CHAPTER

77

BOEING 707 Intercontinental

MAINTENANCE MANUAL

CHAPTER 77

ENGINE INDICATING

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ENGINE PRESSURE RATIO INDICATING SYSTEM - DESCRIPTION AND OPERATION

1 General

A The pressure ratio indicating system for each engine consists of six exhaust pressure (Pt7) sensing probes connected to a manifold around the periphery of the engine exhaust housing, one inlet pressure (Pt2) probe on the right-hand side of the nacelle strut, a pressure ratio transmitter mounted in the nacelle strut and a four tape indicator on the pilot center panel (See figure 1) The Pt7/Pt2 pressure ratio is displayed by a dc torque motor driven tape for each engine The system also provides an input to the CPI/FDR

B Engine Pressure Sensing Probes

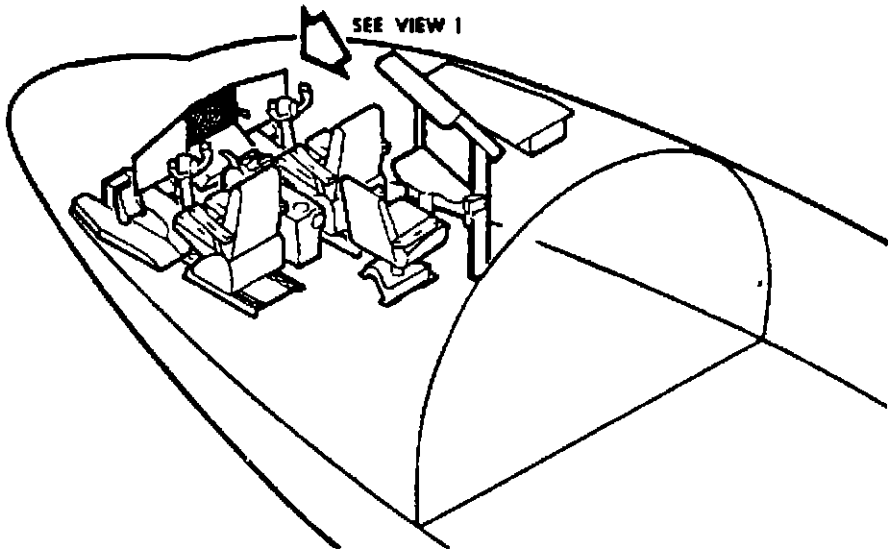
(1) Engine exhaust pressure (Pt7) is detected by six probes extending into the engine exhaust chamber These probes are connected to a common manifold. Engine inlet pressure (Pt2) is sensed by a probe similar to a pitot probe This probe is mounted on the right-hand side of the nacelle strut so that the open end of the tube faces the air stream The Pt2 probe is heated by nose cowl anti-icing air. The Pt2 drain is accessible through access door (L10123-01, L10121-01, R10121-01, R10123-01) on the left-hand side of each engine nacelle strut

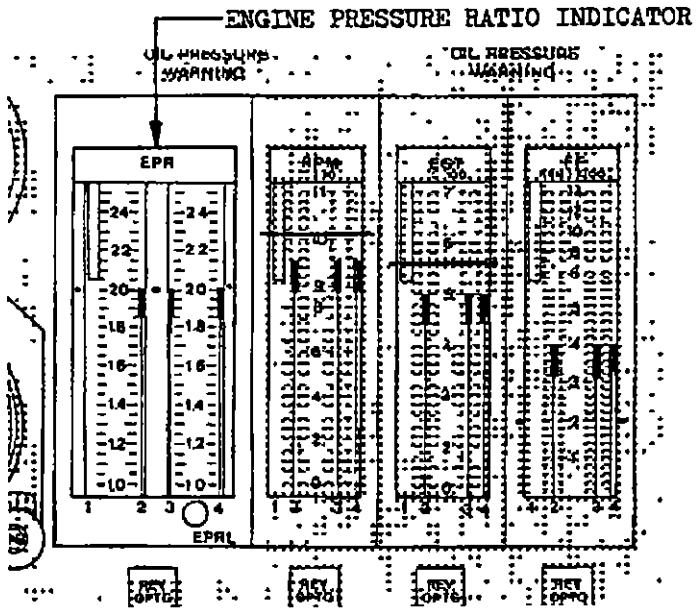
C Engine Pressure Ratio Transmitter

(1) The engine pressure ratio transmitter converts the exhaust pressure (Pt7) and the inlet pressure (Pt2) into a ratio, and generates three-phase electrical signals corresponding to pressure ratio change across a variable capacitor plate It consists of two bellows, an amplifier, a motor-gear train, and a synchronous generator The engine pressure ratio transmitter is mounted above the midspar of the nacelle strut, just forward of the closure rib The engine exhaust and inlet pressures are applied to the bellows assembly in the transmitter A change in either of these pressures causes a change in position of a variable capacitor plate which, with the aid of the amplifier and the motor-gear train, causes the generator rotor to rotate and generate three-phase electrical signals (See figure 1 and 2)

D Engine Pressure Ratio Indicator

(1) The engine pressure ratio (EPR) vertical scale indicator, in exactly the same manner as the EGT indicator, employs four double-ended tapes (scales) attached at one end to precision tape drive reels that are powered by dc torque motors The tapes are connected at the other end to low torque pring return mechanisms The system provides a direct mechanical link between the tape and torque drive, which is coaxially mounted with a servo feedback pot to provide a simple servo mechanism. All electronics are located in the rear portion of the instrument, included in the

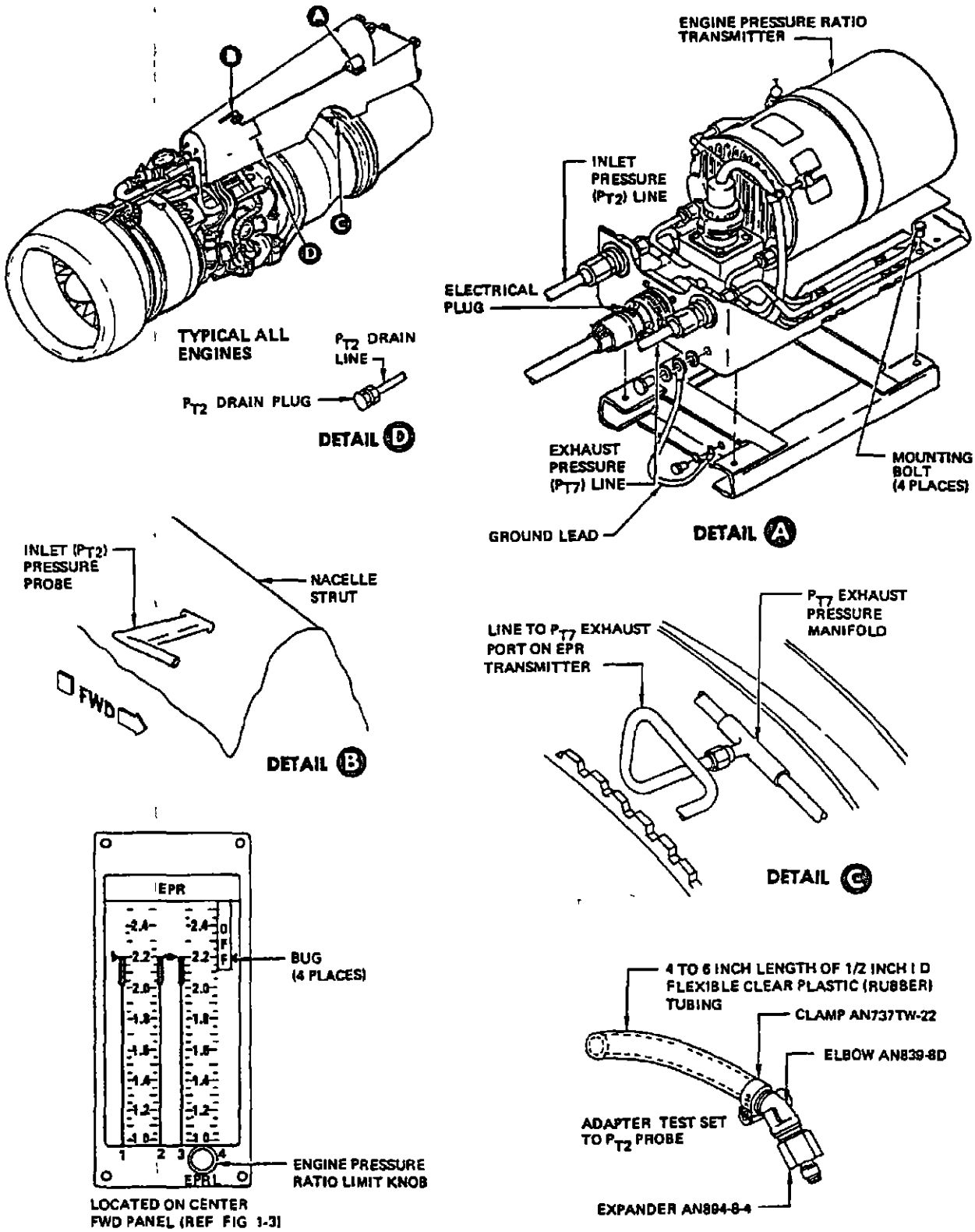




VIEW 1

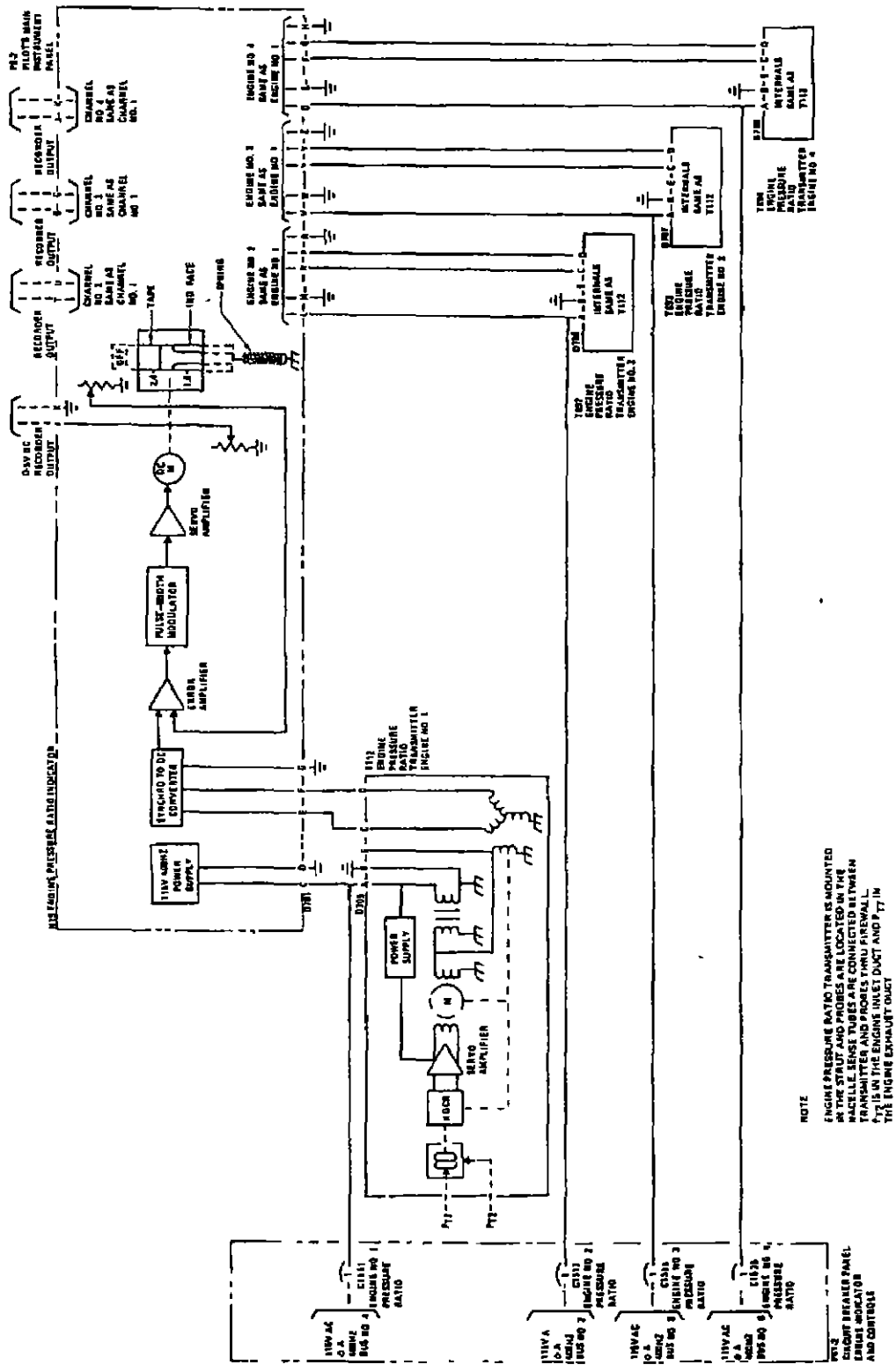
CENTER INSTRUMENT PANEL

Engine Pressure Ratio Indicating System Component Location
Figure 1 (Sheet 1 of 2)



Engine Pressure Ratio Indicating Component Location System
Figure 1 (Sheet 2 of 2)

Ref. T O 1E-3A-2-31-1
Page 5-15 Change 21



Engine Pressure Ratio Indicating System Schematic
Figure 2
Ref T O 1E-3A-2-31-1
Page 5-17 Change 6

instrument are its own failure monitor circuits that sense the following

(a) Loss of primary power

(b) Signal loss

(c) Motor electrical failure

(d) Amplifier failure

(2) Failure of item (a), (c) or (d), listed above, will drive the tape down to an off scale position and the word OFF in black letters on a red back ground will appear Loss of signal (item (b) above) will cause the tape to go to bottom of the scale but the OFF flag will not appear

ENGINE PRESSURE RATIO INDICATING SYSTEM - TROUBLE SHOOTING

1 General

A Table 101 lists symptoms, probable causes, isolation procedures and corrective actions as an aid in isolating causes ofEngine Pressure Ratio Indicating System failures.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
EPR indicator inaccurate	Defective indicator		Replace indicator
	Defective transducer	Check ratio accuracy with transducer tester	Replace transducer.
	Water in Pt_2 line.	Drain Pt_2 line	
	Clogged tubing or pressure probes.	Test response of system through pressure probes with transducer tester and adapter fittings	Blow out tubing with clean dry air
	Inlet pressure probe clogged with ice	Check that anti-icing air passages are clear in pressure probe fairings.	Melt the ice and blow out probe with clean dry air
EPR indicator stationary when engine is running	EPR circuit breaker on P61-2 circuit breaker panel not closed.		Close circuit breaker.
	Defective indicator		Replace indicator
	Defective wiring or transducer	Measure 115 volt ac power on terminals pins A and B of applicable electrical connector (D705 or D706 or D707 or D708) on transducer If voltage is not present check aircraft wiring	Repair or replace wiring.
		If voltage is present this indicates a defective transducer	Replace transducer

Engine Pressure Ratio Indicating System Trouble Shooting
Table 101

ENGINE PRESSURE RATIO INDICATING SYSTEM - REMOVAL/INSTALLATION

1 EPR Transmitter - Removal (See figure 1)

A Open applicable ENGINE START & INDICATORS - ENGINE-EPR circuit breaker on P61-2 circuit breaker panel

B Open applicable nacelle strut access door L10121-03, R10121-03, L10123-03 or R10123-03

C Disconnect inlet (Pt2) and exhaust (Pt7) pressure lines at pressure connections on transmitter

D Remove four mounting bolts and turn transmitter until ground lead and electrical plug on EPR transmitter are easily accessible (approximately 30°)

E Disconnect electrical plug on EPR transmitter

F Disconnect ground lead from front of EPR transmitter

G Lift transmitter free of strut

2 EPR Transmitter - Installation. (See figure 1.)

A. Verify that applicable ENGINE START & INDICATORS - ENGINE-EPR circuit breaker in P61-2 panel is open

B Set EPR transmitter into position in strut so that electrical connections are accessible

C Connect ground lead to front of transmitter

D. Connect electrical plug to transmitter Secure with safety wire as required

E Reposition transmitter and start B-nuts for inlet (Pt2) and exhaust (Pt7) pressure lines to pressure connections on transmitter Tighten only finger tight

F Install four mounting bolts to attach transmitter to bracket

G Finish tightening inlet (Pt2) and exhaust (Pt7) B-nuts

H Close applicable access door.

