Brake	P6-3	E18	bat bus
Anti-skid, Inboard	P6-3	E16	bat bus
Anti-skid, Outboard	P6-3	E17	28 vdc bus 1
APU Control	P6-5	B1	
APU Control	P6-4	D11	
APU Fire Detection	P6-2	A23	
APU Fire Extinguisher Bottle	P6-2	C23	hot bat bus
APU Fuel Boost Pump (option)	P6-5	C8	
APU Generator, AC Indication	P6-4	A11	
APU Start	P18-5		hot bat bus
ASYM Mode	P18-2	D7	
ATC 1	P18-1	B3	
ATC 2	P6-1	D16	
Aural Warn	P6-3	D18	bat bus
Auto Brakes Control	P6-3	A17	
Auto Slat 1 (AC)	P6-2	B14	
Auto Slat 1 (DC)	P6-2	B15	
Auto Slat 2 (AC)	P6-2	C14	
Auto Slat 2 (DC)	P6-2	C15	
Auto Speed Brake	P6-2	B9	28 vdc bus 2
Auto Throttle (AC)	P18-1	D3	
Auto Throttle (DC)	P18-1	D4	
Auto Transformer 2	P6-1	B5	
Auto Transformer, Air Data 1	P18-2	A6	
Auto Transformer, Air Data 2	P6-1	B5	
Aux Power Unit Start	P18-5	C1	
B Sys, Electric Hyd Pump Cont	P6-2	A14	
B Sys, Electric Hydraulic Pump	P6-11	C2	
B Sys, Hyd Oil Quantity Ind	P6-2	C16	
B Sys, Pressure Indicator, Hyd	P6-2	D16	
Bat Bus	P6-5	C7	
Bat Bus Control, Auto	P6-5	B2	hot bat bus
Bat Bus Control, Manual	P6-5	B3	hot bat bus
Bat Charger	P6-4	D8	GS

Bat Charger	Equip Bay		
Bat Charger, Alternate	P6-4	F8	#2 main bus
Bat Indication	P6-5	C2	
Bat Overheat Indication	P6-5	C1	hot bat bus
Bleed Air, Valves Left	P6-4	B3	28 vdc bus 1
Bleed Air, Valves Right	P6-4	B2	28 vdc bus 2
Boarding Music Tape (AC)	P6-1	E6	
Boarding Music Tape (DC)	P6-1	E5	
Brake Pressure Indicator	P6-2	A17	28 vac xfr bus 2
Brakes, Anti-skid, Inboard	P6-3	E16	
Brakes, Anti-skid, Outboard	P 6-3	E17	
Brakes, Auto, Control	P 6-3	A17	
Brakes, Parking	P 6-3	E18	hot bat bus
Bus Protection Panel, Ext Pwr (AC)	P 6-12	D5	
Cabin Air Recirc Fan	P6-4	D5	
Call Chimes, Passenger & Crew	P18-4	A1	dc bus 1
CDU 1, FMCS	P18-2	E9	
CDU 2, FMCS	P18-2	E6	
Chimes, Passenger & Crew	P18-4	A1	
Clacker	P6-1	C7	
Clock	P6-3	B1	hot bat bus
Clock Display	P6-3	A1	
Cargo Smoke Control / Fault	P6-2	D22	
Cargo Smoke Detectors, B Loop	P6-2	B22	hot bat bus
Cargo Smoke Detectors, A Loop	P6-2	B23	hot bat bus
Coffee Maker 1 & 2, Aft Galley	Aft Galley		
Coffee Maker, Forward Galley	Fwd Galley		
Comparator 2 (Mon)	P6-1	A 9	
Comparator 2 (Pwr)	P6-1	A10	
Compass 1, XFMR (ALTN)	P6-1	B12	
Compass 2, XFMR (ALTN)	P18-2	B4	
Computer, FMCS	P18-2	E 8	
Cowl Anti-ice Valve, Eng 1	P18-3	A2	
Cowl Anti-ice Valve, Eng 2	P18-3	A1	
CSD 1 Control	P6-4	F11	battery bus
CSD 2 Control	P6-4	F13	battery bus
DAA 1, FMC (DC)	P18-2	C5	hot bat bus
DAA 1, FMC (AC)	P18-2	D1	115 vac stb bus
DAA 1, IRS (AC)	P18-2	D2	115 vac stb bus
DAA 1, IRS (DC)	P18-2	D3	hot bat bus
DAA 2, FMC	P6-1	D13	
DAA 2, FMC (AC)	P6-1	D8	
DAA 2, IRS (AC)	P6-1	D9	
DAA 2, IRS (DC)	P6-1	D10	
DC Bus 1	P6-4	B6	
DC Bus Indication, Stby	P6-5	C1	dc stby bus
DC Bus Indication, Bat	P6-5	C2	28 vdc bat bus
DC Bus Indication, Hot Bat	P6-5	C3	hot bat bus
DC Bus Indication, Bus No 1	P6-5	C4	28 vdc bus 1
DC Bus Indication, Bus No 2, Galley Pwr Cont	P6-5	C5	28 vdc bus 2
DC Bus Indication, TR No. 3	P6-5	C6	TR3
DC Bus, No 1 Electronics	P18-0	3	
DC Bus Power, No 1	P6-5	B8	
DC Bus 2	P6-4	D6	
DC Bus Power No.2	P6-5	B7	
DC Bus, Electronics 2	P6-1	E15	

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DC Standby Power, Battery	P6-5	D2	
DC Standby Power, T/R	P6-5	D3	
Depressure Valve, Engine 1, Hyd	P6-2	B17	
Depressure Valve, Engine 2, Hyd	P6-2	B16	
DME 1	P18-1	B 6	
DME 2	P6-1	C16	
Door Lock	P6-3	C1	
Door Warn	P6-3	A2	
Drain Heater	P18-3	D3	115 vac main bus 2
Drain Mast, Air	P18-3	F5	115 vac main bus 1
Drain Mast, Ground	P18-3	E5	28 vac main bus 2
EGT Ind 1	P6-2	A3	bat bus
EGT Ind 2	P6-2	A2	bat bus
EFIS, Cont Panel L	P18-2	E3	DC Stby
EFIS, Cont Panel R	P6-1	C11	DC bus 2
EFIS, Symbol Gen L	P18-2	E2	115 vac stby bus
EFIS, Symbol Gen R	P6-1	C10	115 vac xfr bus 2
Electrical, 1 Main (28v)	P6-4	E14	
Electrical, 1 Trans (28v)	P6-4	E15	
Electrical, 2 Main (28v)	P6-4	F14	
Electrical, 2 Trans (28v)	P6-4	F15	
Electrical, AC Bus 1, A phase	P6-4	B13	
Electrical, AC Bus 1, B phase	P6-4	B14	
Electrical, AC Bus 1, C phase	P6-4	B15	
Electrical, AC Bus 2, A phase	P6-4	B10	
Electrical, AC Bus 2, B phase	P6-4	B11	
Electrical, AC Bus 2, C phase	P6-4	B12	
Electrical, AC Transfer Bus 1, Aph	P6-4	C13	
Electrical, AC Transfer Bus 1, Bph	P6-4	C14	
Electrical, AC Transfer Bus 1, Cph	P6-4	C15	
Electrical, AC Transfer Bus 2, Aph	P6-4	C10	
Electrical, AC Transfer Bus 2, Bph	P6-4	C11	
Electrical, AC Transfer Bus 2, Cph	P6-4	C12	
Electrical, APU Generator, AC Ind	P6-4	A11	
Electrical, APU, Control	P6-4	D11	
Electrical, Auto Cont	P6-5	A 6	
Electrical, Battery Charger	P6-4	D 8	
Electrical, Battery Charger	Equip Bay		
Electrical, Battery Charger, Alt	P6-4	F8	
Electrical, Battery Indication	P6-5	C2	
Electrical, Battery Overheat Ind	P6-5	C1	
Electrical, Battery Trans Cont	P6-5	A3	
Electrical, CSD 1 Control	P6-4	F11	bat bus
Electrical, CSD 2 Control	P6-4	F13	bat bus
Electrical, DC Bus 1	P6-4	B 6	
Electrical, DC Bus 1 Indication	P6-5	C4	28 vdc bus 1
Electrical, DC Bus 2	P6-4	D6	
Electrical, DC Bus 2 Indication	P6-5	C5	
Electrical, DC Standby Pwr, Battery	P6-5	D2	
Electrical, DC Standby Pwr, T/R	P6-5	D3	
Electrical, Generator 1, AC Ind	P6-4	A10	
Electrical, Generator 1, Control	P6-4	D10	
Electrical, Generator 1, Low Press	P6-4	E11	
Electrical, Generator 1, Temp	P6-4	E10	
Electrical, Generator 2, AC Ind	P6-4	C12	
Electrical, Generator 2, Control	P6-4	D12	

Electrical, Generator 2, Low Press	P6-4	E13	
Electrical, Generator 2, Temp	P6-4	E12	
Electrical, Generator Power Control	P6-5	B 5	
Electrical, Gnd Svc AC Ind, A phase	P6-4	A13	115 vac grd serv
Electrical, Gnd Svc AC Ind, B phase	P6-4	A14	
Electrical, Gnd Svc AC Ind, C phase	P6-4	A15	115 vac grd serv
Electrical, Ground Service 28V A ph	P6-4	D13	
Electrical, Ground Service 28V B ph	P6-4	D14	
Electrical, Ground Service 28V C ph	P6-4	D15	
Electrical, Hot Bat Bus Indication	P6-5	C3	
Electrical, Int Lt	P6-5	A5	
Electrical, Inverter Control	P6-5	A1	28 vdc bat bus
Electrical, Inverter Power	P6-5	A2	28 vdc bat bus
Electrical, Inverter Volts Ind	P6-5	D5	
Electrical, Service Outlets (115V)	P6-3	E1	
Electrical, Service Outlets (28V)	P6-3	F1	
Electrical, Standby Bus	P6-4	F17	
Electrical, Standby Bus Indication	P6-5	D1	ac xfr bus
Electrical, Standby Bus, Power	P6-4	F16	
Electrical, TR 1	P6-4	A8	
Electrical, TR 2	P6-4	C8	
Electrical, TR 3	P6-4	E8	
Electrical, TR 3 Indication	P6-5	C6	
Electrical, Trans Cont 1	P6-4	E10	
Electrical, Trans Cont 2	P6-4	E12	
Electrical, Transfer Bus Indication	P6-5	D6	
Electronics 1, AC Bus	P18-0	A2	
Electronics 1, DC Bus	P18-0	A3	
Electronics 2, AC Bus 3 phase	P6-1	E13	
Electronics 2, DC Bus	P6-1	E15	
Elevator Pitot, Left	P18-3	D2	115 vac main bus 1
Elevator Pitot, Right	P18-3	D1	115 vac main bus 2
Elex Panel lights, Fwd, Capt, Centr, F/P	Aft Pedestal		
Emergency Exit Sign	P18-3	A12	
Engage Interlock, AFCS System A	P18-1	E4	
Engage Interlock, AFCS System B	P6-2	C3	
Eng 1, Cowl Anti-ice Valve	P18-3	A2	28 vdc bus 1
Eng 2, Cowl Anti-ice Valve	P18-3	A1	28 vdc bus 2
Eng 1 and Wing Control	P18-3	A4	bat bus
Eng 2 and Wing Control	P18-3	A3	
Eng 1 Sync Lock	P6-2	C19	
Eng 2 Sync Lock	P6-2	A18	
Eng 2 Sync Lock, Altn	P6-2	A19	
Engine Vibration Monitor	P6-2	B4	xfr bus 1
Entertainment Tape RPDR (AC)	P6-1	E6	
Entertainment Tape RPDR (DC)	P6-1	E5	
Equipment Cooling, Supply Fan Power, Altn	P18-3	E18	main bus 2
Equipment Cooling, Supply Fan Power, Norm	P18-3	D18	main bus 1
Equipment Cooling, Supply Fan Control, Norm	P18-3	F17	bat bus
Equipment Cooling, Supply Fan Control, Altn	P18-3	F18	DC bus 2
Equipment Cooling, Exhaust Fan Power, Norm	P18-3	B18	ground serv bus
Equipment Cooling, Exhaust Fan Power, Altn	P18-3	C18	main bus 2
Equipment Cooling, Exhaust Fan Control	P18-3	A18	DC bus 2
External Power & Fueling Control	P6-5	B4	
External Power Control	P6-5	D4	hot bat bus
External Power DC	Equip Bay		