I. Perform EPR accuracy check (See pages 506 and 507)

J During next engine run, verify that the applicable EPR indicator tape is functioning Perform a leak check if necessary per paragraph

3 EPR Indicator Removal (See figure 1)

A Open four ENGINE START & INDICATORS - ENGINE-EPR circuit breaker on P61-2 panel

CAUTION THE ENGINE PRESSURE RATIO (EPR) TRANSDUCER IS EXTREMELY SENSITIVE TO ANY SUDDEN SHOCK. HANDLE TRANSDUCER CAREFULLY AND DO NOT DROP

B Remove the four retaining screws on face of indicator and carefully pull out indicator until electrical connector becomes accessible.

C. Disconnect electrical connector from indicator and place protective caps on connector

4 EPR Indicator Installation. (See figure 1)

A Verify that four ENGINE START & INDICATORS - ENGINE-EPR circuit breakers on P61-2 panel are open

CAUTION THE ENGINE PRESSURE RATIO (EPR) TRANSDUCER IS EXTREMELY SENSITIVE TO ANY SUDDEN SHOCK HANDLE TRANSDUCER CAREFULLY AND DO NOT DROP

B Remove protective cap from electrical connector and connect electrical connector to indicator

C Insert EPR indicator through front of P9-2 panel and secure with the four retaining screws

D Perform EPR accuracy check. (See pages 502)

E During the next engine run, verify that the EPR indicator tape are functioning

ENGINE PRESSURE RATIO INDICATING SYSTEM - ADJUSTMENT/TEST

Part No Or Type Designator	Figure And Index No	Nomenclature	Use And Application
Equivalent tools or test equipment are authorized for use unless Identified by a no substitute notation			
TOOLS			
None			
TEST EQUIPMENT			
TTU-205E		Pressure Temperature Test Set	Supplies, measures, and controls pressure, used for pitot static and EPR system test
26800 Airsearch		Pressure Ratio Tester	To check EPR transmitter leakage and accuracy
AN/PSM-6 (Simpson 260)		Multimeter	To check EPR transitter voltage
4 to 6 inch length clear flexible plastic (rubber) tubing (Local Purchase)		Adapter, Test Set to Pt2 Probe	To connect Pressure Ratio Tester to Pt2 probe
AN737TW-22 (Local Purchase)		Clamp	To secure clear flexible tubing to elbow
AN839-8D		Elbow	To connect flexible tubing to expander.
AN894-8-4		Expander	To connect adapter, test set to Pt2 probe (flexible tubing to Pressure Ratio Tester) hose
AN815-4J (Local Purchase)		Union	To check EPR transmitter leakage and accuracy

Engine Pressure Ratio Indicating System Tools and Test Equipment
Table 501
Ref DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

1. General

A Tools And Test Equipment.

(1) Refer to table 501 for a listing of the required tools and test equipment

(2) There are no consumables required for this system.

B Operational Checkout

(1) The engine pressure ratio system tubing and transmitter on each engine must be checked for leakage as follows before performing an accuracy check

C EPR System Leakage Check Using TTU- 205 Test Set

WARNING DO NOT OPERATE TTU-205 TEST SET UNSHELTERED FROM A RAIN ENVIRONMENT.

WHEN CONNECTED DIRECTLY TO AN EXTERNAL POWER SOURCE, ENSURE TEST SET IS PROPERLY GROUNDED TO POWER UNIT AS A POTENTIAL ELECTRICAL SHOCK HAZARD TO PERSONNEL AND EQUIPMENT MAY EXIST.

ENSURE TEST SET IS TURNED OFF BEFORE ELECTRICAL HOOKUP

CAUTION· PERMANENT DAMAGE TO EPR TRANSMITTER MAY OCCUR IF THE MAXIMUM PT7 (PITOT PRESSURE) EXCEEDS 750 KNOTS (70 INCHES OF MERCURY ABSOLUTE)

TO PREVENT DAMAGE TO THE TTU-20S TEST SET, OBSERVE THE FOLLOWING CAUTIONS

ENSURE THAT TTU-205 ALTITUDE INDICATION DOES NOT DROP BELOW -1,Q00 FEET ALTITUDE FEET ALTITUDE AND SO KNOTS AIRSPEED.

KEEP PT2 (STATIC PRESSURE) OPENINGS CLOSED UNTIL COMPLETION OF TEST AND TESTER IS STABILIZED AT AMBIENT PRESSURE

BEFORE TURNING OFF TEST SET, SET TO FIELD ELEVATION AND SO KNOTS AIRSPEED

(1) Open access door on the left-hand side of the nacelle strut to gain access to EPR transmitter. Open left or right side cowling to gain access to exhaust pressure tubing connections.

Ref DRW CDRL 43/44 Issue D Dated May 19/89
Paragraph 7 30

(2) Remove Pt2 drain cap

(3) Disconnect inlet pressure (Pt2) tubing from transmitter INLET port Disconnect tubing from the exhaust pressure (Pt7) manifold and from transmitter EXHAUST port If there is evidence of water contamination, blow lines out vvith clean dry air, applying air pressure from transmitter end of tubing

(4) Reconnect inlet pressure tubing and exhaust pressure tubing to transmitter

(5) Apply two wraps of 1/2-inch side flexible tape around Pt2 pressure probe to seal forward and rear ports

(6) Visually check EPR transducer tubing for chafing and security Move EPR transducer about on mount to check for chafing of tubing and security of mount

(7) Set up TTU-205 test set

(a) Locate test set on a horizontal surface (±10°).

(b) Open PRESSURE EQUALIZER valve on outside of case and remove cover

(c) Set POWER switch to OFF

CAUTION DO NOT CONNECT PITOT PRESSURE TO PT2 LINE THIS COULD DAMAGE EPR TRANSMITTER

(d) Connect STATIC PRESSURE hose of test set to P12drain Use AN816-6 union or equivalent adapter between test set hose and Pt2 drain

(e) Connect PITOT PRESSURE hose to Pt7 exhaust pressure tubing at manifold (use AN815-4 union or equivalent) and to test set

(f) Connect ground wire between test set and electrical power source

(g) Connect test set to 115V 400 Hz power source

(h) Close STATIC PRESSURE VENT and PITOT PRESSURE VENT valves

(i) Set NORMAL/READ EXT switch to NORMAL

(j) Set ALTITUDE HOLD switch to NORMAL

(k) Set ALTITUDEX lOOO FEET control to 10.

(l) Center ALTITUDE TRIM control (5 turns total)

Ref. DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

(m) Set ALTITUDE RATE X 1000 FEET/MINUTE to 10

(n) Set AIRSPEED KNOTS control to 50

(o) Center AIRSPEED TRIM control

(p) Set AIRSPEED RATE KNOTS/MINUTE control to 200

(q) Set LEAK TEST AIS and ALT switches to OFF

(r) Set MACH LIMIT SET control to 1.24

(s) Set MACH LIMIT switch to NORMAL

(t) Set MODULATION AMPLITUDE control to 0.

(u) Set MODULATION FREQUENCY HZ control to OFF.

(v) Set POWER switch to ON and check POWER light illuminated.

(w) Check MACH LIMIT DISABLED light out.

(x) Check LEAK TEST ALT and A/S lights out

(y) Check ALTITUDE HOLD light out.

(z) Check READ EXT light out and NORMAL light illuminated

(8) Allow 10 minutes for TTU-205 test set to warm up

(a) Check STATIC PRESSURE and PITOT PRESSURE READY lights illuminated and WARNING INDICATORS lights out

(b) Check ALTITUDE and AIRSPEED indicators stable as set

(9) Slowly rotate ALTITUDE X 1000 FEET control to 0, SEAL LEVEL and allow ALTITUDE indicator to stabilize on reading

(10) Slowly rotate ALTITUDE X 1000 FEET control to 36 and allow ALTITUDE indicator to stabilize on reading.

(11) Set LEAK TEST ALT switch to ON

(a) LEAK TEST ALT light illuminated

(b) STATIC PRESSURE READY light out

(c) Allow ALTITUDE indicator to stabilize.

Ref.: DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7.30

(d) ALTITUDE indicator should not decrease more than 830 feet in 5 minutes (or 155 feet in one minute)

(12) Set LEAK TEST ALT switch to OFF

(a) LEAK TEST ALT light out.

(b) Allow STATIC PRESSURE READY light to illuminate

(13) Set ALTITUDE X 1000 FEET control to 0, SEA LEVEL and allow ALTITUDE indicator to stabilize on reading

(14) Set AIRSPEED KNOTS control to 750, and allow AIRSPEED indicator to stabilize on reading

(15) Set LEAK TEST A/S switch to ON

(a) LEAK TEST A/X light illuminated

(b) PITOT PRESSURE READY light out

(c) Allow AIRSPEED indicator to stabilize

(d) AIRSPEED indicator should not decrease more than 2 knots in 5 minutes (4 knots in one minute)

(16) Set LEAK TEST A/S switch to OFF

(a) LEAK TEST A/S light out

(b) Allow PITOT PRESSURE READY light to illuminate.

(17) Set AIRSPEED KNOTS control to 50 and allow AIRSPEED indicator to stabilize

NOTE. If accuracy check is to be performed, omit steps 18 through 25

(18) Set ALTITUDE X 1000 FEET control to ambient pressure altitude and allow ALTITUDE indicator to stabilize on reading

(19) Set POWER switch to OFF

(20) Slowly open STATIC PRESSURE VENT and PITOT PRESSURE VENT values

(21) Disconnect TTU-205 test set hoses and cables

(22) Remove adapters from Pt2 and Pt7 lines

Ref DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

(23) Install Pt2 draing cap, reconnect exhaust pressure tubing to the Pt7 manifold on engine

(24) Secure B-nuts with safty wire as required.

(25) Remove tags from Pt2 probe

(26) Install nacelle strut doors and close panels

D EPR Accuracy Check Using TTU-205 Test Set.

NOTE A leakage check must be performed before the following accuracy check

(1) Provide electrical power and verify that the applicable engine EPR circuit breakers are closed.

(2) Using the TTU-205 tester, set the tester ALTITUDE and AIRSPEED indicators to the values specified below When the test indicators are stable on each specified setting, the applicable cockpit EPR indicator must indicate the corresponding pressure ratio.

ENGINE Pt2 PRESSURE (TTU-205 ALTITUDE)	ENGINE Pt7 PRESSURE (TTU-205 AIRSPEED)	EPR INDICATOR PRESSURE RATIO INDICATION
FEET (PSIA)	KNOTS (PSIA)	
-74 (14 73)	744 8 (32 42)	2.20 (± 010)
-74	692 5 (29 47)	2 00 (± 010)
-74	518 6 (22.10)	1 50 (±.010)
35,140(03 44)	432 1 (08.35)	2 43 (±.010)
35,140 (Ref step 3)	367 7 (06 88)	2 00 (± 010)
35,140	264 8 (05 16)	1.50 (± 010)

(3) With test set holding EPR indicator at a reading of 2 00

(a) Note exact reading of EPR indicator

(b) Open applicable engine EPR circuit breaker.

(c) Applicable EPR indicator OFF flag should be displayed

(d) Close circuit breaker.

(e) EPR indicator should read the noted reading within ±0 01 units

Ref : DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

(4) Open EPR circuit breakers (P61-2 panel).

(5) Set ALTITUDE X 1000 FEET control to ambient pressure altitude and allow ALTITUDE indicator to stabilize on reading

(6) Set AIRSPEED KNOTS control to 50 and allow AIRSPEED indicator to stabilize

(7) Set POWER switch to OFF

(8) Slowly open STATIC PRESSURE VENT and PITOT PRESSURE VENT valves

(9) Disconnect TTU-205 test set hoses and cables

(10) Remove adapters from Pt2 drain cap and Pt7 lines.

(11) Install Pt2 drain cap, reconnect exhaust pressure tubing to the Pt7 manifold on the engine.

(12) Secure B-nuts with safety wire as required

(13) Remove tape from Pt2 probe

(14) Install nacelle strut doors and close cowl panels

(15) Remove electrical power, if no longer required for other maintenance

Ref DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

EXHAUST PRESSURE SENSING PROBES AND MANIFOLD - MAINTENANCE PRACTICES

1. Removal/Installation Exhaust Pressure Sensing Probes and Manifold

   A. Remove Exhaust Pressure Sensing Probes and Manifold (See figure 201.)

      (1) Remove side cowl panels. Refer to "Cowl Panels," Chapter 71.

      (2) Disconnect clamps securing manifold to turbine case flange.

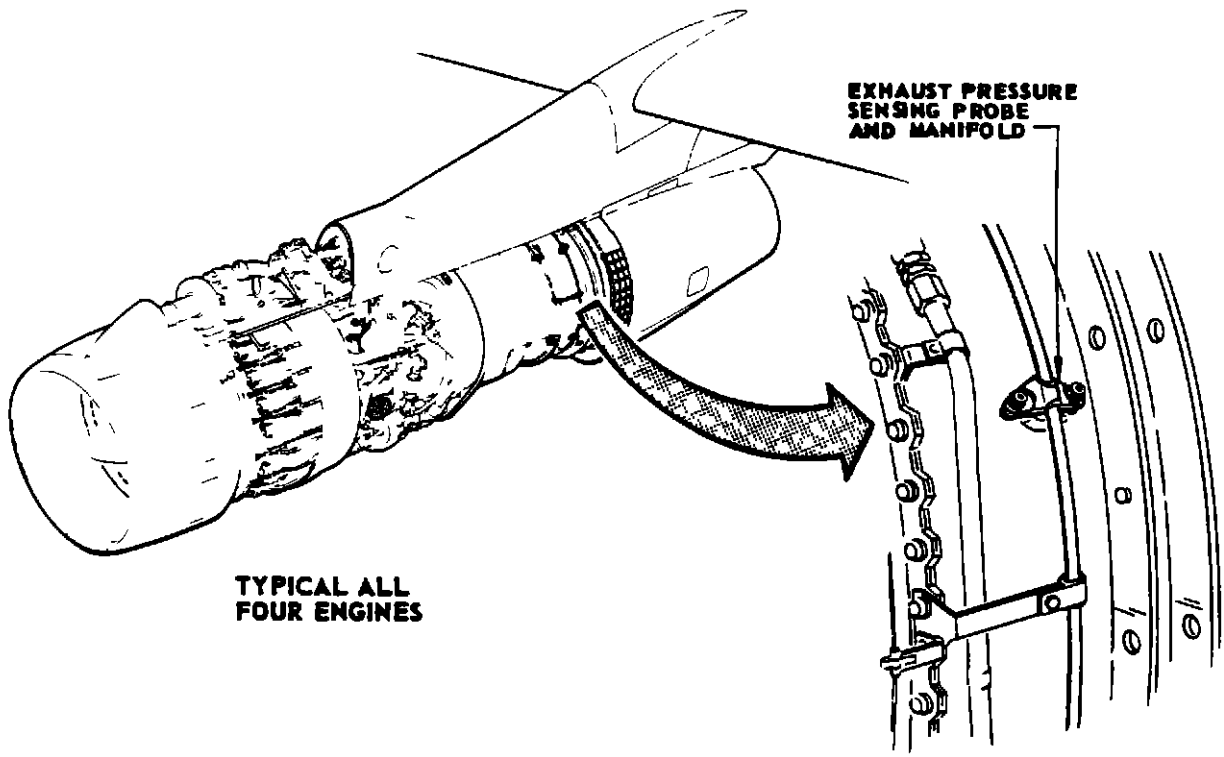
      (3) Disconnect manifold union nuts at 6 o'clock and 12 o'clock.

      (4) Disconnect branch line union nut at approximately 5 o'clock.

      (5) Remove probe mounting bolts and pull either left or right manifold section free of engine.

      (6) Repeat with other section of manifold.

      (7) Remove probes from housings in exhaust casing.



Exhaust Pressure Sensing Probe and Manifold Installation
Figure 201

B. Install Exhaust Pressure Sensing Probes and Manifold (See figure 201.)

(1) Insert probes into housings around exhaust casing.

(2) Position one section of exhaust pressure sensing manifold around periphery of engine turbine chamber.

(3) Install probe mounting bolts and secure with locknuts.

(4) Repeat procedure for opposite manifold section.

(5) Tighten union nuts joining both halfs of sensing manifold together.

(6) Connect clamps securing manifold to turbine case flange.

(7) Tighten union nut joining branch line to manifold assembly.

(8) Install side cowl panels. Refer to "Cowl Panels," Chapter 71.

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - DESCRIPTION AND OPERATION

1. Description

A. The engine exhaust gas temperature (EGT) indicating system has twelve thermocouple elements enclosed in six probes arranged around the engine exhaust housing The one vertical scale indicator, located on the pilot and copilot center panel, has four separate tapes (scales), one for each engine

2 Exhaust Gas Temperature Thermocouples

A The heat of the engine exhaust gas causes the thermocouples to generate a dc millivolt output that is transmitted to the signal conditioning circuit card of the EGT indicator and amplified to a maximum of 5-volt, dc signal (See figure 2) One part of the exhaust gas temperature thermocouple harness averages the electrical output from the six thermocouples by combining the individual signals in a parallel circuit which supplies the exhaust gas temperature indicator The remaining wires in the harness take signals from the six other thermocouples to a test receptacle on the fireseal at the right side of the engine This receptacle is capped off and the circuit is used for engine test purposes only

3 Exhaust Gas Temperature Indicator

A The EGT vertical scale indicator (figure 1) employs four double-ended tapes (scales) attached at one end to precision tape drive reels that are powered by dc torque motors The tapes are connected at the other end to low torque spring return mechanisms The system provides a direct mechanical link between the tape and torque drive, which is coaxially mounted with a servo feedback pot to provide a servo mechanism (See figure 4) Indicator power is provided by four 1-amp circuit breakers on the P61-2 panel. All electronics are located in the rear portion of the instrument; included in the instrument are its own failure monitor circuits that sense the following

(1) Loss of primary power

(2) Signal loss

(3) Motor electrical failure

(4) Amplifier failure

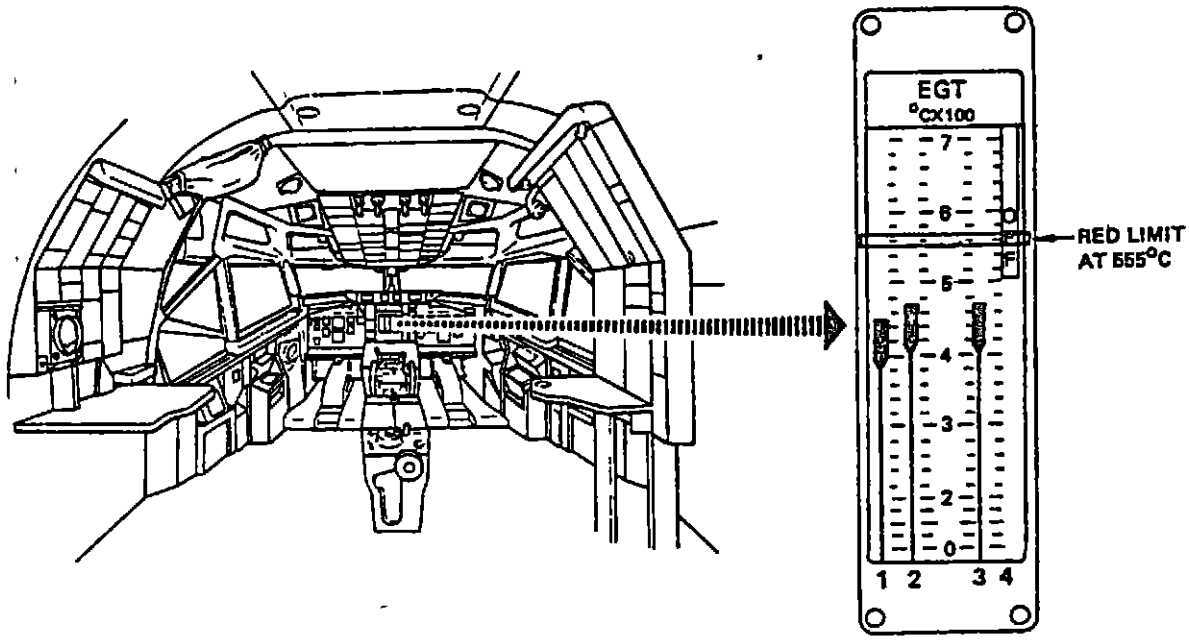
B Failure of items (1), (3) or (4), listed above, will drive the tape down to an off scale position and the word OFF in black letters on a red background will appear Loss of signal (item (2) above) will cause the tape to go to bottom of the scale but the OFF flag will not appear

C. A 0-5 volt dc output from the EGT indicator provides auxiliary signals to the multiplexer portion of the CPI/FDR (crash position indicator/flight data recorder)

4. Exhaust Gas Temperature Thermocouple Harness and Lead

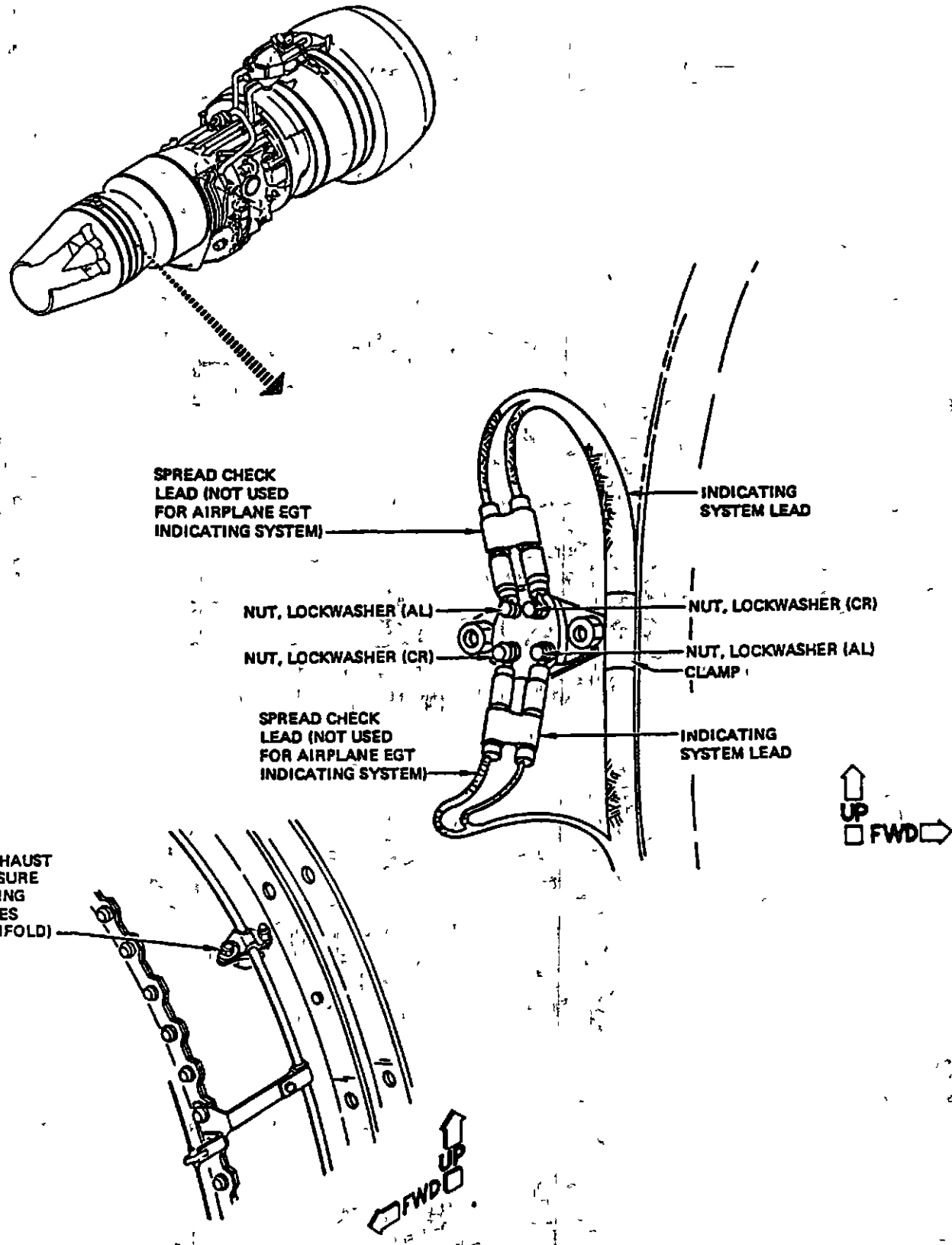
A. One part of the exhaust gas temperature thermocouple harness averages the electrical output from six thermocouples by camining the individual signals in a parallel circuit which supplies the exhaust gas temperature indicator The remaining wires in the harness take signals from the six other thermocouples to a test receptacle on the fireseal at the right side of the engine This receptacle is capped off and the circuit is used for test purposes only

B The thermocouple harness consists of a flexible electrical conduit mounted on the outer circumference of the engine exhaust housing The harness has a two-wire averaging circuit lead fastened to the engine with clips and routed for ward through the engine fireseal to an electrical disconnect plug located at the engine strut firewall. A second outlet from the thermocouple harness terminates at the electrical teet receptacle located at 5 o'clock on the engine fireseal



Exhaust Gas Temperature Indicator
Figure 1

Ref. T O 1E-3A-2-31-1
Page 5-6 Change 2



EGT Thermocouple
Figure 2 (Sheet 1 of 2)
Ref.: T.O. 1E-3A-2-31-1
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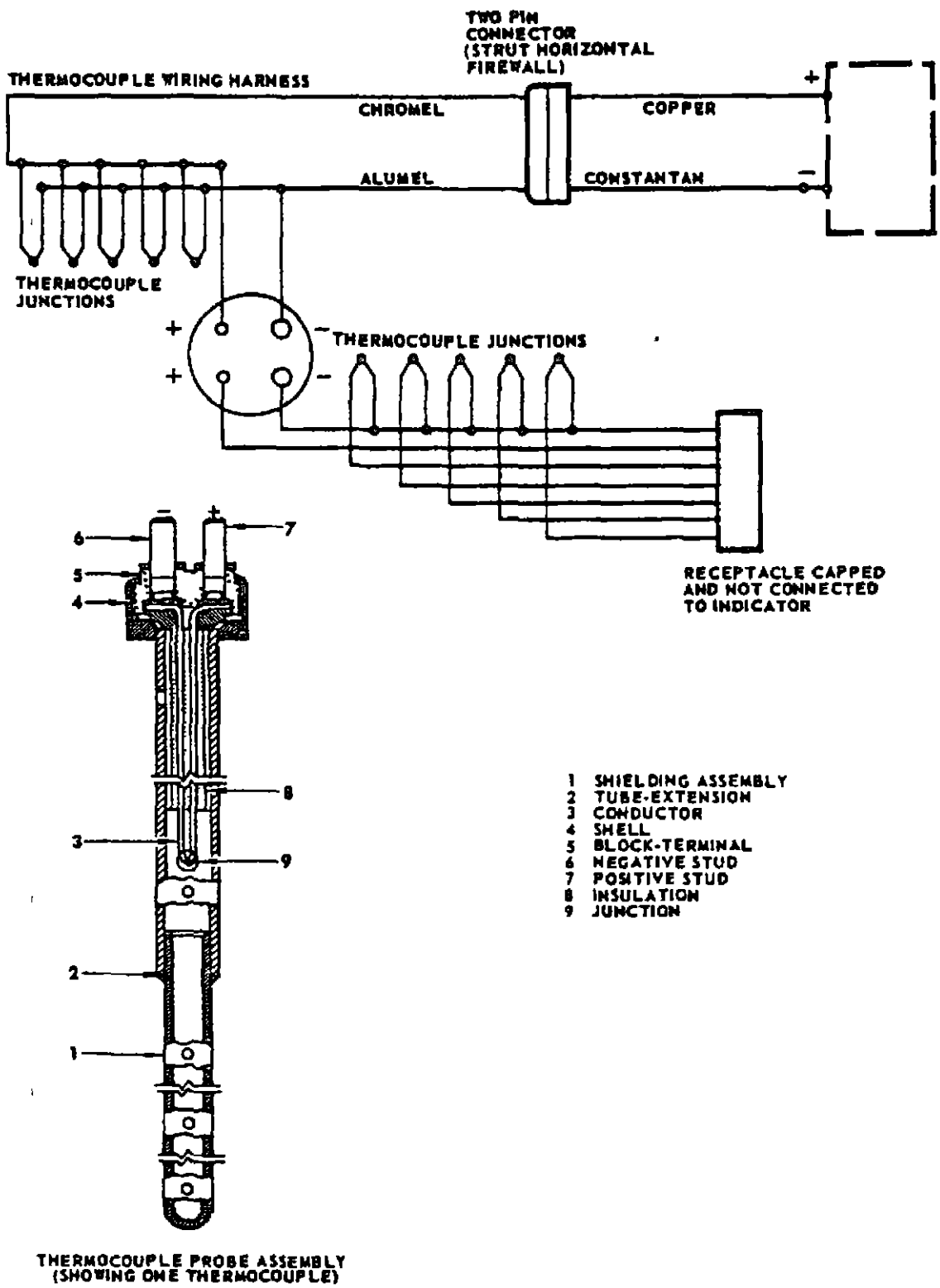


EGT Thermocouple
Figure 2 (Sheet 2 of 2)

Ref MM 707 Chapter 77-16-0
Page 4 dated May 15/63

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - TROUBLE SHOOTING

1 General

A Table 101 lists symptoms, probable causes, isolation procedures and corrective actions as an aid in isolating causes of Exhaust Gas Temperature Indicating System failures.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
No indication on aircraft indicator	Defective indicator.	Test indicator with jetcal analyzer	Replace defective indicator
	Defect in aircraft wiring	Inspect wiring for breaks, loose or incorrect connections Check circuit for grounds	Repair or replace wiring
	Defective thermocouples	Isolate thermocouples at terminal (T999) and check with jetcal analyzer	Replace defective thermocouples
High or low indication on indicator	Defective thermocouple or thermocouples	Isolate thermocouples at terminal (T999) and check with jetcal analyzer	Replace defective thermocouples
	Defective indicator	Isolate indicator an cneck with jetcal analyzer.	Replace indicator if required

Exhaust Gas Temperature Indicating System - Trouble Shooting
Table 101

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - REMOVAL/INSTALLATION

1 EGT Thermocouple Removal. (See figure 2)

A Open appropriate ENGINE START & INDICATORS - EGT & RPM (N1) circuit breaker on P61-1 panel

B Obtain access to thermocouples by opening engine side cowls

C Remove engine wiring harness leads from thermocouple.