External Power, Bus Prot Panel (AC)	P6-12	D5	115 vac ext power
External Power, Ground Service	P6-12	D8	
External Power, Lavatory Mirror	P6-3	D1	
Extinguisher Bottle, APU	P6-2	C23	
Extinguisher Bottle, Left	P6-2	C24	
Extinguisher Bottle, Left	P6-2	D24	
Extinguisher Bottle, Right	P6-2	C22	
Extinguisher Bottle, Right	P6-2	D23	
Fasten Seat Belt	P18-3	A9	
FCC AFCS Sys A (DC)	P18-1	E3	
FCC AFCS Sys B (DC)	P6-2	C2	
FDR Position Sensor	P18-2	B2	
Fire Detection, Ovrht, WW, Wing-Body	P6-2	B24	115 vac xfr bus 1
Fire Detection, APU	P6-2	A23	bat bus
Fire Detection, Engine 1	P6-2	A24	bat bus
Fire Detection, Engine 2	P6-2	A22	bat bus
Fire Detection, Master Warn & Cont	P6-2	B23	bat bus
Fire Extinguishers, Bottle, APU	P6-2	C23	hot bat bus
Fire Extinguishers, Bottle, Right	P6-2	C24	hot bat bus
Fire Extinguishers, Bottle, Left	P6-2	D24	hot bat bus
Fire Extinguishers, Bottle, Altn Right	P6-2	C22	hot bat bus
Fire Extinguishers, Bottle, Altn Left	P6-2	D23	hot bat bus
Flap (shutoff valves)	P6-2	D12	28 vdc bus 1
Flap Load Relief	P6-2	D13	28 vdc bus 2
Flap Position Ind, Leading Edge	P6-2	C12	
Flap Position Ind, Trailing Edge	P6-2	C12	28 vac xfr bus 2
Flap, Trailing Edge Drive, Alt (AC)	P6-2	D10	115vac xfr bus 2
Flight Control Shutoff Valve, Flt Cont	P6-2	A9	28 vdc bus 1
Flight Control Shutoff Valve, Flt Cont	P6-2	A10	28 vdc bus 2
Flight Control Shutoff Valve, Spoiler	P6-2	A11	28 vdc bus 2
Flight Control Shutoff Valve, Stby Rudder	P6-2	A12	bat bus
Flight Recorder (AC)	P18-2	C 9	
Flight Recorder (DC, Bat)	P18-2	C10	bat bus
Flush Motor, Lavatory, Forward, 3ph	P18-4	C6	
Flush Motor, Lavatory, L Aft, 3 ph	P18-4	B6	
Flush Motor, Lavatory, R Aft, 3 ph	P18-4	B3	
FMC, DAA 1	P18-2	C5	
FMC, DAA 1 (AC)	P18-2	D1	
FMC, DAA 2	P6-1	D13	
FMC, DAA 2 (AC)	P6-1	D8	
FMCS CDU 1	P18-2	E9	115 vac elex bus 1
FMCS CDU 2	P18-2	E6	
FMCS Cmptr No 1	P18-2	E8	115 vac elex bus 1
FMCS Mode Annunciator	P18-2	E 7	
F/O ADI (ALTN)	P18-2	B2	
Fwd Outflow Valve	P6-4	C5	
Fuel Boost Pump, Aux Tank, Aft	P6-3	F7	
Fuel Boost Pump, Aux Tank, Fwd	P6-3	F3	
Fuel Boost Pump, Center Tank, Left	P6-3	E5	main bus 2
Fuel Boost Pump, Center Tank, Right	P6-3	D5	main bus 1
Fuel Boost Pump, Tank 1, Aft	P6-3	C7	xfr bus 1
Fuel Boost Pump, Tank 1, Fwd	P6-3	B7	main bus 1
Fuel Boost Pump, Tank 2, Aft	P6-3	C3	xfr bus 2
Fuel Boost Pump, Tank 2, Fwd	P6-3	B3	main bus 2
Fuel Cont, 1 Aft, 2 Fwd, Ctr L, Aux Aft	P6-3	E3	DC bus 1
Fuel Cont, 1 Fwd, 2 Aft, Ctr R, Aux Fwd	P6-3	E7	DC bus 2

Fuel Cross Feed Valve	P6-3	C5	bat bus
Fuel Indicator, Flow/Used Engine 1	P6-3	A6	28 vdc bus 1
Fuel Indicator, Flow/Used Engine 2	P6-3	A5	28 vdc bus 2
Fuel Panel Ind	P6-3	F6	
Fuel Quantity	P6-3	A4	115 vac stb bus
Fuel Quantity Ind, R Tank	P6-3	F3	
Fuel Quantity Ind, Ctr Tank	P6-3	F4	
Fuel Quantity Ind, L Tank	P6-3	F5	
Fuel Shutoff Valve	P6-3	B5	
Fuel Shutoff Valve, Eng 1	P6-3	D7	sw hot bat bus
Fuel Shutoff Valve, Eng 2	P6-3	D3	sw hot bat bus
Fuel Temp Ind	P6-3	A3	28 vac bus 2
Fuel, Aux Tank Fueling	P6-3	F5	
Fuel and External Power Control	P6-5	B4	sw hot bat bus
Fuel, Ext Power, Ground Fueling	P6-3	A7	ex ac pwr bus
Fuel, Master Caution	P6-3	D10	
Galley 1 & 6	P6-11	C7	
Galley 1 & 6	P6-11	C8	
Galley 1 & 6	P6-11	C9	
Galley 3	P6-12	C7	
Galley 3	P6-12	C8	
Galley 3	P6-12	C9	
Galley Light	P18-3	B10	
Galley, Aft, Coffee Maker 1 & 2	Aft Galley		
Galley, Aft, Oven 1, 2 & 3	Aft Galley		
Galley, Aft, Warmer 1 & 2	Aft Galley		
Galley, Aft, Work Light	Aft Galley		
Galley, Forward, Coffee Maker	Fwd Galley		
Galley, Forward, Oven 1 & 2	Fwd Galley		
Galley, Forward, Work Light	Fwd Galley		
Gasper Fan	P6-4	E17	
Generator 1, AC Indication	P6-4	A10	
Generator 1, Control	P6-4	D10	
Generator 1, Low Oil Pressure	P6-4	E11	115ac xfr bus 1
Generator 1, Oil Temperature	P6-4	E10	DC bus 1
Generator 2, AC Indication	P6-4	A12	
Generator 2, Control	P6-4	D12	
Generator 2, Low Oil Pressure	P6-4	E13	115 vac xfr bus 2
Generator 2, Oil Temperature	P6-4	E12	dc bus 2
Generator Bus 1, Main Distribution	P6-11	A2	
Generator Bus 2, Main Distribution	P6-12	A2	
Generator Power Control	P6-5	B5	hot bat bus
Glide Slope 1	P18-1	A2	
Glide Slope 2	P6-1	A16	
Ground Prox Warning	P18-1	A7	
Ground Service	P6-11	D8	
Ground Service AC Ind, A phase	P6-4	A13	
Ground Service AC Ind, B phase	P6-4	A14	
Ground Service AC Ind, C phase	P6-4	A15	
Ground Service, 26V A Phase	P6-4	D13	
Ground Service, 28V B phase	P6-4	D14	
Ground Service, 28V C phase	P6-4	D15	
Ground Service, External Power	P6-12	D8	
Hot Battery Bus	P18-5	B1	
Hot Battery Bus Indication	P6-5	C3	
Hydraulic Pressure Ind, A System	P6-2	D17	28 vac xfr bus 2

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Hydraulic Pressure Ind, B System	P6-2	D16	28 vac xfr bus 1
Hydraulic Pump, A System, Electric	P6-12	C2	115 vac gen bus 2
Hydraulic Pump, B System, Electric	P6-11	C2	115 vac gen bus 1
Hydraulic Pump Depres Valve, Eng 1	P6-2	B17	28 vdc bus 2
Hydraulic Pump Depres Valve, Eng 2	P6-2	B16	28 vdc bus 1
Hydraulic Pump, Electric, Cont, Sys A	P6-2	A15	28 vdc bus 2
Hydraulic Pump, Electric, Cont, Sys B	P6-2	A14	28 vdc bus 1
Hydraulic Pump, Standby (Normal)	P6-11	A8	
Hydraulic Pump, Standby, Alternate	P6-12	A8	
Hydraulic Quantity Ind, A System	P6-2	C17	
Hydraulic Quantity Ind, B System	P6-2	C16	
Hydraulic Shutoff Valve, Engine 1	P6-2	B19	bat bus
Hydraulic Shutoff Valve, Engine 2	P6-2	B18	bat bus
Idle Cont	P6-2	A4	28 vdc bus 1
Ignition, Engine 1, Left	P6-2	B8	
Ignition, Engine 1, Right	P6-2	B7	115 vac stb bus
Ignition, Engine 2, Left	P6-2	B6	
Ignition, Engine 2, Right	P6-2	B5	115 vac stb bus
Instrument Comparator 2 (Mon)	P6-1	A9	
Instrument Comparator 2 (Pwr)	P6-1	A10	
Instrument XFR (Transfer)	P18-2	A2	28 vdc stb bus
Instrument XFMR-1 (Transformer 1)	P18-2	A1	
Inst Transformer 2	P6-1	A12	
Interphone Power, Capt & Observer	P6-2	B21	
Interphone Power, Capt (2 Bus)	P6-2	A21	
Interphone Power, Capt (Bat)	P6-2	A20	
Interphone Power, F/O & Equip Rack	P6-2	B20	
Interphone Power, F/O (2 Bus)	P6-2	D21	
Interphone Power, F/O (Bat)	P6-2	D20	
Interphone Power, Flt Int Amp	P6-2	C21	
Interphone Power, Service Interph	P6-2	C20	
Inverter Control	P6-5	A1	
Inverter Power	P6-5	A2	
Inverter Volts Indication	P6-5	D5	
IRS 1 (AC)	P18-2	D4	115 vac stb bus
IRS 1 (DC)	P18-2	D5	sw hot bat bus
IRS 2 (AC)	P6-1	D11	115 vac bus 2
IRS 2 (DC)	P6-1	D12	sw hot bat bus
IRS (AC), DAA 2	P6-1	D9	
Isolation valve	P6-4	B1	115 vac xfr bus 1
IVSI / RA #1	P18-2	B6	
Landing Gear, Air/Gnd Relay & Lts	P6-3	C18	bat bus
Landing Gear, Anti-skid, Inboard	P6-3	E16	
Landing Gear, Anti-skid, Outboard	P6-3	E17	
Landing Gear, Aural Warn	P6-3	D18	
Landing Gear, Latch & Press Warning	P6-3	C17	bat bus
Landing Gear, Nose Air/Gnd	P6-3	D17	28 vdc bus 2
Landing Gear, Nose Steering	P6-3	D16	115 vac bus 2
Landing Gear PTU Bypass Valve Ctl 1	P6-2	D18	
Landing Gear PTU Bypass Valve Ctl 2	P6-2	D19	
Landing Gear Xfer Valve, Primary	P6-2	D14	28 vdc bus 1
Landing Gear Xfer Valve, Secondary	P6-2	D15	28 vdc bus 1
Lavatory Flush Motor, Forward, 3 ph	P18-4	C6	
Lavatory Flush Motor, L Aft, 3 ph	P18-4	B6	
Lavatory Flush Motor, R Aft, 3 ph	P18-4	B3	
Lavatory Mirror / Ext Pwr	P6-3	D1	

Lavatory Smoke Det	P18-4	A1	
Lavatory Water Heater, Forward	P18-4	A6	115 vac bus _
Lavatory Water Heater, L Aft	P18-4	A7	115 vac bus _
Lavatory Water Heater, R Aft	P18-4	A5	115 vac bus _
Leading Edge Flap Position Ind	P6-2	C12	
Light, Access Compartment	P18-3	F14	
Light, AFDS Flood	P6-3	E14	
Light, Air Conditioning Compartment	P18-3	F16	
Light, Anti-collision (Beacon), Bot	P18-3	C16	
Light, Anti-collision (Beacon), Top	P18-3	C15	
Light, Background	P6-3	A12	
Light, Background, Standby	P6-3	A11	
Light, Capt Instrument Panel (3)	CA Rud Adj		
Light, Cargo Compartment, Aft	P18-3	E15	
Light, Cargo Compartment, Forward	P18-3	E16	
Light, Ceiling (Pass) Cont, Brt L	P18-3	E 6	
Light, Ceiling (Pass) Cont, Brt R	P18-3	F12	
Light, Ceiling (Pass) Cont, Night	P18-3	E 7	
Light, Ceiling (Pass), Gnd Svc Brt	P18-3	E11	
Light, Ceiling (Pass), Gnd Svc Nite	P18-3	E12	
Light, Ceiling (Pass), Gnd Svc R	P18-3	E10	
Light, Ceiling (Passenger), Left	P18-3	E 9	
Light, Ceiling (Passenger), Right	P18-3	E 8	
Light, Center Console Panel, (4) Fwd, Capt, Centr, F/P	Aft Console		
Light, Center Instrument Panel (2)	CA Rud Adj		
Light, Circuit Breaker Panel	P6-3	C11	
Light, Compass, Standby	P6-3	A13	
Light, Control Stand	P6-3	A10	
Light, Digital Dimming, Capt	P6-3	B10	
Light, Digital Dimming, F/O	P6-3	B 9	
Light, Dome White	P6-3	A9	bat bus
Light, Electrical Rack	P18-3	E14	
Light, Elec Panel	P 6-3	C9	
Light, Emer, F/O's, Oxy Panel (5)	FO Rud Adj		
Light, Emergency Exit	P18-3	A12	
Light, Entry Bright	P18-3	B 8	
Light, Entry Dim	P6-5	B6	hot bat bus
Light, FO Instrument Panel	FO Rud Adj		
Light, Galley	P18-3	B10	
Light, Galley, Aft Work	Aft Galley		
Light, Indicator Master Dim, Bat	P6-3	B13	
Light, Indicator Master Dim, DC 1	P6-3	B14	
Light, Indicator Master Dim, DC 2	P6-3	B15	bat bus
Light, Indicator, Master Dim, Dim / Test Cont	P6-3	C12	
Light, Indicator Master Dim, Sect 1	P6-3	C13	
Light, Indicator Master Dim, Sect 2	P6-3	C14	
Light, Indicator Master Dim, Sect 3	P6-3	C15	
Light, Indicator Master Dim, Sect 4	P6-3	D13	
Light, Indicator Master Dim, Sect 5	P6-3	D14	
Light, Indicator Master Dim, Sect 6	P6-3	D15	
Light, Landing, Inboard Left	P18-3	A16	
Light, Landing, Inboard Right	P18-3	A15	
Light, Landing, Outboard Left	P18-3	A14	
Light, Landing, Outboard Right	P18-3	A13	
Light, Lavatory Dome	P18-3	F10	
Light, Lavatory Mirror, Aft	P18-3	F11	

Light, Lavatory Mirror, Forward	P6-3	D1	
Light, Logo, Left	P18-3	C14	
Light, Logo, Right	P18-3	C13	
Light, Map & Kit	P6-3	A14	
Light, Mode Control Panel	CA Rud Adj		
Light, Observer Reading	P6-3	A15	
Light, Overhead, 28V Primary	P6-3	E9	
Light, Overhead, 28V Sec	P6-3	E11	
Light, Overhead, 5V Sec	P6-3	F9	
Light, Overhead, 5V Sec	P6-3	F10	
Light, Overhead, 5V Sec	P6-3	F11	
Light, Overhead, 5V Sec	P6-3	F12	
Light, Overhead, 5V Sec	P6-3	F13	
Light, Overhead, 5V Sec	P6-3	F14	
Light, Panel & Instr, 28V Primary, Capt & Ctr	P6-3	B12	
Light, Panel & Instr, 28V Primary, F/O	P6-3	B11	
Light, Panel & Inst, CB Panel	P6-3	C11	
Light, Panel & Inst, Elex Panel	P6-3	C9	
Light, Position Steady (Navigation)	P18-3	B16	
Light, Position Strobe	P18-3	B14	
Light, Reading Stn, Left	P18-3	D6	
Light, Reading Stn, Left	P18-3	D7	
Light, Reading Stn, Left	P18-3	D8	
Light, Reading Stn, Left	P18-3	D9	
Light, Reading Stn, Left	P18-3	D10	
Light, Reading Stn, Left	P18-3	D11	
Light, Reading Stn, Left	P18-3	D12	
Light, Reading Stn, Right 340 -464	P18-3	C6	
Light, Reading Stn, Right 464 -500D	P18-3	C7	
Light, Reading Stn, Right 500D-608	P18-3	C8	
Light, Reading Stn, Right 608 -720	P18-3	C9	
Light, Reading Stn, Right 720 -727E	P18-3	C10	
Light, Reading Stn, Right 727E-844	P18-3	C11	
Light, Reading Stn, Right 844 -945	P18-3	C12	
Light, Runway Turnoff, Left	P18-3	D16	
Light, Runway Turnoff, Right	P18-3	D15	
Light, Seat Belt	P18-3	A9	
Light, Sign Control (Passenger)	P18-3	A11	
Light, Standby Power Ind	P6-5	A5	
Light, Taxi	P18-3	D14	
Light, Test & Dim	P6-3	C12	bat bus
Light, Wheel Wells	P18-3	F15	
Light, Window (Passenger), Left	P18-3	B7	
Light, Window (Passenger), Right	P18-3	B6	
Light, Wing Scan	P18-3	B13	
Light, Work & Threshold	P18-3	B9	
Lock, Door	P 6-3	C 1	
Mach Airspeed Indicator	P18-2	B10	26 vac st
Mach Airspeed Indicator 2	P 6-1	C5	
Mach Trim, A System, AC	P18-1	E6	
Mach Trim, A System, DC	P18-1	E7	
Mach Trim, B System, AC	P 6-2	B2	
Mach Trim, B System, DC	P 6-2	B1	
Mach Warn Sys 1	P18-2	B7	
Mach Warn Sys 2	P 6-1	C7	
Main Distribution, Generator Bus 1	P 6-11	A2	

Main Distribution, Generator Bus 2	P 6-12	A2	
Marker Beacon	P18-1	A6	
Master Caution, Air Conditioning	P6-3	D 8	
Master Caution, Annunciator Bus 1	P6-3	D11	
Master Caution, Annunciator, Bat	P6-3	D12	
Master Caution, Anti-ice	P6-3	D9	
Master Caution, Engines	P6-2	A5	
Master Caution, Fuel	P6-3	D10	
Master Warn & Cont	P6-2	B23	batt bus
MCP, AFCS, DC	P18-1	D1	
Mode Annunciator, FMCS	P18-2	E7	
Music Tape RPDR (AC)	P6-1	E6	
Music Tape RPDR (DC)	P6-1	E5	
N1 Tach Indicator, Engine 1	P6-2	D3	batt bus
N1 Tach Indicator, Engine 2	P6-2	D1	batt bus
N2 Tach Indicator, Engine 1	P6-2	D4	DC bus 1
N2 Tach Indicator, Engine 2	P6-2	D2	DC bus 2
No Smoking	P18-3	A10	
Oil Quantity Ind, A System Hyd	P6-2	C17	
Oil Quantity Ind, B System Hyd	P6-2	C16	
Oil Quantity, Engine 1	P6-2	D7	115 vac bus 1
Oil Quantity, Engine 2	P6-2	D5	115 vac bus 2
Oil Temp & Pressure, Engine 1 (AC)	P6-2	D8	28 vac xfr bus 1
Oil Temp & Pressure, Engine 2 (AC)	P6-2	D6	28 vac xfr bus 2
Oven #1 & #2, Forward Galley	Fwd Galley		
Oven #1, #2 & #3, Aft Galley	Aft Galley		
Overheat, Wheel Well, Wing-Body	P6-2	B24	
Oxygen, Indicator	P18-3	F6	
Oxygen, Manual Control	P18-3	F7	
Oxygen, Passenger, Left	P18-3	F9	
Oxygen, Passenger, Right	P18-3	F8	
PA Amp, Bat	P6-1	D5	
Pack Valve, Left	P6-4	C4	batt bus
Pack Valve, Right	P6-4	C3	batt bus
Passenger & Crew Call / Lav Smoke Det	P18-4	A1	dc bus 1
Passenger Address Amplifier, Bat	P6-1	D5	
Pitot Static Indication, Capt	P6-3	F18	28 vac main bus 1
Pitot Static Indication, F/O	P6-3	F17	28 vac main bus 2
Pitot Static, Heater, Capt Lower R	P18-3	C2	115 vac xfr bus 1
Pitot Static, Heater, Capt Upper L	P18-3	C1	115 vac xfr bus 1
Pitot Static, Heater, F/O Lower L	P18-3	C4	115 vac xfr bus 2
Pitot Static, Heater, F/O Upper R	P18-3	C3	115 vac xfr bus 2
Position Sensor (inop)	P18-2	C8	
Potable Water Quantity Indicator	P18-4	A2	
Pressurization Control, Auto (AC)	P6-4	F1	xfr bus 1
Pressurization Control, Auto (DC)	P6-4	F2	dc bus 1
Pressurization Control, Manual (AC)	P6-4	F5	xfr bus 2
Pressurization Control, Manual (DC)	P6-4	F6	standby dc
Pressurization Control, Stby (AC)	P6-4	F3	xfr bus 2
Pressurization Control, Stby (DC)	P6-4	F4	dc bus 2
Pressurization, Isolation Valve	P6-4	B1	
Pressurization, Outflow Valve, Fwd	P6-4	C5	115 vac main bus 1
Pressurization, Outflow Valve, Htr	P6-4	D5	115 vac main bus 2
Pressurization, Overheat	P6-4	D4	
Pressurization, Pressure Indicator	P6-4	D1	
Printer	P18-2	E10	

Radar, Weather Indicator	P6-1	D14	
Radar, Weather R/T	P6-1	D15	
Radio Altm 1	P18-1	B6	
Radio Altm 2	P6-1	C15	
Rain Repellent, Left	P18-3	B4	
Rain Repellent, Right	P18-3	B3	28 vdc bus 2
Rain, Windshield Wiper, Left	P18-3	B2	28 vdc bus 1
Rain, Windshield Wiper, Right	P18-3	B1	
Ram Air Mod Cont	P6-4	E3	
Ram Air Mod Left	P6-4	E2	
Ram Air Mod Right	P6-4	E1	
Recirc Fan, Cabin	P6-4	E5	main bus 2
Recirc Fan, Control	P6-4	B4	
Recirc Fan, Energzd	P6-4	B5	
Recorder, Flight (AC)	P18-2	C9	
Recorder, Flight (DC, Bat)	P18-2	C10	
Recorder, Voice	P18-2	C6	
RMI 1	P18-1	B4	stby AC
RMI 2	P6-1	B15	ac xfr bus 2
Rudder Trim Control	P6-2	C10	115 vac xfr bus 1
Rudder Trim Indicator	P6-2	C11	28 vac xfr bus 1
Seat Belt Sign	P18-3	A9	
SELCAL 1	P18-2	D15	dc bus 1
SELCAL 2	P6-1	D1	dc bus 2
Sensor Exc, AFCS System A (AC)	P18-1	E1	
Sensor Exc, AFCS System B (AC)	P6-2	C1	
Service Outlets (115V AC)	P6-3	E1	
Service Outlets (26V AC)	P6-3	F1	
Slat, Auto 1 (AC)	P6-2	B14	
Slat, Auto 1 (DC)	P6-2	B15	
Slat, Auto 2 (AC)	P6-2	C14	
Slat, Auto 2 (DC)	P6-2	C15	
Smoke Detector, Lav	P18-4	A1	
Speed Brake, Auto	P6-2	B9	
Spoiler Shutoff Valve	P6-2	A11	28 vdc bus 2
Stabilizer Trim	P18-0	1	
Stab Trim Actuator	P6-2	B11	115 vac xfr bus 2
Stab Trim Control	P6-2	B13	28 vdc bus 2
Stall Warn 2 (AC)	P6-1	A6	115 vac elex bus 2
Stall Warn 2 (DC)	P6-1	A7	28 vdc elex bus 2
Stall Warn (AC)	P18-2	D8	115 vac stby bus
Stall Warn (DC)	P18-2	D9	stby DC
Stall Warn, Asym Mode	P18-2	D7	
Start Valve Eng 1	P6-2	A8	
Start Valve Eng 2	P6-2	A7	
Stby Altimeter / ASI Vib	P18-2	B9	stby DC
Stby Bus	P6-4	F17	
Stby Bus, Indication (light)	P6-5	D1	28 vdc hot bat bus
Stby Bus, Power	P6-4	F16	115 vac xfr bus
Stby Horizon	P18-2	C1	
Stby Hydraulic Pump, Alternate	P6-12	A8	
Stby Hydraulic Pump, Normal	P6-11	A8	
Stby Rudder Shutoff Valve	P6-2	A12	28 vdc batt bus
Standby Power, Auto Control	P6-5	A6	28 vdc bus 1
Standby Power, Ind light	P6-6	A5	
Switched Hot Battery Bus	P18-5		

Tach Indicator, Engine 1 N1	P6-2	D3	
Tach Indicator, Engine 1 N2	P6-2	D4	
Tach Indicator, Engine 2 N1	P6-2	D1	
Tach Indicator, Engine 2 N2	P6-2	D2	
TAT Indicator	P18-2	A7	26 vac stby
TCAS	P18-0	B2	
Temp Control, 35° F Left	P6-4	A2	
Temp Control, 35° F Right	P6-4	A1	
Temp Control, Auto Left	P6-4	A4	
Temp Control, Auto Right	P6-4	A3	
Temp Control, Manual	P6-4	A5	
Temperature Ind	P6-4	D2	
Temp Probe (Rosemount)	P18-3	C5	115 vac main bus 2
Terrain Display	P18-1	B7	
Thrust Reverser Cont, Altn	P6-2	C18	
Thrust Reverser Cont, Engine 1	P6-2	C8	sw HB
Thrust Reverser Cont, Engine 2	P6-2	C6	sw HB
Thrust Reverser Ind, Engine 1	P6-2	C7	28 vdc bus 1
Thrust Reverser Ind, Engine 2	P6-2	C5	28 vdc bus 2
Total Air Temperature Indicator	P18-2	A7	26 vac stby bus
Trailing Edge Flap Drive, Alt (AC)	P6-2	D10	
Trailing Edge Flap Position Ind	P6-2	C13	
Transfer Bus 1, Alternate	P6-12	B2	
Transfer Bus 1, Normal	P6-11	B2	
Transfer Bus 2, Alternate	P6-11	B5	
Transfer Bus 2, Normal	P6-12	B5	
Transfer Bus Indication	P6-5	D6	
Transformer, Inst 1	P18-2	A1	
Transformer, Inst 2	P6-1	A12	
TR Unit 1	P6-4	A 8	
TR Unit 2	P6-4	C 8	
TRUnit 3	P6-4	E 8	
Transformer/Rectifier 3 Indication	P 6-5	C6	
Transponder 1	P18-1	B3	
Transponder 2	P6-1	D16	
Trim Control, Aileron	P6-2	C9	
Trim Control, Rudder	P6-2	C10	
Trim Indicator, Rudder	P6-2	C11	
Trim, Stabilizer	P18-0	A1	
Turbofan Valve, L	P6-4	C2	28 vdc bus 1
TurboFan Valve, R	P6-4	C1	
Vacuum Cleaner Receptacle, Aft	P18-4	C2	
Vacuum Cleaner Receptacle, Forward	P18-4	C1	
Valve Position Ind	P6-4	D3	
Vertical Speed Indicator 1	P18-2	B6	
Vertical Speed Indicator 2	P6-1	C4	
VHF 1, Comm	P18-2	D12	
VHF 2, Comm	P6-1	C 2	
VHF 3, Comm	P18-2	D14	
VHF Nav, G/S 1 (non EFIS)	P18-1	A2	
VHF Nav, G/S 2 (non EFIS)	P6-1	A16	
VHF Nav-1, VOR/ILS (EFIS)	P18-1	A1	
VHF Nav-2, VOR/ILS (EFIS)	P6-1	A15	
VHF Nav, VOR/LOC 1	P18-1	A1	
VHF Nav, VOR/LOC 2	P 6-1	A15	
Vibration Monitor, Engine	P 6-2	B4	

CIRCUIT BREAKERS (CLASSIC)