D. Remove two bolts and locknuts that fasten thermocouple to turbine exhaust case and pull thermocouple free from engine

2 EGT Thermocouple Installation. (See figure 2)

A. Verify that appropriate ENGINE START & INDICATORS - EGT & RPM (N1) circuit breaker on P61-2 panel is open

B Place thermocouple in its hole on circumference of turbine exhaust case

C Secure thermocouple to case with its two bolts and locknuts, placing harness supporting bracket on forward bolt Tighten bolts to a torque of 45 (+5) inch-pounds

D Secure harness to thermocouple with its nuts and lockwashers. Tighten smaller nuts to a torque of 15 (+1) inch-pounds Tighten larger nuts to a torque of 22 (+3) inch-pounds

E Close and latch engine side cowls

F Reset circuit breakers called out in step A

G During next engine run, verify that the applicable EGT indicator tape is functioning

3 EGT Indicator Removal (See figure 1)

A. Open applicable ENGINE START & INDICATOBS - EGT & RPM (N1) circuit breaker on P61-2 panel

B Remove the four round-head screws on face of indicator and carefully pull out indicator until connector is accessible

C. Disconnect electrical connector from indicator and place protective cap on wire connector

4 EGT Indicator Installation (See Figure 1.)

A. Verify that applicable ENGINE START & INDICATORS - EGT & RPM (N1) circuit breaker on P61-2 panel is open.

B Remove protective cap from electrical connector and connect electrical connector to indicator.

C Carefully insert EGT indicator through front of P9-2 panel and secure with the four retaining screws.

D Reset circuit breaker called out in step A.

E During the next engine run, verify that the applicable EGT indicator is functioning.

EXHAUST GAS TEMPERATURE INDICATING SYSTEM - ADJUSTMENT/TEST

1 EGT SYSTEM

A. Tools And Test Equipment.

(1) Refer to table 501 for a listing of the required tools and test equipment

Part No Or Type Designator	Figure And Index No	Nomenclature	Use And Application
Equivalent tools or test equipment are authorized for use unless Identified by a no substitute notation			
TOOLS			
GG-W-00686 Type II, Class 1, Style A		Torque Wrench (0-150 inch-pounds)	Tighten nuts on EGT thermocouple harness
TEST EQUIPMENT			
H119M Howell		Jetcal Tester	To check EGT indicating system
AN/PSN-6 (Simpson 260)		Multimeter	To check EGT indicating system

Exhaust Gas Temperature Indicating System Tools and Test Equipment
Table 501

Ref · DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

B Operational Checkout.

(1) The H119M jetcal tester is used to check the EGT indicating system

C Jetcal Calibration Check

(1) Prior to use, the tester must be checked Internally generated temperature, RPM signals, and barometric pressure are used to check the accuracy of the tester as follows.

WARNING WHEN CONNECTED DIRECTLY TO AN EXTERNAL POWER UNIT, ENSURE TEST SET IS PROPERLY GROUNDED TO POWER UNIT AS A POTENTIAL ELECTRIC HAZARD TO PERSONNEL AND EQUIPMENT MAY EXIST

(2) Set FUNCTION SELECTOR SWITCH to OFF

(3) Connect the power inlet cable to POWER CABLE receptacle and to a 115-volt, 50-400-HZ power source.

(4) Set FUNCTION SELECTOR SWITCH to TRIM-T/C Allow a 10-minute warmup period

(5) Set TEMP SWITCH to CAL 600-C position The tester TEMP indicator should read 600 degrees C

(6) Set RPM SWITCH to CAL 100% position The tester ROM indicator should read 100.0 percent

(7) Contact the tower to obtain the local barometric pressure

(8) Set PRESSURE SWITCH TO CAL BAROMETRIC position The tester PRESSURE indicator should be adjusted to local barometric pressure

(9) Each indicator has a CAL ADJ potentiometer that may be adjusted to meet the values listed in steps 3 and 4

(10) Set TEMP SWITCH to OPERATE, RPM SWITCH to OFF and PRESSURE SWITCH to OFF.

D Thermocouple Continuity Check.

(1) Check engine thermocouple circuit continuity by heating each thermocouple independently and checking for a temperature increase on the EGT indicator as follows.

Ref.· DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7.30

WARNING WHEN CONNECTED DIRECTLY TO AN EXTERNAL POWER UNIT, ENSURE TEST SET IS PROPERLY GROUNDED TO POWER UNIT AS A POTENTIAL ELECTRIC HAZARD TO PERSONNEL AND EQUIPMENT MAY EXIST

(1) Set FUNCTION SELECTOR SWITCH ON EGT tester to OFF position

(2) Connect engine analyzer power cable (BH499A) to POWER CABLE receptacle

(3) Connector heater cable (BH405) to HEATER cable receptacle on engine analyzer and to junction box (BH361-8)

(4) Connect heater probe (BH978-70) to junction box

(5) Set TEMP INPUT SWITCH to HEATER CABLE position.

(6) Adjust PER CENT TEMP CONTROL to 0 0 percent

(7) Connect engine analyzer cable (BH499A) to a 115-volt ac, 400 Hz power source

(8) Set FUNCTION SELECTOR SWITCH to TRIM T/C position

(9) Set TEMP SWITCH to OPERATE position.

WARNING HEATER PROBES ARE EXTREMELY HOT AND SHOULD BE HANDLED WITH CARE

(10) Set PER CENT TEMP CONTROL to 100.0

(11) Provide external electrical power

(12) Establish communications

(13) Verify that applicable ENGINE and INDICATORS - EGT & RPM (N1)- ENG circuit breakers on circuit breaker panels are closed

E. EGT System Accuracy Check

(1) The accuracy check is used to test the entire EGT system by heating all engine thermocouples and comparing the temperature displayed on the aircraft temperature indicator with the heater probe temperature displayed on the jetcal TEMP indicator

WARNING WHEN CONNECTED DIRECTLY TO AN EXTERNAL POWER UNIT, ENSURE TEST SET IS PROPERLY GROUNDED TO POWER UNIT AS A POTENTIAL ELECTRIC HAZARD TO PERSONNEL AND EQULPMENT MAY EXIST

(2) Set FUNCTION SELECTOR SWITCH to OFF

(3) Set PERCENT TEMP CONTROL to 0 0

Ref : DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7.30

(4) Connect heater cable (BH405) to junction box (BH361-8) and to HEATER CABLE receptacle

(5) Connect the heater probes (BH978-70) to the junction box

(6) Connect power cable (BH499A) to POWER CABLE receptacle

CAUTION. BOTH THE HEATER PROBE AND HEATER PROBE CABLE LENGTH ARE EXTREMELY CRITICAL. THEREFORE, NEVER CHECK AN ENGINE WITHOUT FIRST DETERMINING THAT THE PROBES AND PROBE CABLE LENGTH ARE ALL IDENTICAL AND CORRECT FOR THE PARTICULAR THERMOCOUPLE. COMBINING HEATER PROBES OF DIFFERENT PART NUMBERS AND HEATER PROBES WITH CABLES OF UNEQUAL LENGTH WILL PRODUCE ERRONEOUS READINGS.

(7) Place a heater probe over each engine thermocouple The heater probes must fit firmly and be positioned properly on the thermocouples.

(8) Connect power cable (BH499A) to a 115-volt, 50-400 (±5) Hz power source

(9) Set FUNCTION SELECTOR SWITCH to TRIM-T/C, set TEMP INPUT SWITCH to HEATER CABLE, and TEMP SWITCH to OPERATE

WARNING HEATER PROBES ARE HOT AND SHOULD BE HANDLED WITH CARE

(10) Adjust PER CENT TEMP CONTROL potentiometer to 70 0 (approximately 600~C) After the test temperature has been reached, allow 10 minutes soak time to stabilize the probe temperature

NOTE The time necessary to heat and stabilize probes depends upon line voltage, ambient temperature, and air currents Some engines, after being idle for some time, collect moisture on the thermocouple terminals and extra time must be allowed for this moisture to evaporate Normally a 10 minute soak time is sufficient However, if after 10 minutes the system is not within limits, an additional 20 minutes soak time should be allowed. If the system is still not within tolerance, out-of-tolerance difference is system error

(10) If nessary, place a cover over the engine tail cone and inlet to obtain stabilization at test temperature

(11) The difference between the heater probe temperature indicated on the tester and the aircraft indicator reading is the error in the aircraft system and must not exceed ±10°C.

(12) Set PER CENT TEMP CONTROL to 0.0 percent and let heater probes cool off.

(13) Set FUNCTION SWITCH to OFF

Ref . DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

(14) Disconnect power cable from power source and remove the heater probes from engine and tester

Ref. DRW CDRL 43/44 Issue D dated May 19/89
Paragraph 7 30

EXHAUST GAS TEMPERATURE THERMOCOUPLE HARNESS AND LEAD -

MAINTENANCE PRACTICES

1. Removal/Installation Exhaust Gas Temperature Thermocouple Harness and Lead

A. Remove Thermocouple Harness and Lead

(1) Remove teflon tape from thermocouple averaging circuit connector, located forward of engine fireseal, and disconnect terminals. (See figure 201, view 1).

(2) Remove locknuts and bolts securing averaging circuit connector terminal support fitting to engine fireseal.

(3) Pulling aft on averaging circuit lead, remove terminal support fitting from engine fireseal.

(4) Remove locknuts and bolts securing test receptacle mounting bracket to engine fireseal.

(5) Remove test receptacle from mounting bracket.

(6) Pulling aft on test circuit lead, remove receptacle from engine fireseal.

(7) Disconnect thermocouple leads from probe terminals.

(8) Remove nuts and screws securing thermocouple harness and lead supporting clips.

NOTE: Tag harness and lead supporting clips being removed to assure their reinstallation in same location.

(9) Remove harness and leads.

CAUTION: IN ALL HANDLING AND STORAGE, THE HARNESS AND LEADS SHOULD BE HUNG ON A RACK OR LAID ON A CLEAN TABLE FREE OF OIL AND MATERIAL WITH WHICH IT MAY BECOME ENTANGLED. SEVERE REPEATED FLEXING AND BENDING OR TWISTING WILL BREAK OR FRAY THE EXPOSED INSULATION. IF HUNG ON A RACK, CARE MUST BE TAKEN NOT TO INTRODUCE ANY SMALL RADIUS BENDS IN ANY PART OF THE ASSEMBLY.

(10) Remove nuts and screws securing averaging circuit lead (from engine fireseal to strut firewall) supporting clips.

(11) Disconnect averaging circuit lead connector at strut firewall (See figure 201, detail A), and remove lead.

B. Install Thermocouple Harness and Lead.

(1) Position averaging circuit lead (from engine fireseal to strut firewall) on engine, and install supporting clips using screws and nuts.

(2) Connect averaging circuit connector at strut firewall.

(3) Position harness and leads on engine, and install supporting clips using screws and nuts.

(4) Connect thermocouple leads to probe terminals.

(5) Pull test receptacle forward through engine fireseal. (See figure 201, view 1.)

(6) Secure test receptacle to mounting bracket.

(7) Secure test receptacle mounting bracket to engine fireseal using bolts and locknuts.

(8) Pull averaging circuit connector terminal support fitting forward through engine fireseal. (See figure 201, view 1.)

(9) Secure averaging circuit connector terminal support fitting to engine fireseal using bolts and locknuts.

(10) Connect overaging circuit connector terminals and wrap connection with teflon tape.

CAUTION: BE SURE THERE IS ENOUGH INSULATING MATERIAL BETWEEN THE TWO SETS OF CONNECTED TERMINALS TO PREVENT SHORTING OUT THE SYSTEM.

2. Adjustment/Test Exhaust Gas Temperature Thermocouple Harness and Lead

A. Equipment and Materials

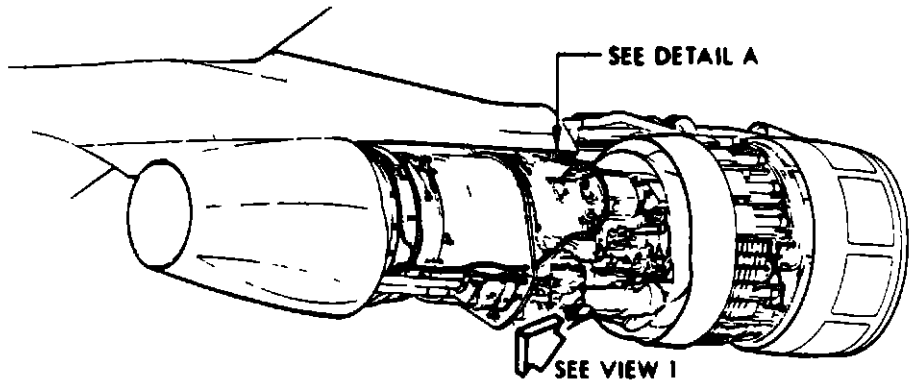
(1) Sensitive resistance measuring device - ohmmeter with a center scale value of approximately 10 ohms.

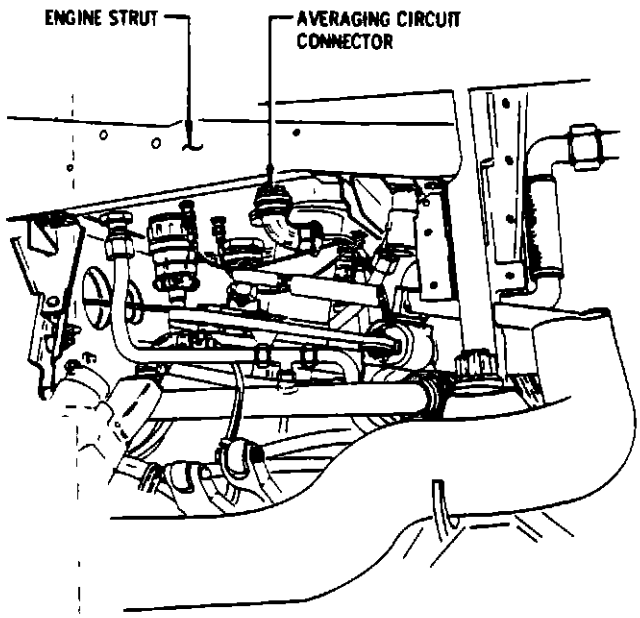
(2) Low voltage ohmmeter capable of measuring resistance of 50,000 ohms. Meter should utilize less than 40 volts (dc) and should have an accuracy of five percent.

B. Test Thermocouple Harness and Lead Resistance.

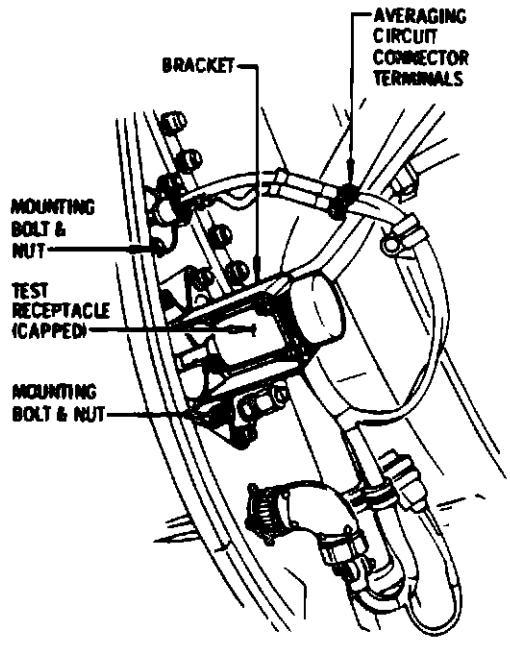
(1) Open both cowl panels on engine.

(2) Remove teflon tape from thermocouple averaging circuit connector, located forward of engine fireseal, and disconnect terminals. (See figure 201, view 1).





DETAIL A



VIEW 1

9 Jun 15/63

Exhaust Gas Temperature Thermocouple Harness and Lead Installation
Figure 201

(3) Place ohmmeter (sensitive) terminals in contact with averaging circuit fireseal connector alumel and chromel terminals (see figure 202), and measure resistance. Maximum allowable resistance is 2.05 ohms at 68°F (20°C).

(4) Remove protective cap from test receptacle.

(5) Place one ohmmeter terminal on test receptacle pin "I," other terminal on pin "A," and measure resistance. Maximum allowable resistance is 2.5 ohms at 68°F (20°C).

(6) Repeat step (5) always leaving one ohmmeter terminal on pin "I," or common pin, and placing other terminal on each chromel pin successively ("C," "D," "E," "G," "H").

(7) If resistance is not within limits, disconnect both sets of leads from thermocouple probes, and measure resistance of each thermocouple. (Resistance across thermocouple alumel and chromel terminals). Resistance of each thermocouple shall not exceed 0.250 ohms.

(8) If resistance of each thermocouple is within limits, harness and leads are faulty, and should be replaced.

C. Test Thermocouple Harness and Lead Continuity

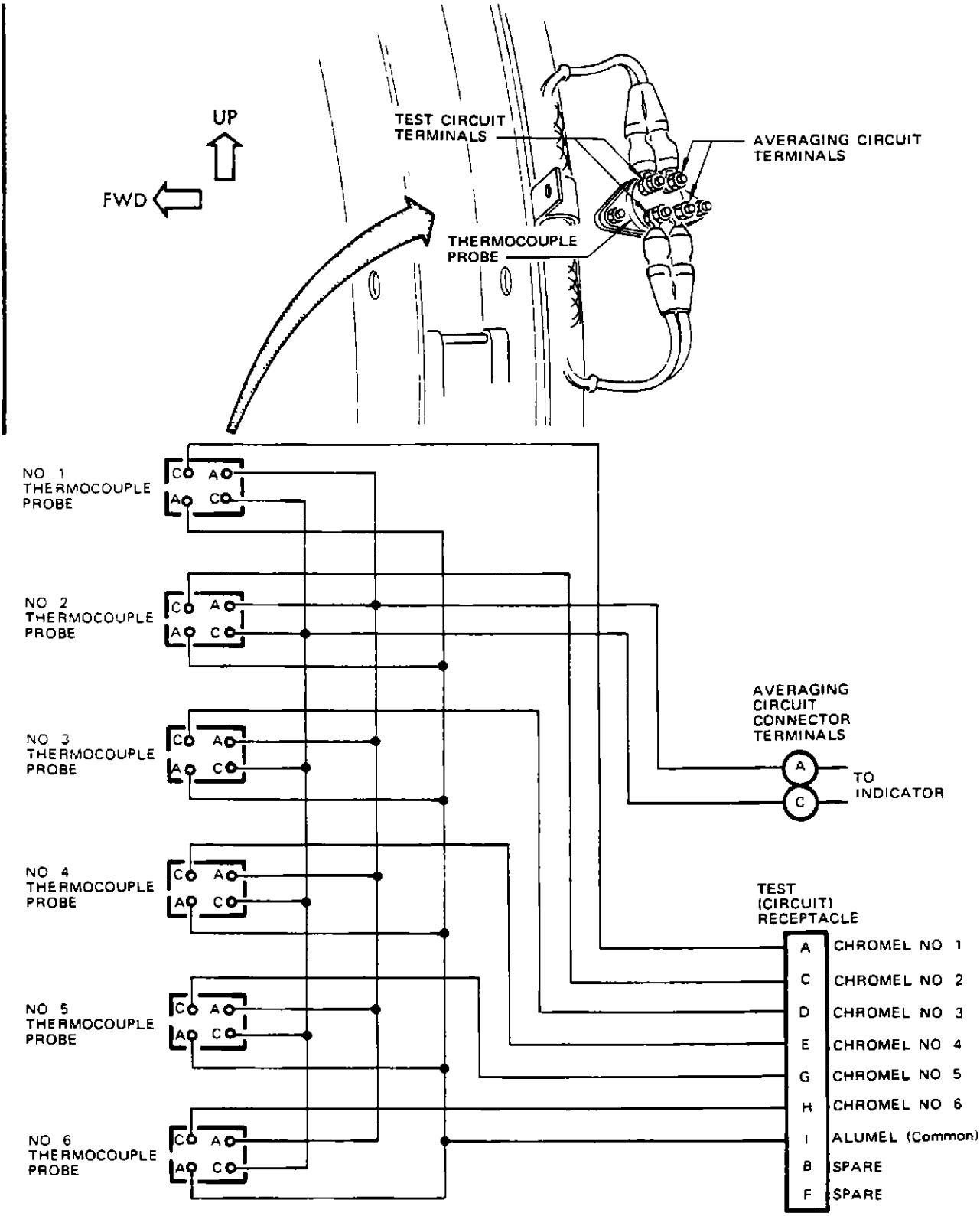
(1) Install jumper across averaging circuit connector alumel and chromel terminals.

(2) Disconnect both averaging circuit leads from thermocouple probe terminal studs on each probe if not already disconnected. Refer to figure 201.

(3) Place or clamp ohmmeter (sensitive) terminals in contact with one set of disconnected thermocouple probe lead terminals. Refer to figure 202.

(4) Flex harness and leads gently and observe instrument needle. If continuity does not exist, replace harness and leads.

NOTE: Broken wires which come in contact intermittently due to flexing will cause needle to fluctuate. False intermittent indications will result if ohmmeter terminals are not in firm contact with clean terminals, or if ohmmeter terminals or leads are defective.



Thermocouple Harness and Lead Wiring Diagram
Figure 202

(5) Repeat steps (3) and (4) for other thermocouple probes.

(6) Remove jumper from connector alumel and chromel terminals.

(7) Place one ohmmeter terminal in contact with test receptacle pin "I" and other ohmmeter terminal in contact with test receptacle pin "A."

(8) Flex harness and leads gently and observe instrument needle. If continuity does not exist, replace harness and leads. Refer to note in step (4).

(9) Repeat steps (7) and (8) always leaving one ohmmeter terminal in contact with pin "I," or common pin, and placing other ohmmeter terminal in contact with each chromel pin successively ("C," "D," "E," "G," "H").

D. Test Thermocouple Harness and Lead Insulation Resistance.

WARNING. TO REDUCE POSSIBILITY OF IGNITING FUEL, DO NOT USE A MEGGER OR OTHER HIGH VOLTAGE OHMMETER.

(1) Check averaging circuit insulation resistance between conductors by placing one ohmmeter (low voltage, high resistance) terminal in contact with connector alumel terminal, and other ohmmeter terminal in contact with chromel terminal, and measure resistance. Resistance shall not be less than 50,000 ohms.

(2) Check averaging circuit insulation resistance between conductor and ground by placing one ohmmeter terminal in contact with connector alumel terminal and other ohmmeter terminal in contact with stainless steel wire braid and measure resistance. Resistance shall not be less than 50,000 ohms.

(3) Repeat step (2) using averaging circuit chromel terminal.

(4) Disconnect both test circuit leads from thermocouple probe studs on each probe. Refer to figure 202.

(5) Check test circuit insulation resistance between conductors by placing one ohmmeter terminal in contact with receptacle pin "I" and other ohmmeter terminal in contact with each chromel pin successively and measure resistance. Resistance shall not be less than 50,000 ohms.

(6) Check test circuit insulation resistance between conductor and ground by placing one ohmmeter terminal in contact with receptacle pin "I" and other ohmmeter terminal in contact with stainless steel wire braid and measure resistance. Resistance shall not be less than 50,000 ohms.

(7) Repeat step (6) using every chromel pin in place of alumel pin "I."

(8) If resistance in any previous step was measured less than 50,000 ohms, proceed as follows: If full-scale deflection (zero ohms) was recorded, reject parts; if large (but not full-scale) deflection was recorded, presence of carbon or excessive moisture was indicated. Carbon yields a fairly steady reading. Moisture tends to produce readings which waver or drift after 5 to 30 seconds.

(9) If presence of moisture was indicated, remove harness and leads and bake at 200° to 250°F (93° to 121°C) for one hour and recheck resistance. A substantial increase in readings indicates that moisture was cause of original low values.

(10) Install harness and leads.

(11) Connect leads to thermocouple probe studs.

(12) Replace protective cap on test receptacle.

(13) Connect averaging circuit connector terminals, and wrap connection with teflon tape.

CAUTION: BE SURE THERE IS ENOUGH INSULATING MATERIAL BETWEEN THE TWO SETS OF CONNECTED TERMINALS TO PREVENT SHORTING OUT THE SYSTEM.

(14) Close engine cowl panels.

ENGINE TACHOMETER SYSTEMS - DESCRIPTION AND OPERATION

1 General

A The engine tachometer system consists of two generator units (N1 and N2) on each engine and corresponding tachometer indicators in the flight deck Tachometer system N1 indicates the speed of rotation of the low pressure compressor One N1 indicator with four vertical scales (one for each engine) is located on the pilots center panel (See figure 1) Tachometer system N2 registers the speed of rotation of the high pressure compressor Their are four (separate) indicators located on the P11 flight engineer panel All tachometer indicators depict the speed of rotation as a percentage of the maximum permissible engine speed.

2 Engine Tachometer Generator

A. The engine tachometer generators (N1 and N2) provide three-phase ac power for the operation of the indicators Each generator consists of a stator and a permanent magnet rotor The generator drive shaft turns the rotor inside the stator coils which produce an electrical signal whose frequency is a function of the engine compressor rpm This signal is transmitted to the corresponding tachometer indicator by a two-wire system, the third phase is completed by the ground. (See figure 2.) The N1 tachometer generator is located on the front compressor accessory drive and the N2 tachometer generator is located on the aft right side of the main accessory drive gearbox (See Figure 3) Each generator is driven by its respective compressor rotor through reduction bearing

NOTE The same model generator drives both the N1 and N2 indicators, but the N1 tachometer generator rotates clockwise (looking at the mounting pad) and the N2 generator rotates counterclockwise

(1) Loss of primary power

(2) Signal loss

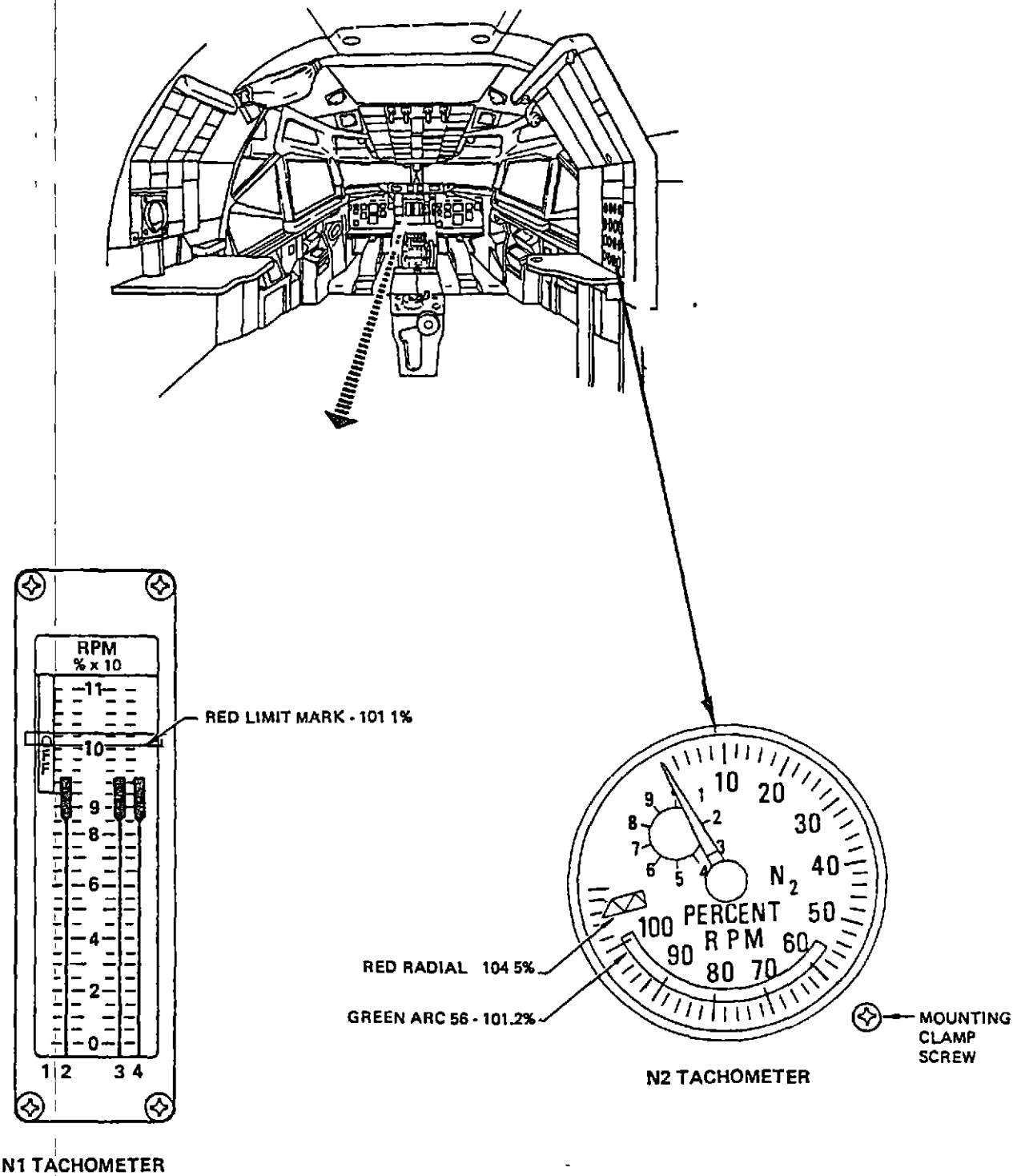
(3) Motor electrical failure

(4) Amplifier failure

B. Failure of item (1), (3) or (4) listed above, will drive the tape down to an off scale position and the word OFF in black letters on a red background will appear. Loss of signal (item (2) above) will cause the tape to go to bottom of the scale but the OFF flag will not appear

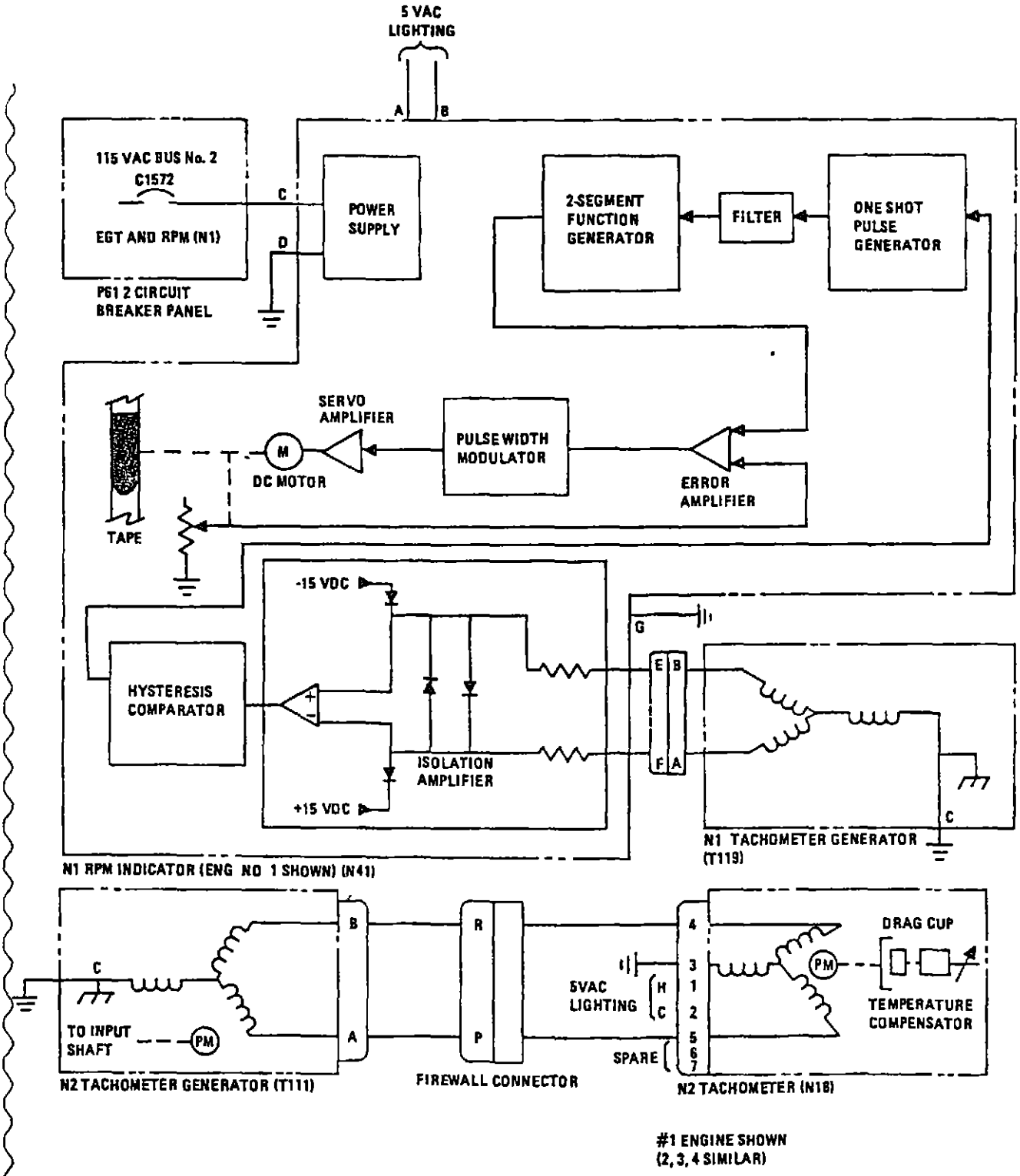
3. Engine N2 Tachometer Indicators

A. Each of the four N2 indicators, located on P11, the flight engineer panel, contains a three-phase synchro-motor driving an induction drag cup mechanism. The indicator dial is calibrated from zero to 110% (See figure 1.) Each indicator is hermetically sealed.