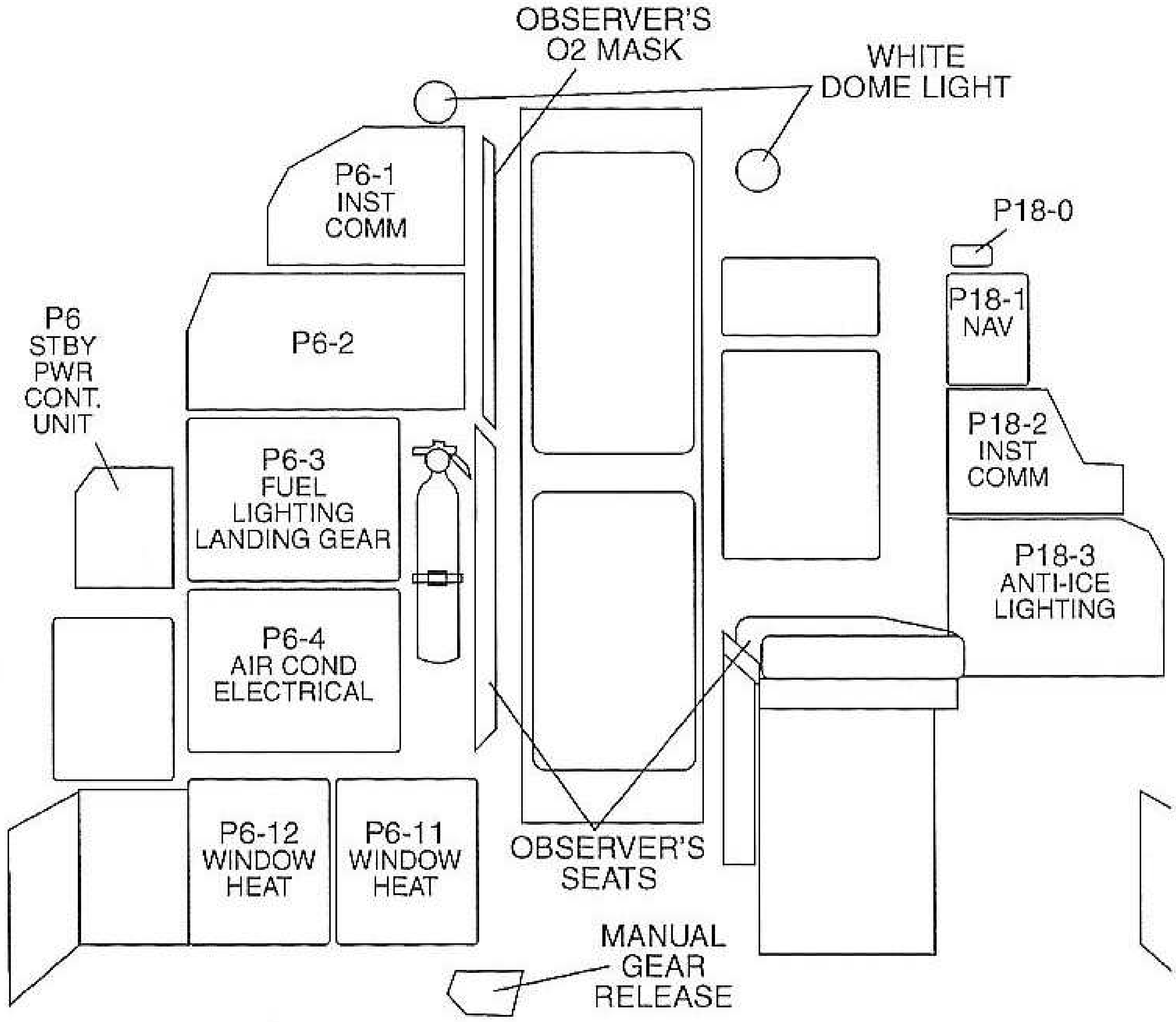
Vibrator, Standby Alt/AS Indicator	P18-2	B9	28 vdc stby
Voice Recorder	P18-2	C6 D7	
VOR/LOC 1	P18-1	A1	
VOR/LOC 2	P6-1	A15	
VSI 1	P18-2	B6	115 vac bus 1
VSI 2	P6-1	C4	115 vac bus 2
Warning, Altitude Alert Audio	P18-2	D6	
Warning, Anti-skid Fail	P6-3	E18	
Warning, Door	P6-3	A2	
Warning, Ground Proximity	P18-1	A7	
Warning, Landing Gear, Aural	P6-3	D18	
Warning, Landing Gear, Latch & Pres	P6-3	C17	
Warning, Light, AFCS System A (Bat)	P18-1	E5	
Warning, Light, AFCS System B (Bat)	P6-2	C4	
Warning, Mach 1	P18-2	B7	
Warning, Mach 2	P6-1	C7	
Warning, Stall (AC)	P18-2	D8	
Warning, Stall, Assymetry Mode	P18-2	D7	
Water Heater, Lavatory, Forward	P18-4	A6	
Water Heater, Lavatory, L Aft	P18-4	A7	
Water Heater, Lavatory, R Aft	P18-4	A5	
Water Quantity Indicator	P18-4	A2	dc bus 1
Weather Radar, Indicator	P6-1	D14	
Weather Radar, R/T	P6-1	D15	
Wheel Well Overheat, Fire Detection	P6-2	B24	
Window Anti Ice, Left Front	P6-11	B9	115 vac gen bus 1
Window Anti Ice, Left Side	P6-12	B9	115 vac gen bus 2
Window Anti Ice, L4 & L5	P6-11	B7	115 vac gen bus 1
Window Anti Ice, Right Front	P6-12	B8	115 vac gen bus 2
Window Anti Ice, Right Side	P6-11	B8	115 vac gen bus 1
Window Anti Ice, R4 & R5	P6-12	B7	115 vac gen bus 2
Window Heat, Cont, Left Front (AC)	P18-3	F1	115 vac main bus 1
Window Heat, Cont, Left Front (DC)	P18-3	F2	
Window Heat, Cont, Left Side (AC)	P18-3	F3	115 vac main bus 2
Window Heat, Cont, Left Side (DC)	P18-3	D2	
Window Heat, Cont, Right Front (AC)	P18-3	E1	115 vac main bus 2
Window Heat Cont, Right Front (DC)	P18-3	E2	
Window Heat, Cont, Right Side (AC)	P18-3	E3	115 vac main bus 1
Window Heat, Cont, Right Side (DC)	P18-3	E2	
Windshield Wiper, Left	P18-3	B2	28 vdc bus 2
Windshield Wiper, Right	P18-3	B1	28 vdc bus 1
Wing Anti-ice Valve	P18-3	A5	115 vac xfr bs 1
Wing-Body Overheat, Fire Detection	P6-2	B24	
Work Light, Forward Galley	Fwd Galley		
Yaw Damper (AC)	P18-1	D5	
Yaw Damper (DC)	P18-1	D6	DC bus 1

COCKPIT CIRCUIT BREAKERS (NG)

The circuit breaker legend will vary from one carrier to the next. This is due to airline specific configurations.

Panels P91 and 92 are in the EE bay.
P91 is on the left side of the airplane; P92 is on the right.
The fuel pumps circuit breakers are in the EE bay.

Don't reset a fuel pump, lav flush motor, or fuel quantity indicating system circuit breaker.



Before resetting a CB ask yourself:
"How important is that component to the flight?"
"What else is happening that caused the circuit breaker to trip?
Phase of flight? Weather conditions?

Preflight:
If a circuit breaker if found tripped during preflight, it may be reset once unless there is reason to believe it has tripped due to an electrical fault.

After block-out:
If a circuit breaker has tripped after block-out, do not reset it. Continue the flight with the CB left out provided the system is not required per the MEL.
One reset of a CB is allowed after a cooling period of 2 minutes if called for in a non-normal checklist or at the discretion of the Captain if the system is necessary for the safe completion of the flight. Do not attempt a second reset.

If a circuit breaker has tripped due to a perceived electrical manfuntion, notify maintenance. Do not reset the breaker.

CIRCUIT BREAKERS (NG)

AC APU Gen Ind	P91	C11	
AC Bus 1, A phase	P6-4	B13	
AC Bus 1, B phase	P6-4	B14	
AC Bus 1, C phase	P6-4	B15	
AC Bus 2, A phase	P6-4	B10	
AC Bus 2, B phase	P6-4	B11	
AC Bus 2, C phase	P6-4	B12	
AC Bus, No 1 Electronics	P18-0	2	
AC Gen 1 Ind	P91	B12	
AC Gen 2 Ind	P92	B12	
AC Standby Bus Power	P6-4	D18	
AC Transfer Bus 1, A phase	P6-4	C13	
AC Transfer Bus 1, B phase	P6-4	C14	
AC Transfer Bus 1, C phase	P6-4	C15	
AC Transfer Bus 2, A phase	P6-4	C10	
AC Transfer Bus 2, B phase	P6-4	C11	
ACARS MU AC	P6-1	E7	115 vac xfr bus 1
ACARS CMU AC	P6-1	E8	115 vac xfr bus 1
ACARS CMU DC	P6-1	E9	28 vdc bus 2
ACMS	P6-1	E4	115 vac elec pwr 1
ADF 1	P18-1	A4	115 vac stby bus
ADF 2	P6-1	A17	115 vac xfr bus 2
ADIRU, Left, DC	P18-1	E5	sw. hot battery bus
ADIRU, Left, AC	P18-1	E7	ac stby bus
ADIRU, Right, AC	P6-1	C14	ac xfr bus 2
ADIRU, Left, EXC	P18-2	E8	28 vac stby bus
ADIRU, Right, EXC	P6-1	C15	28 vdc xfr bus 2
ADIRU, Right DC	P6-1	C17	hot battery bus
AFCS, Sys A, FCC (DC)	P18-1	D2	28 vdc bus 1
AFCS, Sys A, Engage Interlock	P18-1	D3	28 vdc bus 1
AFCS, Sys A, Mach Trim (AC)	P18-1	C4	115 vac xfr bus 1
AFCS, Sys A, Mach Trim (DC)	P18-1	D4	28 vdc bus 1
AFCS, Sys A, Sensor Exc (AC)	P18-1	C5	115 vac xfr bus 1
AFCS, Sys A, Warn Light (Bat)	P18-1	D1	28 vdc sw. hot bat bus
AFCS, Sys B, FCC (DC)	P6-2	B3	28 vdc bus 2
AFCS, Sys B, Engage Interlock	P6-2	B4	28 vdc bus 2
AFCS, Sys B, Mach Trim (AC)	P6-2	C1	115 vac xfr bus 2
AFCS, Sys B, Mach Trim (DC)	P6-2	B2	28 vdc bus 2
AFCS, Sys B, Sensor Exc (AC)	P6-2	C2	115 vac xfr bus 2
AFCS, Sys B, Warn Light (Bat)	P6-2	B1	28 vdc sw. hot bat bus
Air Cond Bleed Air, Press Ind	P6-4	B5	115 vac xfr bus 2
Air Cond Bleed Air, Valve Isln	P6-4	A5	115 vac xfr bus 1
Air Cond Bleed Air, Valves Left	P6-4	A7	28 vdc bus 1
Air Cond Bleed Air, Valves Right	P6-4	B7	28 vdc bus 2
Air Cond Bleed Air, XDCR Left	P6-4	A6	28 vdc bus 1
Air Cond Bleed Air, XDCR Right	P6-4	B6	28 vdc bus 2
Air Cond Compt Lt	P92	C3	28vac grd serv bus 2
Air Cond Mix Valve Pos Ind (6-7)	P6-4	D7	
Air Cond Overboard Exhaust Valve, Cont	P6-4	D1	battery bus
Air Cond Overboard Exhaust Valve, Reconfig Cont	P6-4	D2	28 vdc bus 2
Air Cond Overheat (6-7)	P6-4	C4	battery bus
Air Cond Pack/Eng Bleed Air, Overheat, Left	P6-4	C8	bat bus
Air Cond Pack/Eng Bleed Air, Overheat, Right	P6-4	C7	bat bus
Air Cond Pack Controller, Left Electronic DC (8-9)	P6-4	A9	28 vdc bus 1
Air Cond Pack Controller, Left Electronic AC (8-9)	P6-4	A11	115 vac xfr bus 1
Air Cond Pack Controller, Right Electronic DC (8-9)	P6-4	B9	28 vdc bus 2
Air Cond Pack Controller, Right Electronic AC (8-9)	P6-4	B11	115 vac xfr bus 2
Air Cond Pack Cont Valve, Left	P6-4	C6	battery bus
Air Cond Pack Cont Valve, Right	P6-4	C5	battery bus 1