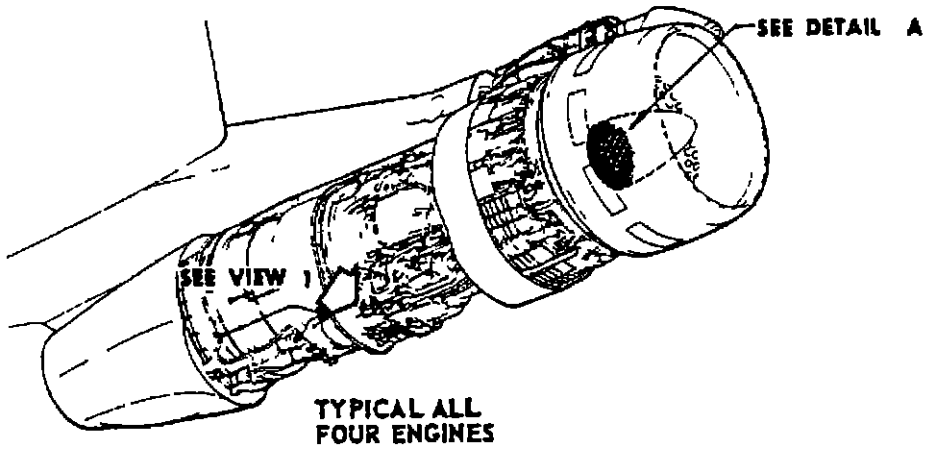
Engine Tachometer System Equipment Location
Figure 1

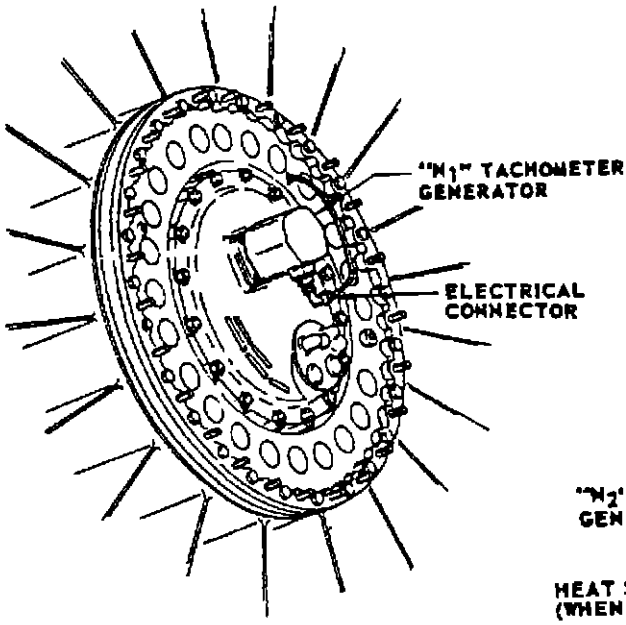
Ref T O. 1E-3A-2-31-1
Page 5-22A Change 6

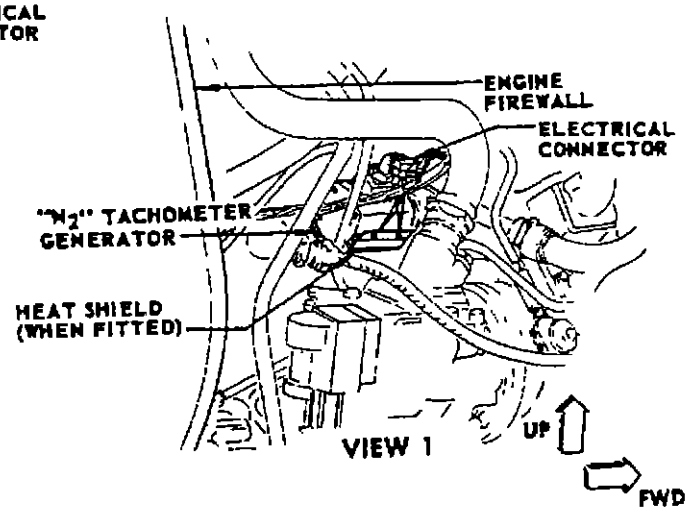


Engine Tachometer Indicating System - Schematic
Figure 2

Ref T O 1E-3A-2-31-1
Page 5-23







Engine Tachometer System - Generator Location
Figure 3
Ref : MM B 707
Chapter 77-17-1 Page 201 dated Nov 15/62

ENGINE TACHOMETER INDICATING SYSTEM - TROUBLE SHOOTING

1 General

A. Table 101 lists symptoms, probable causes, isolation procedures and corrective actions as an aid in isolating causes of Engine Tachometer Indicating System failures

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
RPM indicator reads zero rpm when engine is running.	Defective indicator	Check indicator using TTU-27/E test set	Replace indicator Replace tachometer generator
	Defective tachometer generator	If replacing indicator fails to correct the trouble, replace tachometer generator	
RPM indicator reads much less than actual engine rpm or fluctuating	Defective indicator	Check indicator reading using TTU-27/E test set	Replace indicator
	Open wire between tachometer generator and indicator	Check wiring continuity	Repair wiring
	Defective tachometer generator	If wiring is good, tachometer generator probably defective	Replace tachometer generator

Engine Tachometer Indicating System - Trouble Shooting
Tablme 101

ENGINE TACHOMETER INDICATING SYSTEM - REMOVAL/INSTALLATION

1. N1 Tachometer Generator - Removal (See figure 401)

   A Open ENGINE START & INDICATORS - EGT & RPM (N1) - ENG circuit breaker on P61-2 flight engineer circuit breaker panel for applicable engine

   B. Remove engine nose dome by loosening the six contained nuts through the small access openings

   C Disconnect electrical connector (5) from tachometer generator

   D Remove four nuts (1) and washers (2) attaching tachometer to drive pad (4)

   E. Remove tachometer generator (7) and discard gasket (3)

2 N1 Tachometer Generator - Installation (see figure 401)

   NOTE Verify that the ENGINE START & INDICATORS - EGT & RPM (N1) - ENG circuit breaker on the P61-2 panel is open

   A Place new gasket (9) on drive pad Lubricate drive shaft with (MIL-L-7808) engine oil

   B Carefully align drive shaft splines and install tachometer generator (1) on mounting pad with electrical receptacle (12) facing down

   C Install clip (11A) on lower left hand stud and install three washers and four nuts to attach generator to drive pad Tighten nuts and safety wire

   D Install electrical connector (11) on generator (1) and secure to clip (11A) with safety wire

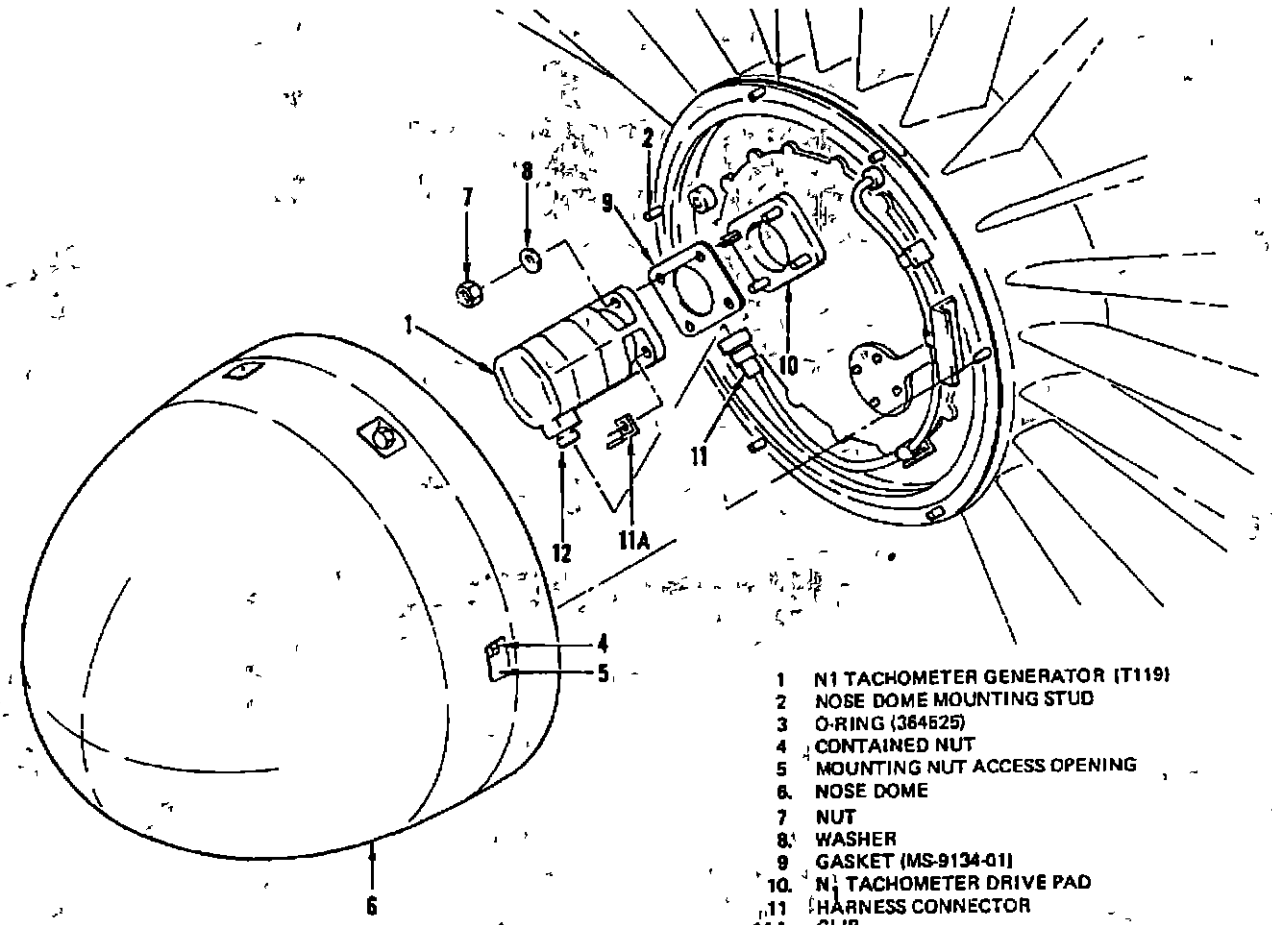
   E Lubricate O-ring (3) with (MIL-L-7808) engine oil and install on drive pad flange

   F Position nose dome (6) on drive pad flange, being careful not to dislodge the O-ring, and engage the six contained nuts (4) through the small access openings (5)

   G Tighten nuts (4) to a torque value of 120 (+20) inch-pounds

   H Close ENGINE START & INDICATORS - EGT & RPM (N1) circuit breaker on P61-2 flight engineer circuit breaker panel for applicable engine

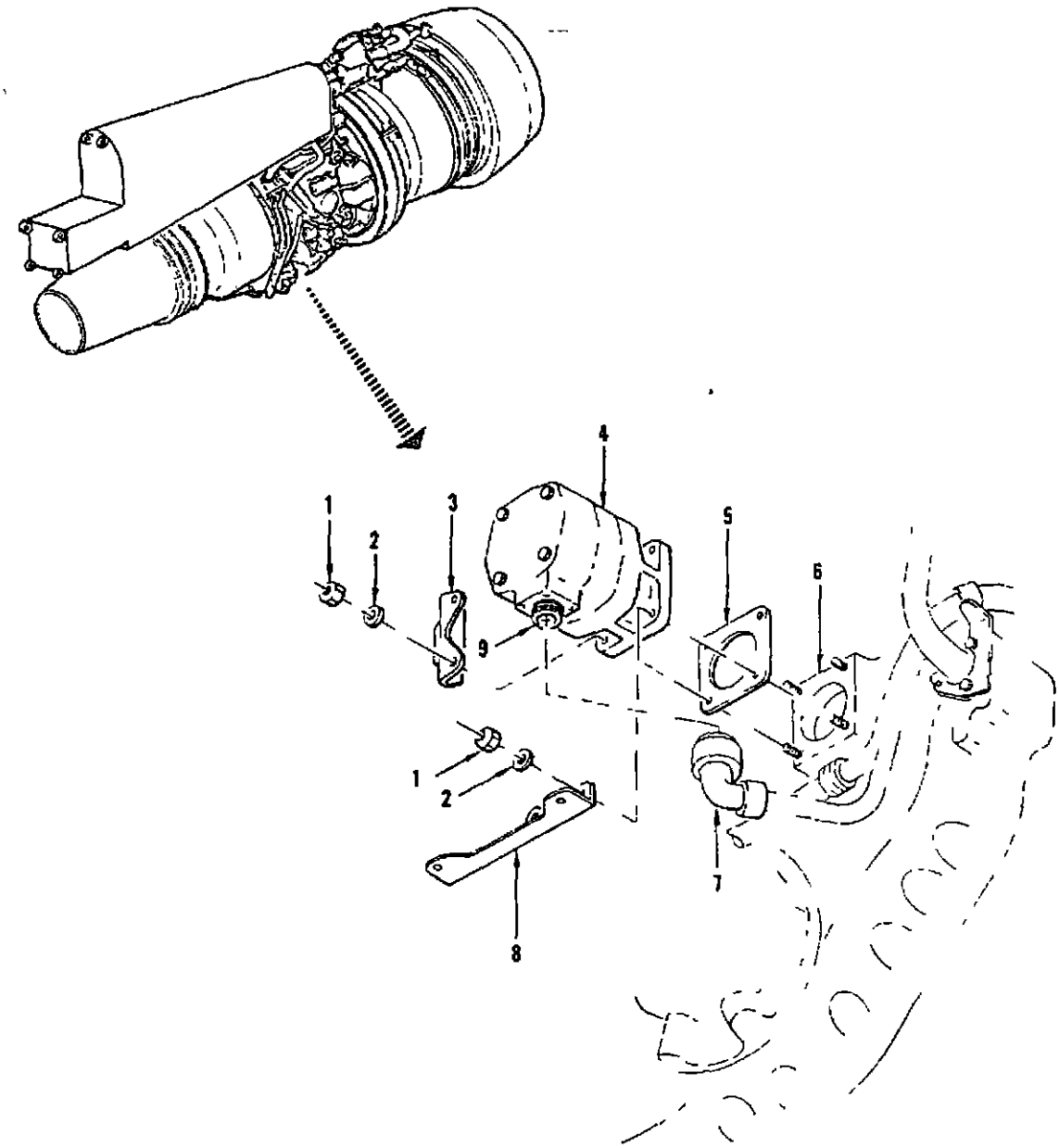
   I During next engine run, verify that applicable N1 tachometer is functioning