Air Cond Ram Air Mod Cont, Left	*P6-4*	*A8*	*28 vdc bus 1*
Air Cond Ram Air Mod Cont, Right	*P6-4*	*B8*	*28 vdc bus 2*
Air Cond Ram Air Mod Left	*P6-4*	*A4*	*115 vac xfr bus 1*
Air Cond Ram Air Mod Right	*P6-4*	*B4*	*115 vac xfr bus 2*
Air Cond Recirc Fan, Cabin (6-7)	*P6-4*	*E4*	*115 vac main bus 1*
Air Cond Recirc Fan, Control (6-7)	*P6-4*	*E1*	*28 vdc bus 1*
Air Cond Recirc Fan, Right Cont (8-9)	*P6-4*	*E2*	*28 vdc bus 2*
Air Cond Recirc Fan, Right Cabin Air (8-9)	*P6-4*	*E4*	*115 vac main bus 2*
Air Cond Temp Control, 35° F Left (6-7)	*P6-4*	*A1*	
Air Cond Temp Control, 35° F Right (6-7)	*P6-4*	*B1*	
Air Cond Temp Control, Auto Left (6-7)	*P6-4*	*A2*	*115vac xfr bus 1*
Air Cond Temp Control, Auto Right (6-7)	*P6-4*	*B2*	*115vac xfr bus 2*
Air Cond Temp Control, Manual (6-7)	*P6-4*	*A3*	*115vac xfr bus 1*
Air Cond Temp Control Valve Close Left (8-9)	*P6-4*	*A1*	*115 vac xfr bus 1*
Air Cond Temp Control Valve Close Right (8-9)	*P6-4*	*B1*	*115 vac xfr bus 2*
Air Cond Temp Ind	*P6-4*	*D8*	*28 vdc bus 2*
Air Cond Temp Valve/Fan Cont, Aft Pass (8-9)	*P6-4*	*A3*	*115 vac xfr bus 1*
Air Cond Temp Valve/Fan Cont, Fwd Pass (8-9)	*P6-4*	*B2*	*115 vac xfr bus 2*
Air Cond Temp Valve/Fan Cont, Flt Deck (8-9)	*P6-4*	*B3*	*115 vac xfr bus 2*
Air Cond Trim Air Press (8-9)	*P6-4*	*D9*	*28 vdc bus 2*
Air Cond Zone Temp, Duct Ovht, Aft Pass (8-9)	*P6-4*	*C2*	*battery bus*
Air Cond Zone Temp, Duct Ovht, Fwd Pass (8-9)	*P6-4*	*C3*	*battery bus*
Air Cond Zone Temp, Duct Ovht, Flt Deck (8-9)	*P6-4*	*C4*	*battery bus*
Airfone	*P6-1*	*E2*	
Airstair, Actuator (3 phase)	*P6-4*	*B17*	
Airstair, Cont	*P6-4*	*A17*	
Airstair, Door	*P6-4*	*A16*	
Airstair, Stby Door	*P6-4*	*C16*	
Airstair, Stby Cont & Iwd Ent Door Ind	*P6-4*	*C17*	
Airstair, Tread lights	*P6-4*	*A18*	
Alternate T.E. Flap Drive	*P6-2*	*D13*	*115 vac xfr bus 2*
Anti-ice, Alpha Vane Heater, Left	*P18-3*	*C3*	*115 vac xfr bus 1*
Anti-ice, Alpha Vane Heater, Right	*P18-3*	*D3*	*115 vac xfr bus 2*
Anti-Ice, Aux Pitot	*P18-3*	*D6*	*115 vac xfr bus 2*
Anti-Ice, Capt Pitot	*P18-3*	*C1*	*115 vac xfr bus 1*
Anti-ice, Drain Heater	*P18-3*	*E5*	*115 vac main bus 1*
Anti-ice, Drain Mast Heater, Air	*P18-3*	*E4*	*115 vac main bus 1*
Anti-ice, Drain Mast Heater, Ground	*P18-3*	*E3*	*28 vac xfr bus 1*
Anti-ice, Elevator Pitot, Left	*P18-3*	*C4*	*115 vac xfr bus 1*
Anti-ice, Elevator Pitot, Right	*P18-3*	*D4*	*115 vac xfr bus 2*
Anti-ice, Engine 1, Cowl Anti-ice Valve	*P18-3*	*A7*	*28 vdc bus 1*
Anti-ice, Engine 1, Engine & Wing Control	*P18-3*	*A6*	*battery bus*
Anti-ice, Engine 2, Cowl Anti-ice Valve	*P18-3*	*B7*	*28 vdc bus 2*
Anti-ice, Engine 2, Control	*P18-3*	*B6*	*28 vdc bus 2*
Anti-Ice, F/O Pitot	*P18-3*	*D5*	*115 vac xfr bus 2*
Anti-ice, Hose Heaters	*P18-3*	*F16*	*115 vac main bus 1*
Anti-ice, Master Caution	*P6-3*	*D9*	
Anti-ice, Temp Probe (Rosemount)	*P18-3*	*C2*	*115 vac xfr bus 1*
Anti-ice, Windshield Wiper, Left	*P18-3*	*B3*	*28 vdc bus 1*
Anti-ice, Windshield Wiper, Right	*P18-3*	*B1*	*28 vdc bus 2*
Anti-ice, Wing Anti-ice Valve	*P18-3*	*A1*	*115 vac xfr bus 1*
Anti-skid, Inboard	*P6-3*	*E16*	*battery bus*
Anti-skid, Outboard	*P6-3*	*E18*	*DC bus 1*
APU AC Gen Ind	*P91*	*B11 or C11*	
APU Control	*P6-4*	*A14*	*switched hot bat bus*
APU Fan Power	*P6-4*	*B14*	*AC stby bus*
APU Fire Detection	*P6-2*	*A23*	*battery bus*
APU Fire Extinguisher Bottle	*P6-2*	*C23*	*hot battery bus*
APU Fire Switch Power	*P6-2*	*B19*	*hot battery bus*

CIRCUIT BREAKERS (NG)

APU Fuel Boost Pump	P6-4	A12	battery bus
APU Gen Control Unit	P6-4	F12	28 vdc sw hot bat bus
APU Gen Control Unit	P92	C9	28 vdc dc bus 2
APU Start	P18-5		hot bat bus
APU Start Conv	P91	A11	115 vac transfer bus 1
ATC 1	P18-1	B5	115 vac stby bus
ATC 2	P6-1	D14	115 vac xfr bus 2
ATC, Ant switch	P6-1	E14	28 vdc bus 2
ATS Call	P18-2	D14	
Audio, Capt	P6-2	D23	
Audio, F/O	P6-2	D22	
Audio, Obs	P6-2	D24	
Aural Warn	P6-3	D18	battery bus
Auto Brakes Control	P6-3	A17	
Auto Brake Cont 1	P6-3	A18	28 vdc dc bus 1
Auto Brake Cont 2	P6-3	A16	28 vdc dc bus 2
Auto Slat DC 1	P6-2	C14	28 vdc dc bus 1
Auto Slat DC 2	P6-2	B14	28 vdc dc bus 2
Auto Speed Brake	P6-2	B9	28 vdc bus 2
Auto Throttle DC 1	P18-1	E1	28 vdc bus 1
Auto Throttle DC 2	P18-1	E3	28 vdc bus 2
Aux Battery Charger	P91	E3	115 vac gnd serv bus 1
Aux Power Unit Cont	P6-4	A14	28 vdc sw. hot bat bus
Aux Power Unit SCU Fan Power	P6-4	B14	115 vac stby bus
Bat Bus, Sect 1	P6-5	C4	
Bat Bus, Sect 2	P6-5	C5	
Bat Bus, Sect 3	P6-5	A1	
Bat Charger	P92	E1	115 vac gnd serv bus 2
Bat / Stby, Sw Pos Ind	P6-5	B5	
Bleed Air, Overheat, Right	P6-4	C7	
Bleed Air, Overheat, Left	P6-4	C8	
Bleed Air, Press Ind	P6-4	B5	
Bleed Air, Valve Isln	P6-4	A5	
Bleed Air, Valves Left	P6-4	A7	
Bleed Air, Valves Right	P6-4	B7	
Bleed Air, XDCR Left	P6-4	A6	
Bleed Air, XDCR Right	P6-4	B6	
Boost Pump, Tank, Center Left	P91	D6	115 vac xfr bus 1, sect 2
Boost Pump, Tank, Center Right	P92	D6	115 vac xfr bus 2, sect 2
Boost Pump, Tank 1, Aft	P92	D2	115 vac xfr bus 2, sect 2
Boost Pump, Tank 1, Fwd	P91	D2	115 vac xfr bus 1, sect 2
Boost Pump, Tank 2, Aft	P91	D4	115 vac xfr bus 1, sect 2
Boost Pump, Tank 2, Fwd	P92	D4	115 vac xfr bus 2, sect 2
Brake Pressure Indicator	P6-2	A13	
Brakes, Anti-skid, Inboard	P6-3	E16	battery bus
Brakes, Anti-skid, Outboard	P6-3	E18	28 vdc bus 1
Bus Power Control Unit	P6-4	F13	sw hot battery bus
Bus Power Control Unit	P91	C10	28 vdc bus 1
C/B NATS	P6-1	E2	
Clock	P6-3	A2	hot battery bus
Cargo Fire, Ext 2	P18-3	B16	hot battery bus
Cargo Fire, Ext 1	P18-3	B17	hot battery bus
Cargo Fire, Fwd Det B	P18-3	C16	28 vdc bus 2
Cargo Fire, Fwd Det A	P18-3	C17	28 vdc bus 1
Cargo Fire, Aft Det B	P18-3	C18	28 vdc bus 2
Cargo Fire, Aft Det A	P18-3	C19	28 vdc bus 1
Cargo Light Cont	P92	C10	28 vdc bus 2
Cargo Loader Cont, Aft	P6-11	D8	28 vdc gnd serv bus
Cargo Loader Cont, Fwd	P6-12	D8	28 vdc gnd serv bus

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Cargo Loader Drive, Aft	*P91*	*E8*	*115 vac gnd serv bus*
Cargo Loader Drive, Fwd	*P92*	*E4*	*115 vac gnd serv bus*
CDU 1	*P18-2*	*A7*	*ac stby bus*
CDU 2	*P6-1*	*D15*	*ac xfr bus 2*
Clock, Misc	*P6-3*	*A2*	*28 vdc hot battery bus*
Clock, Display	*P6-3*	*A1*	*battery bus*
CMU, ACARS, DC	*P6-1*	*E9*	
CMU-1 AC	*P6-1*	*E8*	
CMU-2 AC	*P6-1*	*E7*	
Coffee Maker 1 & 2, Aft Galley	*Aft Galley*		
Coffee Maker, Forward Galley	*Fwd Galley*		
Communications, HF1	*P18-2*	*E11*	*115 vac xfr bus 1*
Communications, HF2	*P6-1*	*D2*	*115 vac xfr bus 2*
Communications, VHF 1	*P18-2*	*D11*	*28 vdc stby bus*
Communications, VHF 2	*P 6-1*	*C 3*	*28 vdc bus 2*
Communications, VHF 3	*P18-2*	*D12*	*28 vdc bus 2*
Compass 1, Alternate Transformer	*P6-1*	*B12*	
Compass 2, Alternate Transformer	*P18-2*	*B 3*	
Computer, Air Data 1 (26V AC)	*P18-2*	*A9*	
Computer, Air Data 1 (AC)	*P18-2*	*A8*	
Computer, Air Data 2 (26V AC)	*P 6-1*	*B6*	
Computer, Air Data 2 (AC)	*P 6-1*	*B7*	
Computer, FMCS	*P18-2*	*E 8*	
Cowl Anti-ice Valve, Engine 1	*P18-3*	*A7*	
Cowl Anti-ice Valve, Engine 2	*P18-3*	*B7*	
Crew Call	*P18-3*	*A9*	*28 vdc bus 1*
Cross Feed Valve	*P6-3*	*B7*	
Data Loader	*P18-2*	*A9*	*ac xfr bus 1*
DC Bus 1, Sect 2	*P91*	*C12*	
DC Bus 1, Sect 1	*P91*	*A2*	*dc bus 1*
DC Bus 2, Sect 1	*P92*	*C12*	*28 vdc bus 2*
DC Bus 2, Sect 2	*P92*	*A2*	*dc bus 2*
DC Bus 1 XFR	*P91*	*A1*	*dc bus 1*
DC Bus 2 XFR	*P92*	*A1*	*dc bus 2*
DC Bus Indication, Bat	*P6-4*	*F14*	*battery bus*
DC Bus Indication, Bus 1	*P6-4*	*F16*	*28 vdc bus 1*
DC Bus Indication, Bus 2	*P6-4*	*F18*	
DC Bus Indication, Hot Bat	*P6-4*	*E15*	
DC Bus Indication, Sw Hot Bat	*P6-4*	*E16*	
DC Bus Indication, Stby	*P6-4*	*E18*	
Display, Capt EFIS Control Panel	*P18-2*	*D1*	*28 vdc stby*
Display, Capt Inbd	*P18-2*	*D3*	*28 vdc bus 1/stby bus*
Display, Capt Outbd	*P18-2*	*D4*	*28 vdc stby bus*
Display, Ctr Lwr	*P6-1*	*E12*	*28 vdc bus 2*
Display, Ctr Upr	*P18-2*	*D2*	*28 vdc stby bus*
Display, DEU 1 Holdup	*P6-1*	*D10*	*hot bat bus*
Display, DEU 1 Pri	*P18-2*	*D5*	*28 vdc stby bus*
Display, DEU 2 Holdup	*P6-1*	*D9*	*hot battery bus*
Display, DEU 2 Pri	*P6-1*	*D11*	*28 vdc bus 2*
Display, FO EFIS Control Panel	*P6-1*	*E13*	*28 vdc bus 2*
Display, FO Inbd	*P6-1*	*E11*	*28 vdc bus 2*
Display, FO Outbd	*P6-1*	*E10*	*28 vdc bus 2*
DME 1	*P18-1*	*B3*	*115 vac stby bus*
DME 2	*P6-1*	*A14*	*115 vac xfr bus 2*
Door Area Heater - Fwd	*P91*	*A16*	*115 vac main bus 1*
Door Area Heater - Aft	*P91*	*A14*	*115 vac main bus 1*
Door Area Heat Cont	*P18-3*	*E11*	*28 vdc bus 1*
Door Lock	*P6-3*	*E1*	*28 vdc bus 2*
Dual Bat RCCB Remote	*P6-5*	*A4*	