1 N1 TACHOMETER GENERATOR (T119)
2 NOSE DOME MOUNTING STUD
3 O-RING (364525)
4 CONTAINED NUT
5 MOUNTING NUT ACCESS OPENING
6 NOSE DOME
7 NUT
8 WASHER
9 GASKET (MS-9134-01)
10 N1 TACHOMETER DRIVE PAD
11 HARNESS CONNECTOR
11A CLIP
12 GENERATOR ELECTRICAL RECEPTACLE

N1 Tachometer Generator Installation
Figure 401

Ref : T.O 1E-3A-2-31-1
Page 5-27 Change 18



1. NUT
2. WASHER
3. OIL TANK SCUPPER DRAIN SUPPORT BRACKET
4. TACHOMETER GENERATOR(T111)
5. GASKET (MS 9134-01)
6. ACCESSORY GEARBOX PAD
7. ELECTRICAL HARNESS PLUG
8. BRACKET
9. ELECTRICAL RECEPTACLE

N2 Tachometer Generator Installation
Figure 402

Ref T O 1E-3A-2-31-1
Page 5-29 Change 2

3 N2 Tachometer Generator - Removal. (See figure 402.)

A. Open right side cowl panel

B. Disconnect engine wire harness connector (7) from receptacle (9).

C Remove four nuts (1) and washers (2)

D. Remove brackets (8) and (3)

E Remove tachometer generator (4) and discard gasket (5)

4. N2 Tachometer Generator - Installation. (See figure 402)

A. Place new gasket (5) on studs of drive pad (6) Lubricate drive shaft with (MIL-L-7808) engine oil

B Place tachometer generator on mounting pad with electrical receptacle (9) facing down. Carefully align drive shaft splines

C Position brackets (8) and (3) on mounting studs

D. Install four nuts (1) and washers (2). Tighten nuts to a torque value of 60 (±5) inch-pounds

E. Connect engine wire harness connector (7) to receptacle (9) Secure with safety wire

F. Close right side cowl panel

G During next engine run, verify that appropriate N2 tachometer is functioning

5 N1 Tachometer Indicator Removal (See figure 403.)

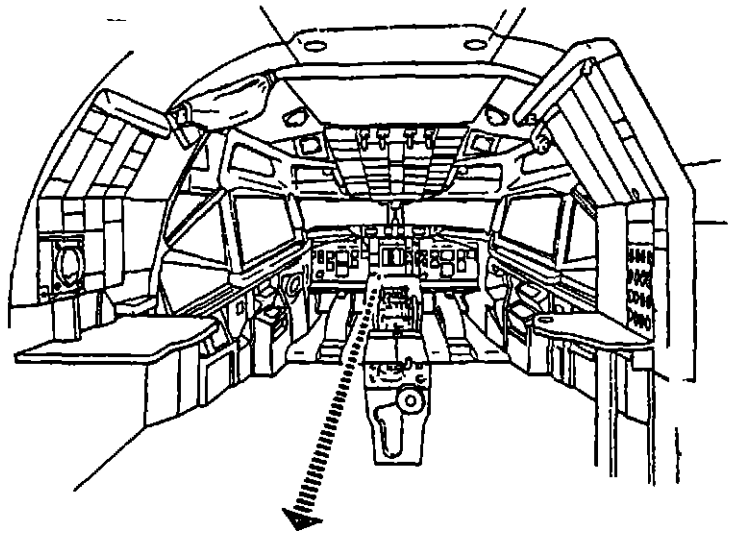
A. Open appropriate ENGINE START & INDICATORS - EGT & RPM (N1) circuit breakers on P61-2 panel

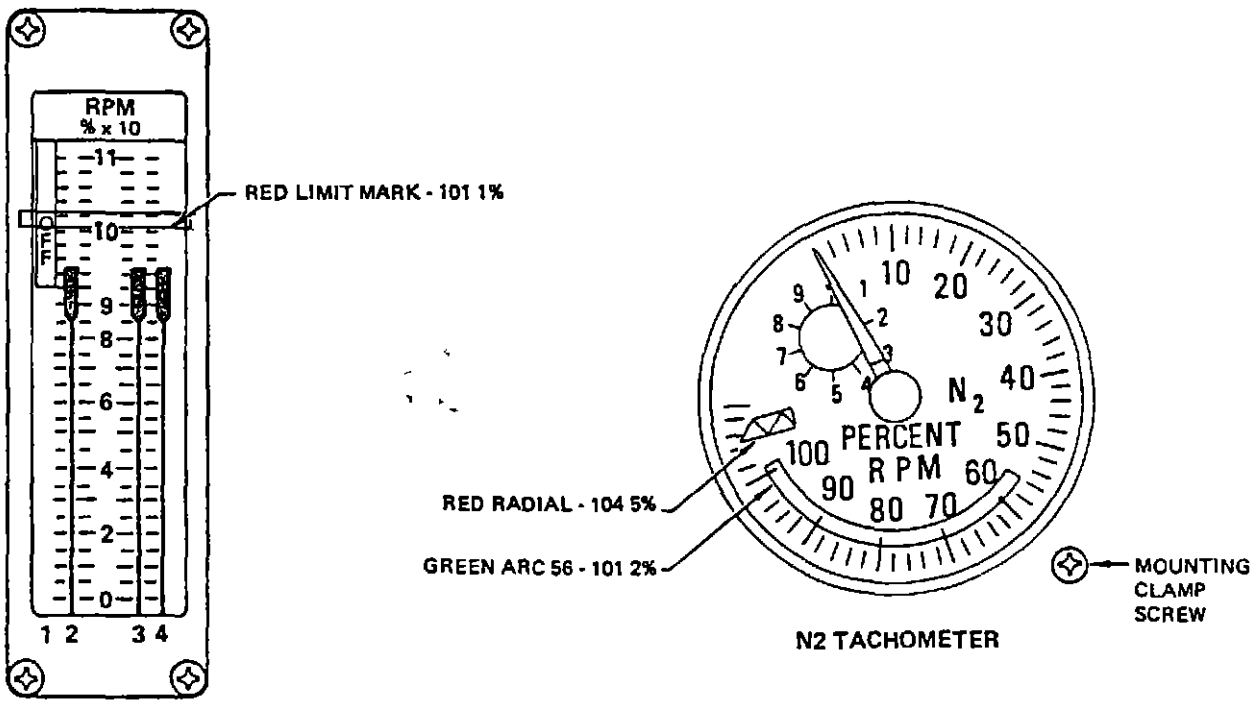
B Remove the four retaining screws on face of indicator and carefully pull out indicator until connector is accessible.

C Disconnect electrical connector from indicator and place protective cap on connector.

6 N1 Tachometer Indicator Installation. (See figure 403.)

A Verify that appropriate ENGINE START & INDICATORS - EGT & RPM (N1) circuit breakers on P61-2 panel are open





Tachometer Indicating System - Indicators Installation
Figure 403

Ref · T O. 1E-3A-2-31-1
Page 5-22A Change 6

B Remove protective cap from electrical connector and connect electrical connector to indicator.

C Carefully insert N1 indicator through front of P9-2 panel and secure with the four retaining screws

D Reset circuit breakers called out in step A

E During the next engine run, verify that the N1 indicator is functioning

7 N2 Tachometer Indicator Removal (See figure 403)

A Open FLIGHT ENGINEER INST PNL - LOWER IND R & EXT circuit breaker on P7 panel

B. Release applicable indicator retaining clamp by loosening the one round-head screw adjacent to applicable N2 indicator and carefully pull out indicator

C. Disconnect electrical connector and install protective cap.

8 N2 Tachometer Indicator Installation (See figure 403)

A Verify that FLIGHT ENGINEER INST PNL - LOWER IND R & EXT circuit breaker on P7 panel is open

B Remove protective cap from applicable N2 wiring connector and connect electrical connector to indicator

C. Carefully slide N2 indicator into P11 flight engineer panel and secure by tightening the retaining clamp round-head screw

D Reset circuit breaker called out in step A

E During the next engine run, verify that the N2 indicator is functioning

ENGINE INSTRUMENT SYSTEM - ADJUSTMENT/TEST

1. General

   A. The engine tachometer system can be tested only during engine run-up

2. Equipment and Materials

   A Master Tachometer (with calibration correction chart)

   B Adapter harness for master tachometer

3. Test Engine Tachometer System

   A Remove tachometer indicator from instrument panel

   B Using adapter harness, connect master tachometer into system in parallel with engine tachometer indicator.

   NOTE Compare reading of the engine tachometer indicator with that of the master instrument at all speeds At speeds below 95% rpm both instruments must agree within 2% rpm. At engine rpm between 95 and 102% both instruments must agree within 1%

4. N1 System

   A Tools And Test Equipment

      (1) Refer to table 501 for a listing of the required tools and test equipment

   B Operational Checkout

      (1) The N1 tachometer indicators provide their own self-test when the engines are running With engines off, the tachometer indicator (N1) can be checked on the flight line by means of a TTU-27/E test set

      (2) N1 indicator RPM check

         (a) Gain access to applicable tachometer generator

         (b) Remove safety wire and disconnect tachometer generator electrical connector

         (c) Connect applicable cable to connector. (Use 204-90057-2 for N1) Connect other end of cable to MAST GEN OUTPUT of TTU-27/E test set

Ref : DRW CDRL 43/44 Issue D dated May 19/89
Paragraphs 7 8 and 7 31

WARNING WHEN CONNENED DIRENLY TO AN EXTERNAL POWER UNIT, ENSURE TEST SET IS PROPERLY GROUNDED TO POWER UNIT AS A POTENTIAL ELECTRIC HAZARD TO PERSONNEL AND EQUIPMENT MAY EXIST

(d) Connect test set to 115 VAC, 400 (± 50 Hz power supply).

(e) Set MASTER GEN - TEST GEN switch to MASTER GEN position.

(f) Set MAST GEN OUTPUT control to its extreme clockwise position

1) Set LOAD OHMS switch and TEST GEN-MASTER GEN phase switch to OFF

2) Set MASTER INDICATOR switch ON

(g) Provide aircraft power.

(h) Select desired RPM by operating INCREASE SPEED knob

(i) Compare aircraft indicator RPM readings with test set at speeds specified below. Below 95%, the readings shall agree within 2% Above 95%, the readings shall agree within 1%

GENERATOR FREQUENCY (CPM) (RPM) (RPM X 1 SCALE)	INDICATOR READING (%)
200	4 8
400	9 5
800	19 0
1600	38 1
2400	57 1
3200	76 2
3400	80.9
3600	85 7
3800	90 5
4000	95 2
4200	100 0
4400	104 8

(2) Decrease TTU-27/E test set RPM to zero

(3) Set MASTER INDICATOR switch to OFF

(4) Remove elenrical power from aircraft, if no longer needed for other maintenance.

(5) Remove power cables and test set

(6) Reconnect and safety wire tachometer generator electrical connector.

Ref : DRW CDRL 43/44 Issue D dated May 19/89
Paragraphs 7.8 and 7.31

PART NO OR TYPE DESIGNATOR	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless Identified by a no substitute notation		
TOOLS		
GG-W-0086 Type II, Class 1, Style A	Torque Wrench 0-150 inch-pounds	To torque tachometer generator nuts
TEST EQUIPMENT		
TTU-27/E	Tachometer Test Set	To check N1 indicator
204-90057-1	Test Cable Set	To connect test set to indicators and generators
AN/PSM-6 (Simpson 260)	Multimeter	To check wiring continuity

Engine Tachometer Indicating System Tools and Test Equipment
Table 501

Ref : DRW CDRL 43/44 Issue D dated May 19/89
Paragraphs 7 8 an d7.31

ENGINE VIBRATION INDICATING SYSTEM - DESCRIPTION AND OPERATION

EFFECTIVITY

TURBOFAN

1 General

A The engine vibration indicating system measures the amount of engine vibration and provides indication of possible engine malfunction Vibration level is indicated on a multiscale engine vibration indicator at the flight engineer's station

B The system consists of two vibration pickups per engine, a vibration indicator, a filter selector switch, a push-to-test switch and a pickup selector switch. Refer to figure 1 Electrical signals are generated by the vibration pickups, amplified by an amplifier and rectified to a pulsating d-c current which is transmitted to the appropriate indicator The push-to-test switch permits simultaneous check of the four indicator and amplifier systems

2 Engine Vibration Pickup

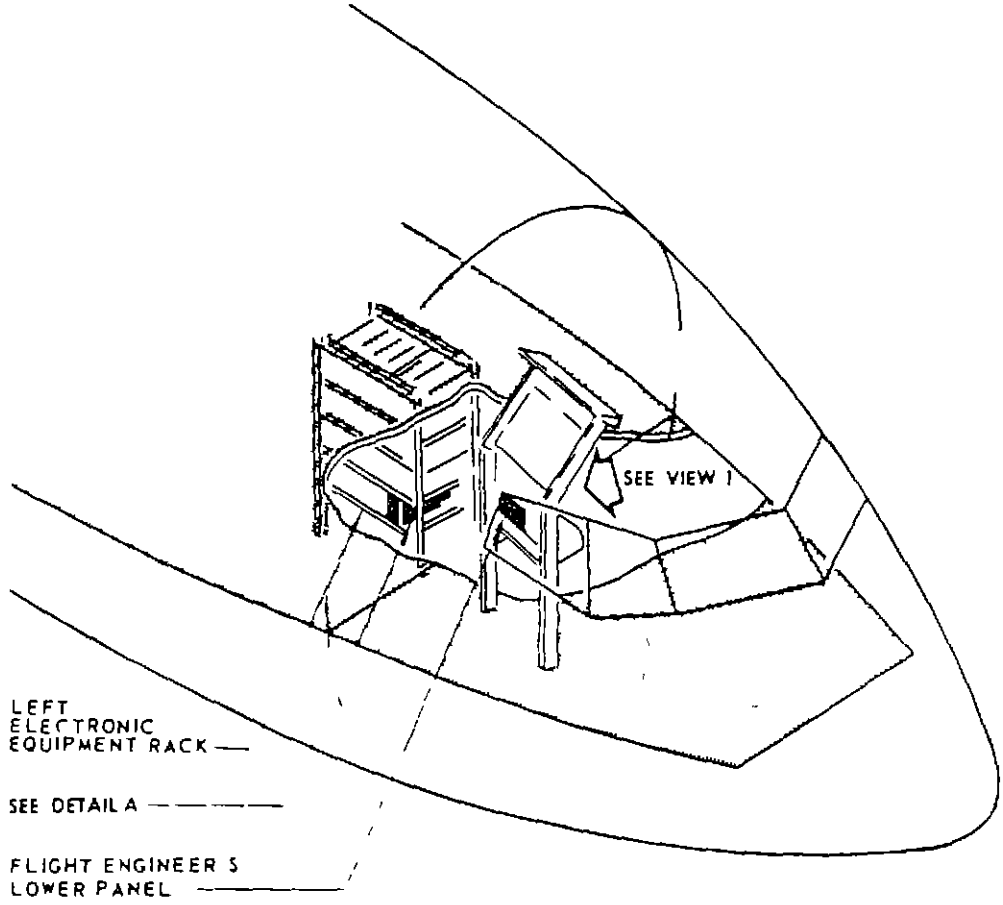
A The engine vibration pickup unit detects and transforms engine vibrations into electrical signals This unit has a heavy stainless steel case containing a coil arranged around a spring suspended magnet One vibration pickup is attached to a bracket located at 9 o'clock on the front flange of the diffuser case The other is on a bracket at 7 o'clock on the turbine case forward flange (See figure 1)