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E/C PC Power	P6-12	A8	
EFIS, Cont Panel, Capt	P18-2	D1	28 vdc stby
EFIS, Cont Panel, FO	P6-1	E13	28 vdc bus 2
Electrical, AC Bus, Stby Bus, 28v AC Disc	P6-4	D15	
Electrical, AC Bus, Stby Bus, 115v AC Ind	P6-4	D16	
Electrical, AC Stby Bus Pwr	P6-4	D18	
Electrical, Gnd Svc DC Hot Bat	P6-4	E12	
Electrical, Gnd Svc Cont	P6-4	E13	
Electrical, TR 3 XFR Relay Cont	P6-4	E11	
Electrical, Transfer Bus 1, 26v AC, Sect 2	P18-3	C5	
Electrical, Transfer Bus 2, 115v AC, Ind	P6-4	D13	
Electrical, Transfer Bus 2, 26v AC, Sect 2	P6-4	D14	
Elevator Tab Valve Right	P6-2	B8	28 vdc bus 2
Elex Panel lights, Capt Fwd/Aft, Centr, F/O	Aft Pedestal		
Eng 1, Alt Pwr, Channel B	P18-2	A4	115 vac xfr bus 1
Eng 2, Alt Pwr, Channel B	P6-2	D7	115 vac xfr bus 2
Eng 1, Alt Pwr, Channel A	P18-2	A5	115 vac xfr bus 1
Eng 2, Alt Pwr, Channel A	P6-2	D8	115 vac xfr bus 2
Eng 1, Engine & Wing Control	P18-3	A6	
Eng 2, Engine Control	P18-3	B6	
Eng 1, Ignition, Left	P18-2	A3	ac xfr bus 1
Eng 1, Ignition, Right	P18-2	A1	ac stby bus
Eng 2, Ignition, Left	P6-2	D6	ac xfr bus 2
Eng 2, Ignition, Right	P6-2	D4	ac stby bus
Eng 1, Run/Pwr	P18-2	B3	28 vdc bus 1
Eng 2, Run/Pwr	P6-2	B5	28 vdc bus 2
Eng 1, Start Lever, Channel A	P18-2	B1	battery bus
Eng 1, Start Lever, Channel B	P18-2	B2	battery bus
Eng 2, Start Lever, Channel A	P6-2	B6	battery bus
Eng 2, Start Lever, Channel B	P6-2	B7	battery bus
Eng 1, Start Valve	P18-2	B8	battery bus
Eng 2, Start Valve	P6-2	C4	battery bus
Eng Fuel, Eng 2, HPSOV Cont	P6-3	E3	battery bus
Eng Fuel, Eng 2, HPSOV Ind	P6-3	E4	
Eng Fuel, Eng 1, HPSOV Cont	P6-3	E5	battery bus
Eng Fuel, Eng 1, HPSOV Ind	P6-3	E6	
Eng Pump Depress Valve 1	P6-2	B15	
Eng Pump Depress Valve 2	P6-2	B	
Engine Vibration Monitor	P6-2	A2	ac xfr bus 2
Entertainment, Audio, LH	P6-1	C7	
Entertainment, Audio, RH	P6-1	C8	
Entertainment, Audio, PA Tape RPDR (AC)	P6-1	C9	
Entertainment, Audio, ENT VID CTR-DC	P6-1	C10	
Entertainment, Audio, ENT VID CTR-AC	P6-1	C11	
Entertainment, Audio, Video 1	P6-1	C12	115 vac xfr bus 1
Entertainment, Audio, Video2	P6-1	C13	115 vac xfr bus 1
Entertainment, Audio, Video3	P6-1	C13	115 vac xfr bus 1
Equipment Cooling Exhaust Fan Control, Altn	P6-4	C15	28 vdc bus 2
Equipment Cooling Exhaust Fan Control, Normal	P6-4	C14	28 vdc gnd serv bus
Equipment Cooling Exhaust Fan Power - Normal	P91	E1	115 vac gnd serv bus 1
Equipment Cooling Exhaust Fan Power - Altn	P92	A10	115 vac xfr bus 2
Equipment Cooling Low Flow Dect, Supply	P18-3	A17	28 vdc bus 2
Equipment Cooling Low Flow Dect, Exhaust	P18-3	A18	28 vdc bus 1
Equipment Cooling Supply Fan Control, Altn	P6-4	C13	28 vdc bus 1
Equipment Cooling Supply Fan Control, Normal	P6-4	C12	28 vdc bus 2
Equipment Cooling Supply Fan Power, Altn	P91	A8	115 vac transfer bus 1
Equipment Cooling Supply Fan Power, Normal	P92	A8	115 vac transfer bus 2
Ext Pwr	P91	A12	
Ext Pwr 1	P92	A18	

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Ext Pwr 2	*P92*	*A15*	
Ext Pwr BPCU	*P92*	*A12*	
Fasten Seat Belt, Left	*P18-3*	*C9*	*28 vac xfr bus 1*
Fasten Seat Belt, Right	*P18-3*	*C8*	*28 vac xfr bus 2*
FCC AFCS System B (DC)	*P6-2*	*B3*	
Fire Detection, Ovrht, WW, Wing-Body	*P6-2*	*A19*	*115 vac xfr bus 2*
Fire Detection, APU	*P6-2*	*A23*	*battery bus*
Fire Detection, Engine 1	*P6-2*	*A24*	*battery bus*
Fire Detection, Engine 2	*P6-2*	*A22*	*battery bus*
Fire Detection, MA Warn & Cont	*P6-2*	*A21*	*battery bus*
Fire Extinguishers, APU	*P6-2*	*B21*	*hot battery bus*
Fire Extinguishers, Right	*P6-2*	*B20*	*hot battery bus*
Fire Extinguishers, Left	*P6-2*	*B22*	*hot battery bus*
Fire Extinguishers, Altn Right	*P6-2*	*B23*	*hot battery bus*
Fire Extinguishers, Altn Left	*P6-2*	*B24*	*hot battery bus*
Flaps Pos Ind, LE	*P6-2*	*C12*	
Flight Control Flap Load Relief	*P6-2*	*A6*	*28 vdc bus 1*
Flight Control Flap Shutoff Valves	*P6-2*	*A7*	*28 vdc bus 1*
Flight Control Shutoff Valve, Flt Cont	*P6-2*	*B13*	*28 vdc bus 2*
Flight Control Shutoff Valve, Flt Cont	*P6-2*	*C13*	*28 vdc bus 1*
Flight Control Shutoff Valve, Spoiler	*P6-2*	*B12*	*28 vdc bus 2*
Flight Control Shutoff Valve, Stby Rud	*P6-2*	*C11*	*battery bus*
Flight Control Altn T.E. Flap Drive	*P6-2*	*D13*	*115 vac xfr bus 2*
Flight Recorder AC	*P18-2*	*C9*	*115 vac xfr bus 1*
Flight Recorder DC	*P18-2*	*C10*	*28 vdc bus 1*
Flight Recorder, Position Sensor	*P18-2*	*C8*	*28 vac xfr bus 1*
FMCS Bite DC	*P18-2*	*B10*	
FMCS CDU 1	*P18-2*	*A7*	*115 vac stby bus*
FMCS CDU 2	*P6-1*	*D15*	*115 vac xfr bus 2*
FMCS Cmptr No 1	*P18-2*	*E8 & A6*	
FMCS, Cmptr 1	*P18-2*	*A6*	*115 vac stby bus*
FMCS, Cmptr 2	*P6-1*	*D16*	*115 vac xfr bus 2*
FMCS, MCDU 1	*P18-2*	*A7*	*115 vac stby bus*
FMCS, MCDU 2	*P6-1*	*D15*	*115 vac xfr bus 2*
FMCS, Xfr	*P6-1*	*E15*	*28 vdc bus 2*
FSEU DC 1	*P6-2*	*A8*	*28 vdc bus 1*
FSEU DC 2	*P6-2*	*A9*	*28 vdc bus 2*
Fuel Boost Pump, Center Tank Left	*P91*	*D6*	*115 vac xfr bus 1*
Fuel Boost Pump, Center Tank Right	*P92*	*D6*	*115 vac xfr bus 2*
Fuel Boost Pump, Tank 1, Aft	*P92*	*D2*	*115 vac xfr bus 2*
Fuel Boost Pump, Tank 1, Fwd	*P91*	*D2*	*115 vac xfr bus 1*
Fuel Boost Pump, Tank 2, Aft	*P91*	*D4*	*115 vac xfr bus 1*
Fuel Boost Pump, Tank 2, Fwd	*P92*	*D4*	*115 vac xfr bus 2*
Fuel Fueling Cont	*P6-3*	*A3*	*hot battery bus*
Fuel Cross Feed Valve	*P6-3*	*B7*	*battery bus*
Fuel, Eng 1, HPSOV Cont	*P6-3*	*E5*	*battery bus*
Fuel, Eng 1, HPSOV Ind	*P6-3*	*E6*	
Fuel, Eng 2, HPSOV Cont	*P6-3*	*E3*	*battery bus*
Fuel, Eng 2, HPSOV Ind	*P6-3*	*E4*	
Fuel Fueling Ind	*P6-3*	*A4*	*hot battery bus*
Fuel Qty 1	*P6-3*	*A6*	*28 vdc bus 1*
Fuel Qty 2	*P6-3*	*A5*	*battery bus*
Fuel Shutoff Valve, Bus	*P6-3*	*C6*	*hot battery bus*
Fuel Shutoff Valve, Pwr Pack	*P6-3*	*C4*	*28 vdc bus 2*
Fuel Spar Valve, Eng 1	*P6-3*	*B4*	*hot battery bus*
Fuel Spar Valve, Eng 2	*P6-3*	*B3*	*hot battery bus*
Fuel Spar Valve Ind	*P6-3*	*B5*	*28 vdc sw. hot battery bus*
Fuel Temp Ind	*P6-3*	*A7*	*28 vac xfr bus 2*
Galley Bus A	*P92*	*F7 (behind hinged panel)*	6

CIRCUIT BREAKERS (NG)

Galley Bus B	P92	F8 (behind hinged panel)	
Galley Bus C	P91	F7 (behind hinged panel)	
Galley Bus D	P91	F8 (behind hinged panel)	
Gasper Fan	P6-4	E7	
Gen 1 Load Shed	P91	C7	28 vdc bus 1
Gen 2 Load Shed	P92	C7	28 vdc bus 2
Generator Control Unit 1	P6-4	F10	battery bus
Generator Control Unit 2	P6-4	F11	28 vdc stby bus
Generator, APU Gen Cont Unit	P6-4	F12	28 vdc sw. hot bat bus
Generator, Bus Pwr Cont Unit	P6-4	F13	
Generator Disc 1	P6-4	F8	battery bus
Generator Disc 2	P6-4	F9	battery bus
GPS 1/MMR 1	P18-1	A7	
GPS 2/MMR 2	P6-1	A9	
Grey Water Drain Valve	P18-3	E19	A9
Ground Prox Warn	P18-1	B7	115 vac xfr bus 1
Ground Serv 1	P91	F1 (behind hinged panel)	
Ground Serv 1, Sect 1	P91	E5	115 vac gnd serv bus 1
Ground Serv 1, 28 vac	P91	E11	115 vac gnd serv bus 1
Ground Serv 2	P92	F1 (behind hinged panel)	
Ground Serv 2, 28 vac	P92	E6	115 vac gnd serv bus 2
Ground Serv Clg Night Cont	P91	C4	
Ground Serv Cont	P6-4	E13	
Ground Serv DC 1	P6-4	D11	
Ground Serv DC Hot Bat	P6-4	E12	
Ground Serv Wdo Brt Cont	P92	C1	28 vac grd serv bus 2
Heads Up Guidance, Cmptr Altn DC	P18-2	C6	
Heads Up Guidance, Cmptr DC	P18-2	C5	
Heads Up Guidance, Control Panel DC	P18-2	C4	
Heads Up Guidance, DEU AC	P18-2	C3	
Heads Up Guidance, DEU Altn AC	P18-2	C1	
Heads Up Guidance, Pwr Mon AC	P18-2	C2	
HF1	P18-2	E11	115 vac xfr bus 1
HF2	P6-1	D2	115 vac xfr bus 2
Hose Heaters	P18-3	F16 or E18	
Hot Bat Bus	P6-5	B3	
HUD Sys. Altn DC	P18-2	C1	28 vdc bus2
HUD, Cont	P18-2	C2	28 vdc bus 1
HUD Sys, Normal DC	P18-2	C3	28 vdc bus 1
Hydraulic, Brake Press Ind	P 6-2	A13	28 vdc bat bus
Hydraulic, Landing Gear Xfer Valve, Primary	P6-2	C16	28 vdc bus 1
Hydraulic, Landing Gear Xfer Valve, Secondary	P6-2	C15	28 vdc bus 1
Hydraulic, PTU Valve, Cont 1	P6-2	A15	28 vdc bus 1
Hydraulic, PTU Valve, Cont 2	P6-2	A16	28 vdc bus 1
Hydraulic Pump, Sys A	P92	F3 (behind panel) xfr bus 2	
Hydraulic Pump, Sys B	P91	F3 (behind panel) xfr bus 1	
Hydraulic Eng Pump Depress Valve 1	P6-2	B15	28 vdc bus 2
Hydraulic Eng Pump Depress Valve 2	P6-2	A17	28 vdc bus 1
Hydraulic, Electric Pump Cont Sys A	P92	C8	28 vdc bus 2
Hydraulic, Electric Pump Cont Sys B	P91	C8	28 vdc bus 1
Hydraulic Shutoff Valve, Eng 1	P6-2	C19	battery bus
Hydraulic Shutoff Valve, Eng 2	P6-2	C18	battery bus
Ignition, Engine 1, Left	P18-2	A3	ac xfr bus 1
Ignition, Engine 1, Right	P18-2	A1	stby ac
Ignition, Engine 2, Left	P6-2	D6	115 vac xfr bus 2
Ignition, Engine 2, Right	P6-2	D4	115 vac stby bus
ILS 1	P18-1	A2	
ILS 2	P6-1	A13	
Instrument Transfer	P18-2	A2 & E2	stby dc 7

Instrument Transformer 1	P18-2	A1	
Inst Transformer 2	P6-1	A12	
Intph and Warn (Interphone & Warn)	P6-2	D21	
Interphone Power, Capt DC 2	P6-2	C23	
Interphone Power, Capt Bat	P6-2	C24	
Interphone Power, F/O DC 2	P 6-2	C21	
Interphone Power, F/O (Bat)	P6-2	C22	
Inverter, Remote (RCCB)	P6-5	A5	battery bus bar
Inverter Volts	P6-5	A2	115 vac inverter
ISFD			28 vdc bat bus
Landing Gear, Air/Gnd Sys 1	P6-3	C16	28 vdc bus 1
Landing Gear, Air/Gnd Sys 2	P6-3	C15	battery bus
Landing Gear, Air/Gnd Relay	P6-3	D15	28 vdc bus 2
Landing Gear, Altn Extend Sol	P6-3	D16	battery bus
Landing Gear, Anti-skid, Inboard	P6-3	E16	battery bus
Landing Gear, Anti-skid, Outboard	P6-3	E18	28 vdc bus 1
Landing Gear, Aural Warn	P6-3	D18	battery bus
Landing Gear, Auto Brake Bite Cont 1	P6-3	A18	28 vdc bus 1
Landing Gear, Auto Brake Bite Cont 2	P6-3	A16	28 vdc bus 2
Landing Gear, Auto Brake Bite	P6-3	A17	
Landing Gear, Latch & Press Warn	P6-3	B17	battery bus
Landing Gear, Nose Gear Steering	P6-3	D17	115 vac xfr bus 2
Landing Gear, Parking Brake	P6-3	B16	28 vdc hot battery bus
Landing Gear, Takeoff Warning Cutoff	P6-3	C18	
Landing Gear Xfer Valve, Primary	P6-2	C16	
Landing Gear Xfer Valve, Secondary	P6-2	C15	
Lavatory Hose Heaters	P18-3	F16	
Lavatory Occupied Sign	P18-3	D9	
Lavatory Smoke Detector	P18-3	E12	28 vdc bus 1
Lavatory Water Heaters, A	P18-3	F13	115 vac main bus 1
Lavatory Water Heaters, D	P18-3	F14	
Lavatory Water Heaters, G	P18-3	F15	
Light, Access Comp	P91	C5	28 vac gnd serv bus 1
Light, Air Cond Compt	P92	C3	28 vac gnd serv bus 2
Light, Anti-collision Red	P18-3	B12	115 vac xfr bus 1
Light, Anti-collision White	P18-3	B13	115 vac xfr bus 1
Light, Auto Dim Entry	P6-4	E10	
Light, Capt Panel (3)	CA Rud Adj		28 vac xfr bus 1
Light, Cargo Compt Lt Aft	P92	C5	28 vac grd serv bus 2
Light, Cargo Compt Lt Fwd	P92	C4	28 vac grd serv bus 2
Light, Cargo Light Cont	P92	C10	28 vdc bus 2
Light, Ceiling, Right	P91	D11	115 vac gnd serv bus 1
Light, Ceiling, Left	P91	D12	115 vac gnd serv bus 1
Light, Center Console Panel, Fwd, Capt, Centr, F/P	Aft Console		
Light, Center Panel (2)	CA Rud Adj		
Light, Circuit Breaker Panel	P6-3	C9	28 vac xfr bus 2
Light, Compass, Standby	P6-3	A13	28 vdc battery bus
Light, Cont 1	P6-3	C11	
Light, Cont 2	P6-3	C12	
Light, Cont 3	P6-3	C13	
Light, Cont 4	P6-3	C14	
Light, Control Stand	P6-3	A8	28 vac xfr bus 2
Light, Dome White	P6-3	A15	battery bus
Light, Elec Rack, Fwd	P91	C2	28 vac gnd serv bus 1
Light, Elec Panel	P6-3	C10	28 vac xfr bus 2
Light, Emer and F/O's Panel (5)	FO Rud Adj		
Light, Emer Chgr, Fwd	P18-3	A11	28 vdc bus 1
Light, Emer Chgr, Left Aft	P18-3	A10	28 vdc bus 1
Light, Emer Chgr, Right Aft	P18-3	B10	28 vdc bus 1

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Light, Emer Panel	P6-3	D8	28 vac stby bus
Light, Entry Brt	P91	E10	115 vac gnd serv bus 1
Light, Entry Dim	P6-4	E9	28 vdc hot battery bus
Light, Galley	P18-3	B10	
Light, Galley	P92	E10	115 vac gnd serv bus 2
Light, General Light Cont	P18-3	D12	28 vdc bus 1
Light, Gnd Serv Clg Night Cont	P91	C4	28 vac gnd serv bus 1
Light, Gnd Serv Wdo Brt Cont	P6-3	D12	28 vac gnd serv bus 2
Light, Indicator Master Dim, Bat	P6-3	D12	
Light, Indicator Master Dim, DC 1	P6-3	D13	
Light, Indicator Master Dim, DC 2	P6-3	D14	28 vdc bus 2
Light, Indicator, Master Dim, Dim / Test Cont	P6-3	D11	battery bus
Light, Indicator Master Dim, Sect 1	P6-3	E11	
Light, Indicator Master Dim, Sect 2	P6-3	E12	
Light, Indicator Master Dim, Sect 3	P6-3	E13	
Light, Indicator Master Dim, Sect 4	P6-3	E14	
Light, Indicator Master Dim, Sect 5	P6-3	F11	
Light, Indicator Master Dim, Sect 6	P6-3	F12	
Light, Indicator Master Dim, Sect 7	P6-3	F13	
Light, Indicator Master Dim, Sect 8	P6-3	F14	
Light, Landing, Left Fixed	P18-3	B15	115 vac xfr bus 1
Light, Landing, Left Retractable	P18-3	C15	115 vac xfr bus 2
Light, Landing, Right Fixed	P18-3	C14	115 vac xfr bus 2
Light, Landing, Right Retractable	P18-3	B14	115 vac xfr bus 1
Light, Lavatory Mirror	P18-3	E14	115 vac gnd serv bus 2
Light, Lav Occupied Sign	P18-3	D9	28 vac xfr bus 1
Light, LCD	P6-4	F1	
Light, Logo, Ilum	P18-3	A15	115 vac main bus 1
Light, Map & Kit	P6-3	A9	28 vac xfr bus 1
Light, Nose Gear Taxi	P18-3	D14	115 vac xfr bus 1
Light, Observer Reading	P6-3	A10	28 vac xfr bus 2
Light, Overhead, 28V Primary	P6-3	D9	
Light, Overhead, 28V Sec	P6-3	D10	
Light, Overhead, 5V Sec	P6-3	E8	
Light, Overhead, 5V Sec	P6-3	E9	
Light, Overhead, 5V Sec	P6-3	E10	
Light, Overhead, 5V Sec	P6-3	F8	
Light, Overhead, 5V Sec	P6-3	F9	
Light, Overhead, 5V Sec	P6-3	F10	
Light, Panel & Instr, 28V Primary, Capt & Ctr	P6-3	B9	ac xfr bus 1
Light, Panel & Instr, 28V Primary, F/O	P6-3	B10	ac xfr bus 2
Light, Panel & Inst, CB Panel	P6-3	C9	
Light, Panel & Inst, Elex Panel	P6-3	C10	
Light, Panel Flood Cont	P6-3	A11	115 vac xfr bus 2
Light, Panel Flood Stby	P6-3	A12	115 vac stby bus
Light, Passenger Reading, Right, Sta 340-451	P92	B1	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 451-500E	P92	B2	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 500E-552	P92	B3	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 552-692	P92	B4	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 692-727B	P92	B5	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 727B-727G	P92	B6	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 727G-768	P92	B7	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 768-880	P92	B8	28 vac xfr bus 2
Light, Passenger Reading, Right, Sta 880-937	P92	B9	28 vac xfr bus 2
Light, Passenger Reading, Left, Sta 340-451	P91	B1	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 451-500E	P91	B2	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 500E-552	P91	B3	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 552-692	P91	B4	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 692-727B	P91	B5	28 vac xfr bus 1

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Light, Passenger Reading, Left, Sta 727B-727G	P91	B6	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 727G-768	P91	B7	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 768-880	P91	B8	28 vac xfr bus 1
Light, Passenger Reading, Left, Sta 880-937	P91	B9	28 vac xfr bus 1
Light, Position, Left	P18-3	A13	115 vac gnd serv bus 1
Light, Position, Right	P18-3	A12	115 vac gnd serv bus 1
Light, Runway Turnoff, Left	P18-3	C13	28 vac xfr bus 1
Light, Runway Turnoff, Right	P18-3	C12	27 vac xfr bus 2
Light, Sect 1	P6-3	E11	
Light, Sect 2	P6-3	E12	
Light, Sect 3	P6-3	E13	
Light, Sect 4	P6-3	E14	
Light, Sect 5	P6-3	F11	
Light, Sect 6	P6-3	F12	
Light, Sect 7	P6-3	F13	
Light, Sect 8	P6-3	F14	
Light, Stby Compass	P6-3	A14	battery bus
Light, Thrsh	P91	C1	28 vac grd serv bus 1
Light, WDO, Left	P92	E12	115 vac grd serv bus 2
Light, WDO, Right	P92	E11	115 vac grd serv bus 2
Light, Wheel well	P92	C2	28 vac grd serv bus 2
Light, Window, Left	P92	E12	115 vac gnd serv bus 2
Light, Window, Right	P92	E11	115 vac gnd serv bus 2
Light, Wing Scan	P18-3	A14	115 vac gnd serv bus 1
Light, Work and Thrsh	P91	C3	28 vac grd serv bus 1
Mach Trim, AC Sys A	P18-1	C4	
Mach Trim, DC Sys A	P18-1	D4	
Mach Trim, AC Sys B	P6-2	C1	
Mach Trim, DC Sys B	P6-2	B2	
Mach Warn Sys 1	P18-2	E3	stby dc
Mach Warn Sys 2	P6-1	B7	28 dc bus 2
Main Bus 1	P91	F6 (behind hinged panel)	
Main Bus 2	P92	F6 (behind hinged panel)	
Marker Beacon 2	P6-1	A13	
Master Caution, Annunciator Bus 1	P6-3	B12	28 vdc bus 1
Master Caution, Annunciator, Bat	P6-3	B13	battery bus
Master Caution, Annunciator, Cont 1	P6-3	C11	
Master Caution, Annunciator, Cont 2	P6-3	C12	
Master Caution, Annunciator, Cont 3	P6-3	C13	
Master Caution, Annunciator, Cont 4	P6-3	C14	
MCP DC 1	P18-1	D5	28 vdc bus 1
MCP DC 2	P6-2	C3	battery bus
MIDU	P6-3	A1	
MMR 1 (GPS 1)	P18-1	A2	ac stby bus
MMR 2 (GPS 2)	P6-1	A13	ac xfr bus 2
MPES MK II, Aeris Fx	P6-1	C8	
MPES MK II, Main Mux	P6-1	C7	
MPES MK II, VCC 28 vac	P6-1	C9	
MPES MK II, VCC 115 vac	P6-1	C10	
MPES MK II, VDU 1-4	P6-1	C11	
MPES MK II, VDU 5-7	P6-1	C12	
MPES MK II, VDU 8-10	P6-1	C13	
Nav Control Panel 1	P18-1	A3	ac stby bus
Nav Control Panel 2	P6-1	A15	ac xfr bus 2
Nav Sensor DC-1	P18-1	B1	dc stby bus
Nav Sensor DC-2	P6-1	A10	28 vdc bus 2
Nitrogen Generation Control	P18-3		
No Smoking, Left	P18-3	C11	28 vac xfr bus 1
No Smoking, Right	P18-3	C10	28 vac xfr bus 2 10
OPC / Laptop	P18-3	F5	

CIRCUIT BREAKERS (NG)

Overboard Exhaust Valve, Cont	P6-4	D1	
Overboard Exhaust Valve, Reconfig Cont	P6-4	D2	
Overwing Flight Lock, Left	P6-2	D2	28 vdc bus 1
Overwing Flight Lock, Right	P6-2	D1	28 vdc bus 2
Overheat, Wheel Well, Wing-Body	P6-2	A19	
Oxygen, Indicator	P18-3	F7	battery bus
Oxygen, Manual Control	P18-3	F8	
Oxygen, Pass, Left	P18-3	F10	battery bus
Oxygen, Pass, Right	P18-3	F9	battery bus
PA Amp, Bat	P6-1	D4	battery bus
Pack Controller, Left Electronic (8-9)	P6-4	A9	
Pack Controller, Left Electronic (8-9)	P6-4	A11	
Pack Controller, Right Electronic (8-9)	P6-4	B9	
Pack Controller, Right Electronic (8-9)	P6-4	B11	
Pack Cont Valve, Left	P6-4	C6	
Pack Cont Valve, Right	P6-4	C5	
Parking Brake	P6-3	B16	hot bat bus
Pass Telephone (NATS)	P6-1	E2	
Passenger Call Right	P18-3	B8	28 vdc bus 2
Passenger Call Left	P18-3	A8	28 vdc bus 1
Passenger Crew Call	P18-3	A9	28 vdc bus 1
Passenger Sign Cont	P18-3	D11	28 vdc bus 1
PC Power, Y/C	P6-12	A8	115 vac xfr bus 2
PC Power, F/C	P6-12	A5	115 vac xfr bus 2
Pot Water Compressor	P91	A18	main bus 1
Pressurization Control, Auto 1	P6-4	F3	dc bus 1
Pressurization Control, Auto 2	P6-4	F5	dc bus 2
Pressurization Control, Ind	P6-4	F7	battery bus
Pressurization Control, Manual	P6-4	F6	battery bus
Pressurization LCD Ltg	P6-4	F1	28 vac xfr bus 2
PRTR (printer)	P6-1	E5	115 vac xfr bus 1
Probe, Indication, Capt	P6-3	F18	dc bus 1
Probe, Indication, F/O	P6-3	F16	dc bus 2
PSEU, Altn	P6-3	D2	28 vdc sw. hot battery bus
PSEU, DC 1	P6-2	A8	
PSEU, DC 2	P6-2	A9	
PSEU, Primary	P6-3	D1	28 vdc gnd serv bus
PTU Valve, Cont 1	P 6-2	A15	28 vdc bus 1
PTU Valve, Cont 2	P 6-2	A16	28 vdc bus 1
Radio Altim 1	P18-1	B4	ac xfr bus 1
Radio Altim 2	P6-1	A16	ac xfr bus 2
Ram Air Mod Cont, Left	P6-4	A8	
Ram Air Mod Cont, Right	P6-4	B8	
Ram Air Mod Left	P6-4	A4	
Ram Air Mod Right	P6-4	B4	
RCCB, Remote (inverter)	P6-5	A4	battery bus bar
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Recirc Fan, Left Cabin Air (8-9)	P18-3	E7	main bus 1
Recirc Fan, Right Cabin Air (8-9)	P6-4	E4	main bus 2
Recirc Fan, Control	P6-4	E1	
Recirc Fan, Left Control (8-9)	P18-3	E9	
Recirc Fan, Right Control (8-9)	P6-4	E2	
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Rudder Authority Limiter	P6-2	C9	28 vdc bus 2 (load)
Rudder Trim Indicator	P6-2	D16	28 vac xfr bus 2
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Run/Pwr, Eng 2	P6-2	B5	
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Sensor Exc, AC, AFCS Sys A	P18-1	C5	

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Service Outlet	*P92*	*E7*	*115vac gnd serv bus 2*
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SMYD-2, Computer DC	*P6-1*	*B5*	*28 vdc bus 2*
SMYD-1, Sensor EXC AC	*P18-2*	*E6*	*28 vac stby bus*
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Stab Trim Control	*P6-2*	*B10*	*28 vdc bus 2*
Stall Warn, Asym Mode	*P18-2*	*E7*	*dc gnd sev bus*
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Start Lever, Eng 1, Channel A	*P18-2*	*B1*	*sw hot battery bus*
Start Lever, Eng 2, Channel B	*P18-2*	*B2*	
Start Lever, Eng 2, Channel A	*P6-2*	*B6*	*sw hot battery bus*
Start Lever, Eng 2, Channel B	*P6-2*	*B7*	
Start Valve Eng 1	*P18-2*	*B8*	*battery bus*
Start Valve Eng 2	*P6-2*	*C4*	*battery bus*
Stick Shaker, Left	*P18-2*	*E4*	*28 vdc stb bus*
Stick Shaker, Right	*P6-1*	*B6*	*28vdc bus 2*
Switched Hot Batt Bus	*P6-5*	*B4*	
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TCAS	*P18-1*	*B6*	*115 vac xfr bus 1*
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Temp Control, 35° F Right (6-7)	*P6-4*	*B1*	
Temp Control, Auto Left (6-7)	*P6-4*	*A2*	
Temp Control, Auto Right (6-7)	*P6-4*	*B2*	
Temp Control, Manual (6-7)	*P6-4*	*A3*	
Temp Control, Valve Close Left (8-9)	*P6-4*	*A1*	
Temp Control, Valve Close Right (8-9)	*P6-4*	*B1*	
Temperature Ind (6-7)	*P6-4*	*D2*	
Terrain Display	*P18-1*	*A7*	*28 vdc bus 1*
Thrust Reverser, Cont, Engine 1	*P18-2*	*B5*	*dc stby bus*
Thrust Reverser, Cont, Engine 2	*P6-2*	*C7*	*battery bus*
Thrust Reverser, Ind, Engine 1	*P18-2*	*B4*	*dc bus 1*
Thrust Reverser, Ind, Engine 2	*P6-2*	*C8*	*dc bus 2*
Thrust Reverser, Interlock, Engine 1	*P18-2*	*B6*	*dc stby bus*
Thrust Reverser, Sync Lock, Engine 1	*P18-2*	*B7*	*stby dc bus*
Thrust Reverser, Interlock, Engine 2	*P6-2*	*C6*	*battery bus*
Thrust Reverser, Sync Lock, Engine 2	*P6-2*	*C5*	*battery bus*
Total Air Temperature Indicator	*P18-2*	*A 7*	
TR1	*P91*	*A6*	*115 vac xfr bus 1*
TR3 ALTN	*P91*	*A4*	*115 vac xfr bus 1*
TR3, DC Indicator	*P6-5*	*C3*	*28 vdc from TR3*
TR3 XFR Relay Cont	*P6-4*	*E11*	
Trailing Edge Flap Position Skew Snsr & Ind, Rt	*P6-2*	*A11*	*28 vac xfr bus 2*
Trailing Edge Flap Position Skew Snsr & Ind, Lt	*P6-2*	*A12*	*28 vac xfr bus 2*
Transfer Bus 1 Sect 2, 28 VAC	*P18-3*	*C5*	
Transfer Bus 1, 28 VAC	*P91*	*B10*	
Transfer Bus 2, 28 VAC	*P92*	*B10*	

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CIRCUIT BREAKERS (NG)

Transfer Bus 2, 115 VAC Ind	P6-4	D13	
Transfer Bus 2, Sect 2, 28 VAC	P6-4	D14	
Trim Air Press (800)	P6-4	D9	
Trim Control, Aileron	P6-2	D18	115 vac xfr bus 2
Trim Control, Rudder	P6-2	D19	115 vac xfr bus 2
TRU 1	P91	A6	115vac xfr bus 1
TRU 2	P92	A4	115 vac transfer bus 2
TRU 3	P92	A6	115 vac transfer bus 2
TRU 3 Altn	P91	A4	115 vac transfer bus 1
Vacuum Outlet, Aft	P92	E9	115 vac gnd serv bus 2
Vacuum Outlet, Fwd	P92	E8	115 vac gnd serv bus 2
Vacuum Waste Ind	P18-3	D19	
Vacuum Waste Blower (behind hinged panel)	P91	F2	115 vac xfr bus 1
Vacuum Waste Cont	P91	C11	28 vdc bus 1/gnd svce bus
VHF 1	P18-2	D11	28 vdc stby bus
VHF 2	P6-1	C3	28 vdc bus 2
VHF 3	P18-2	D12	28 vdc bus 2
VID Cont Center AC	P6-1	C7	
VID Cont Center DC	P6-1	C5	
Video 1	P6-1	D5	
Video 2	P6-1	D6	
Video 3	P6-1	D7	
Video 4	P6-1	D8	
Voice Recorder	P18-2	D7	115 vac xfr bus 2
VOR / MKR BCN 1	P18-1	A1	115 vac stby bus
VOR 2	P6-1	A12	115 vac xfr bus 2
Waste, Water Line Heaters	P18-3	D18	28 vdc gnd serv bus
Water Drain Valve, Grey	P18-3	E19	A9 28 vdc bus 1
Water Qty Ind	P91	C9	28 vdc bus 1
Weather Radar, R/T	P6-1	D13	115 vac xfr bus 2
Window Heat Control, Left Front AC	P18-3	E1	115 vac xfr bus 1
Window Heat Control, Left Front DC	P18-3	F2	
Window Heat Control, Left Side AC	P18-3	D2	115 vac xfr bus 2
Window Heat Control, Left Side DC	P18-3	D2	
Window Heat Control, Right Front AC	P18-3	D1	115 vac xfr bus 2
Window Heat Control, Right Front DC	P18-3	E2	
Window Heat Control, Right Side AC	P18-3	E2	115 vac xfr bus 1
Window Heat Control, Right Side DC	P18-3	E2	
Window Heat Power, Left Front	P6-11	B9	115 vac xfr bus 1
Window Heat Power, Left Side	P6-12	A9	115 vac xfr bus 2
Window Heat Power, L4 & L5	P6-11	B7	115 vac xfr bus 1
Window Heat Power, Right Front	P6-12	A8	115 vac xfr bus 2
Window Heat Power, Right Side	P6-11	B8	115 vac xfr bus 1
Window Heat Power, R4 & R5	P6-12	A7	115 vac xfr bus 2
Windshield Wiper, Left	P18-3	B3	28 vdc bus 1
Windshield Wiper, Right	P18-3	B1	28 vdc bus 2
Wing Anti-ice Valve	P18-3	A1	115vac xfr bus 1
XFR BUS 1 SECT 1	P91	F4 (behind hinged panel)	
XFR BUS 1 SECT 2	P91	F5 (behind hinged panel)	
XFR BUS 2 SECT 1	P92	F4 (behind hinged panel)	
XFR BUS 2 SECT 2	P92	F5 (behind hinged panel)	
Yaw Damper AC	P18-1	C7	115 vac xfr bus 1
Yaw Damper 1 DC	P18-1	D7	28 vdc bus 1
Yaw Damper Indicator	P18-1	C6	115 vac xfr bus 1
Yaw Damper 2 DC	P18-1	D6	28 vdc bus 1
Zone Temp, Duct Ovht, Aft Pass (8-9)	P6-4	C2	
Zone Temp, Duct Ovht, Fwd Pass (8-9)	P6-4	C3	
Zone Temp, Duct Ovht,Flt Deck (8-9)	P6-4	C4	

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SMOKE, FIRE, FUMES IN THE COCKPIT OR CABIN

1. Oxygen Masks & Smoke Goggles (if required).. On
2. Cabin Door .... Close
3. Crew Communications (if required) .... Establish

RUNAWAY STABILIZER

Condition: Stabilizer trim wheel continues uncommanded rotation

1. Control Column.. Hold Firmly
   If uncommanded trim motion continues, the stab trim commands are interrupted when the control column is displaced in the opposite direction
2. Autopilot (if engaged)... Disengage
   Control airplane pitch attitude manually with control column and main electric trim. Do not re-engage the autopilot.

If runway stabilizer continues:

3. Stabilizer Trim Cutout Switches ....Cutout

If runway stabilizer continues:

4. Stabilizer Trim Wheel .... Grasp and Hold

UNCOMMANDED RUDDER

1. Autopilot.. Disengage
2. Maintain control of the aircraft with all available flight controls. If roll is uncontrollable, immediately reduce pitch/AOA and increase airspeed. Do not attempt to maintain altitude until control is recovered.
3. Autothrottle .... Disengage
   Verify thrust is symmetrical

UNCOMMANDED YAW OR ROLL

1. Maintain control of the aircraft with all available flight controls. If roll is uncontrollable, immediately reduce pitch/AOA and increase airspeed. Do not attempt to maintain altitude until control is recovered.
2. Autopilot (if engaged)... Disengage
3. Autothrottle (if engaged).. Disengage
   Verify thrust is symmetrical
4. If yaw or roll continues:
   Yaw Damper .... Off

LOSS OF THRUST ON BOTH ENGINES

1. Engine Start Switches .... FLT
2. Engine Start Levers...Cutoff

EGT decreasing:

3. Start Levers ....Idle Detent

GENERIC RECALL ITEMS

CABIN ALT WARN HORN / RAPID DEPRESS / LOSS OF PRESSURIZATION

1. Oxygen Masks & Regulators .... On / 100%
2. Crew Communications .... Establish
3. Pressurization Mode Selector .... Man
4. Outflow Valve Switch .... Close
   If pressurization is restored, continue manual operation to maintain proper cabin altitude.
5. Passenger Signs .... On

If Cabin Is Uncontrollable:

6. Passenger Oxygen Switch .... On
   Activate passenger oxygen if cabin altitude exceeds or is expected to exceed 14,000 ft.

Initiate Emergency Descent if unable to control cabin pressure above 14,000 ft or conditions require a rapid descent

1. "Emergency Descent" .... Announce on PA and advise ATC
2. Engine Start Switches .... CONT
3. Thrust Levers .... Close
4. Speed Brake .... Flight Detent
5. Descent .... Initiate
6. Target Speed .... Mmo/Vmo
7. Level-Off Altitude .... Lowest safe altitude or 10,000 ft (whichever is higher)

ABORTED ENGINE STARTS

Condition: One or more of the following conditions occur:

No N1 rotation before the start lever is raised to IDLE (fan is not rotating)
No oil pressure indication by the time the engine is stabilized at IDLE
No increase in EGT in 10 sec on ground or 30 sec in fllight after start lever to IDLE
No increase, or very slow increase in N1 or N2 after EGT indication (hung start)
EGT rapidly approaching or exceeding the start limit (hot start)

Before Engine Start Lever Raised To Idle:

1. Engine Start Switch .... Cutoff

After Engine Start Lever Raised To Idle: / Before Starter Cutout

1. Engine Start Lever .... Cutoff
   After motoring the engine for 60 seconds:
2. Engine Start Switch .... Off

After Start Lever Raised To Idle: / After Starter Cutout

1. Engine Start Lever .... Cutoff
   After N2 decreases to below 20%, motor engine for 60 seconds
2. Engine Start Switch .... Off

REJECTED TAKEOFF

1. Thrust Levers .... Close
2. Wheel Brakes .... Maximum (Manual or thru Autobrakes)

Without Delay

3. Speedbrake Lever .... Up
4. Thrust Reversers .... Maximum

ENGINE LIMIT / SURGE / STALL

1. Autothrottle (if engaged) .... Disengage
2. Thrust Lever .... Retard
   Retard until indications remain within appropriate limits or thrust lever is closed.

AIRSPEED UNRELIABLE

Conditions: Pitch attitude not consistent with existing phase of flight, altitude, thrust, and weight, or noise and/or low frequency buffeting.

Erroneous or unreliable airspeed indications may be caused by blocked or frozen pitot-static system(s) or a severely damaged or missing radome.

1. Airplane Attitude / Thrust .... Adjust
2. Probe Heat .... Check On
3. Mach / Airspeed Indicators .... Cross Check
   Crosscheck ground speed and winds provided by the IRS and FMC to determine airspeed accuracy if IAS is questionable.

ENGINE FIRE, SEVERE DAMAGE OR SEPARATION

1. Autothrottle .... Disengage
   Allows thrust levers to remain where manually positioned.
2. Thrust Lever .... Close
   Assists in recognition of the affected engine.
3. Engine Start Lever .... Cutoff
4. Engine Fire Warning Switch .... Pull
   To manually unlock the engine fire warning switch, press the override and pull

If the engine fire warning switch or ENG OVERHEAT light remains illuminated:

5. Engine Fire Switch .... Rotate L or R
   Rotate to the stop and hold for one second.

If after 30 second the engine fire warning switch or ENG OVERHEAT light remains illuminated

6. Engine Fire Switch .... Rotate to Remaining Bottle
   Rotate to theopposite side and hold for one second.

ENGINE OVERHEAT

1. Autothrottle .... Disengage
   Allows thrust levers to remain where manually positioned.
2. Thrust Lever .... Close

If the ENG OVERHEAT light remains illuminated:

3. Accomplish ENGINE FIRE, SEVERE DAMAGE OR SEPARATION checklist.

PASSENGER EVACUATION

Captain:

1. Parking Brake .... Set
2. Speedbrake Lever .... Down Detent
   Prevents possible interference or injury to passengers evacuating through the overwing escape hatches.

If time allows, verify the flaps are 40 before the start levers are moved to Cutoff

3. Engine Start Levers (Both) .... Cutoff
4. Evacuation .... Advisd the cabin to evacuate
5. Engine and APU Fire Switches .... Override and Pull

If an engine or APU fire light is illuminated:

6. Related Fire Switches .... Rotate and Hold

First Officer:

1. Flap Lever 40
2. Pressurization Mode Selector .... Manual
3. Outflow Valve .... Open
   Hold until the outflow valve is fully open.
4. Tower .... Advise

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