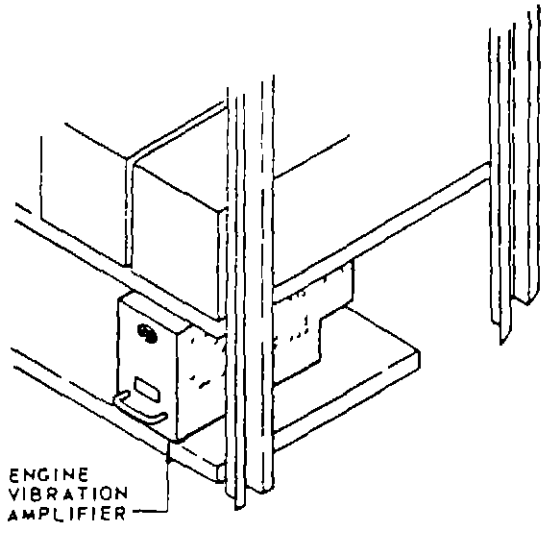
B Engine vibration causes movement of the pickup housing and coil while the magnet tends to remain at rest A voltage is generated proportional to the relative movement between the magnet and the coil The maximum peak to peak displacement between the magnet and the pickup case is approximately 0 50 inch

3. Engine Vibration Amplifier

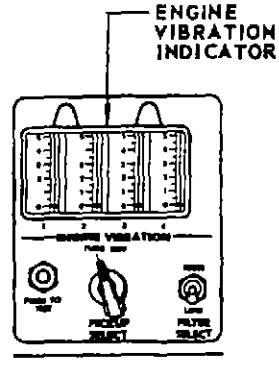
A The engine vibration amplifier unit amplifies and rectifies the pickup signals before feeding them to the appropriate indicator The amplifier assembly is made up of four amplifier modules each with a rectifier section to change output to pulsating d-c Two high pass filters in each module allow selection, using the filter selector switch, of the engine vibration frequency range registered on the indicators

B The amplifier assembly is mounted on a chassis together with its power supply unit and is located on the electronic equipment rack (See detail A, figure 1)





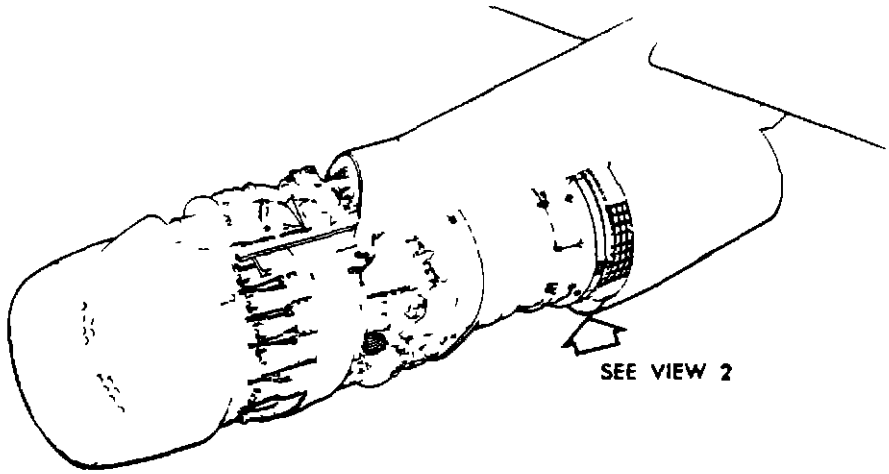
DETAIL A



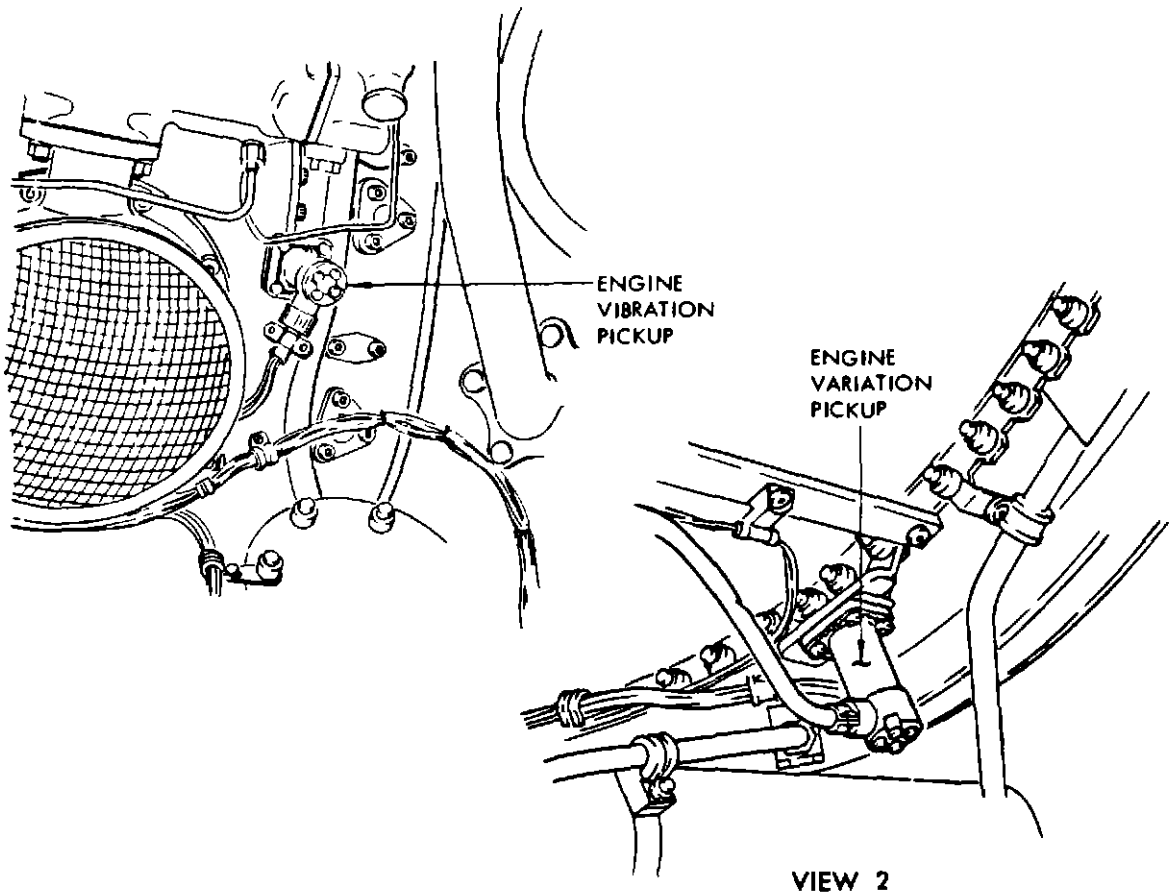
FLIGHT ENGINEERS' LOWER INSTRUMENT PANEL

VIEW 1

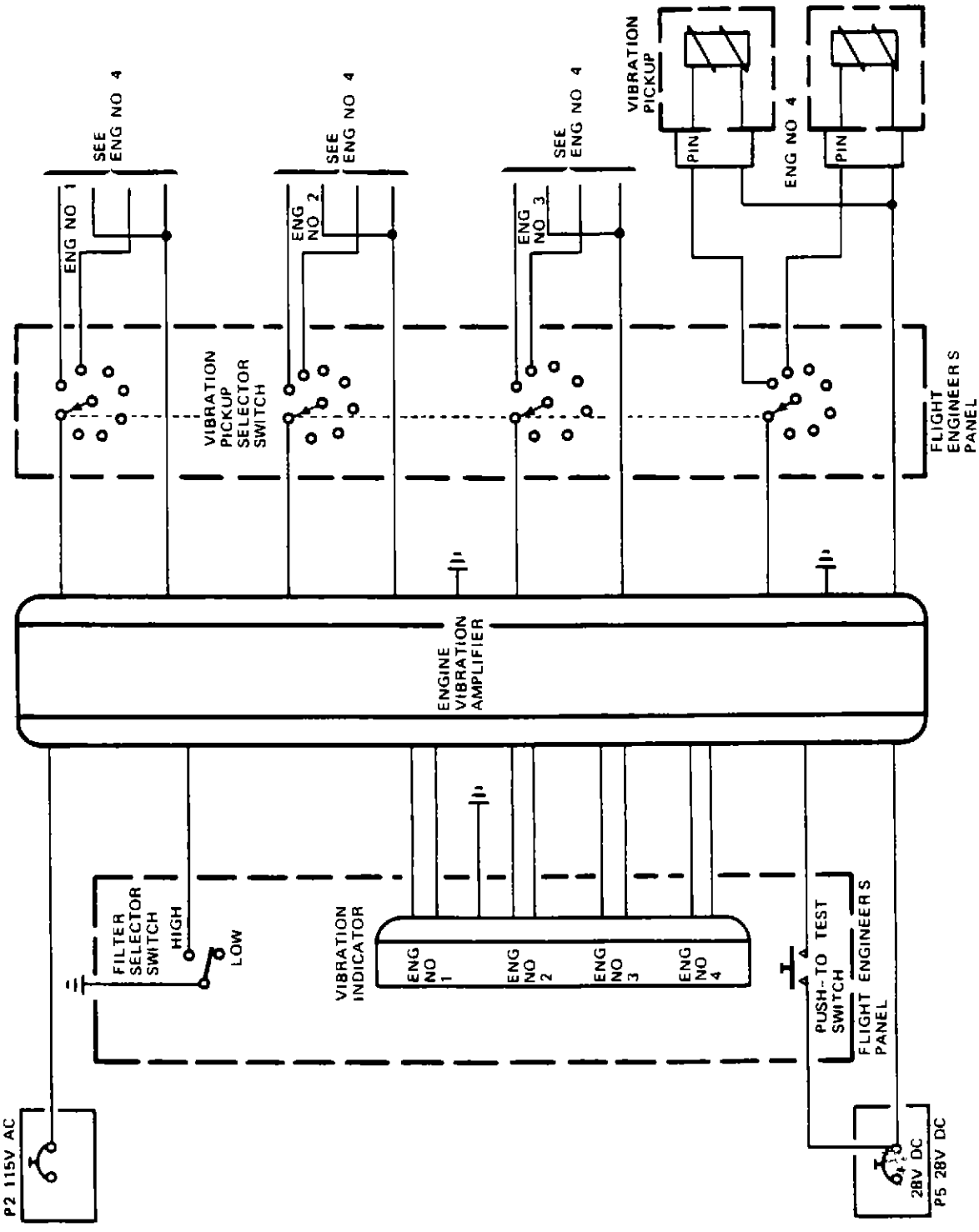
Engine Vibration Indicating System Equipment Location
Figure 1 (Sheet 1 of 2)



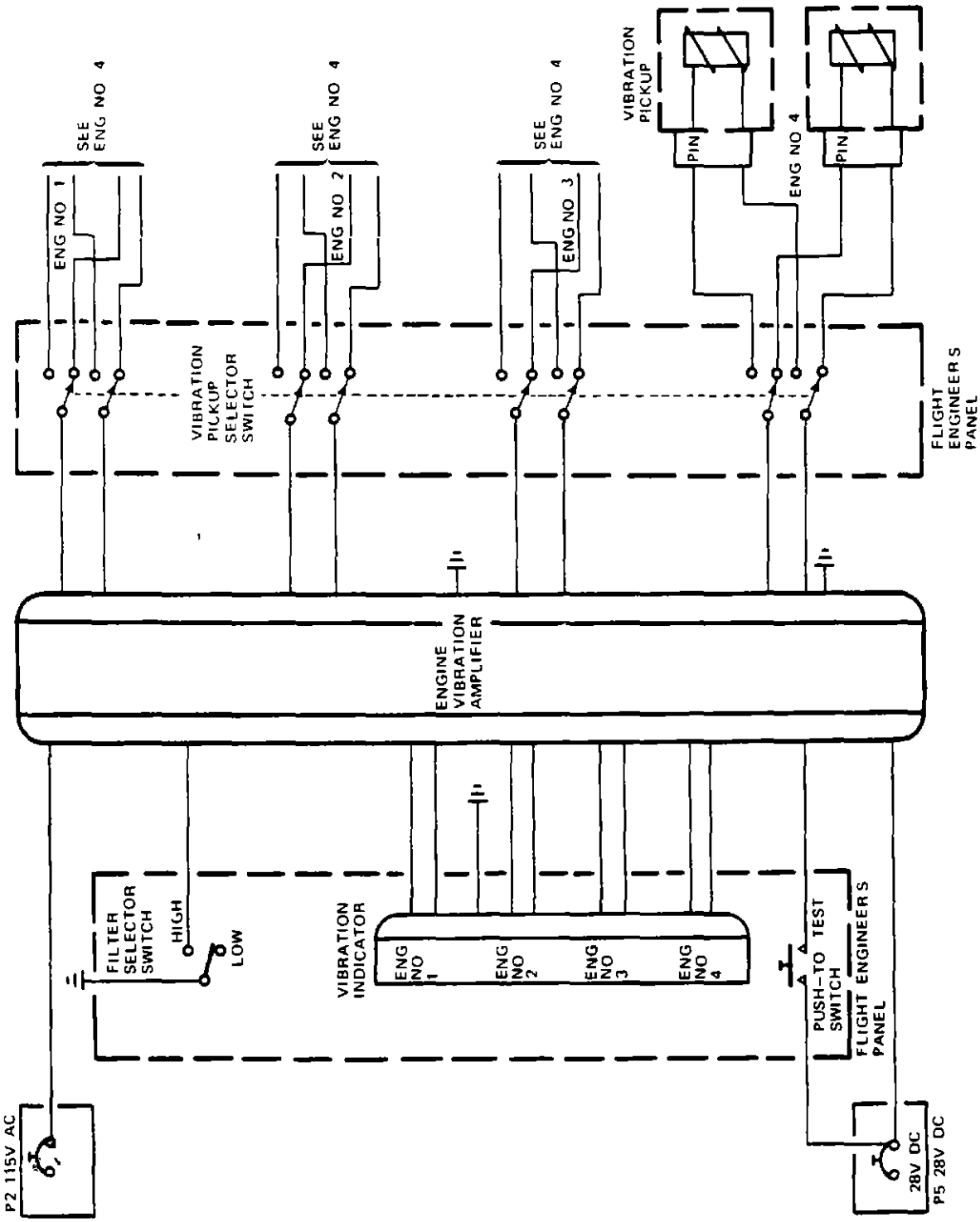
TYPICAL ALL
FOUR ENGINES



VIEW 2



Engine Vibration System Circuit
Figure 2 (Sheet 1)



Engine Vibration System Circuit
Figure 2 (Sheet 2)

BOEING Intercontinental 707

MAINTENANCE MANUAL

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4. Engine Vibration Indicator

A. The engine vibration indicator is a multiple indicator with four vertical scales in a single compact case. Each scale has six major graduations, numbered zero through 5, and five minor graduations. The indicator is calibrated in "Relative Amplitude," to allow for changes in the standard allowable vibration level. The indicator movement is damped to enable the pointer to stabilize within one-half second after a switching operation.

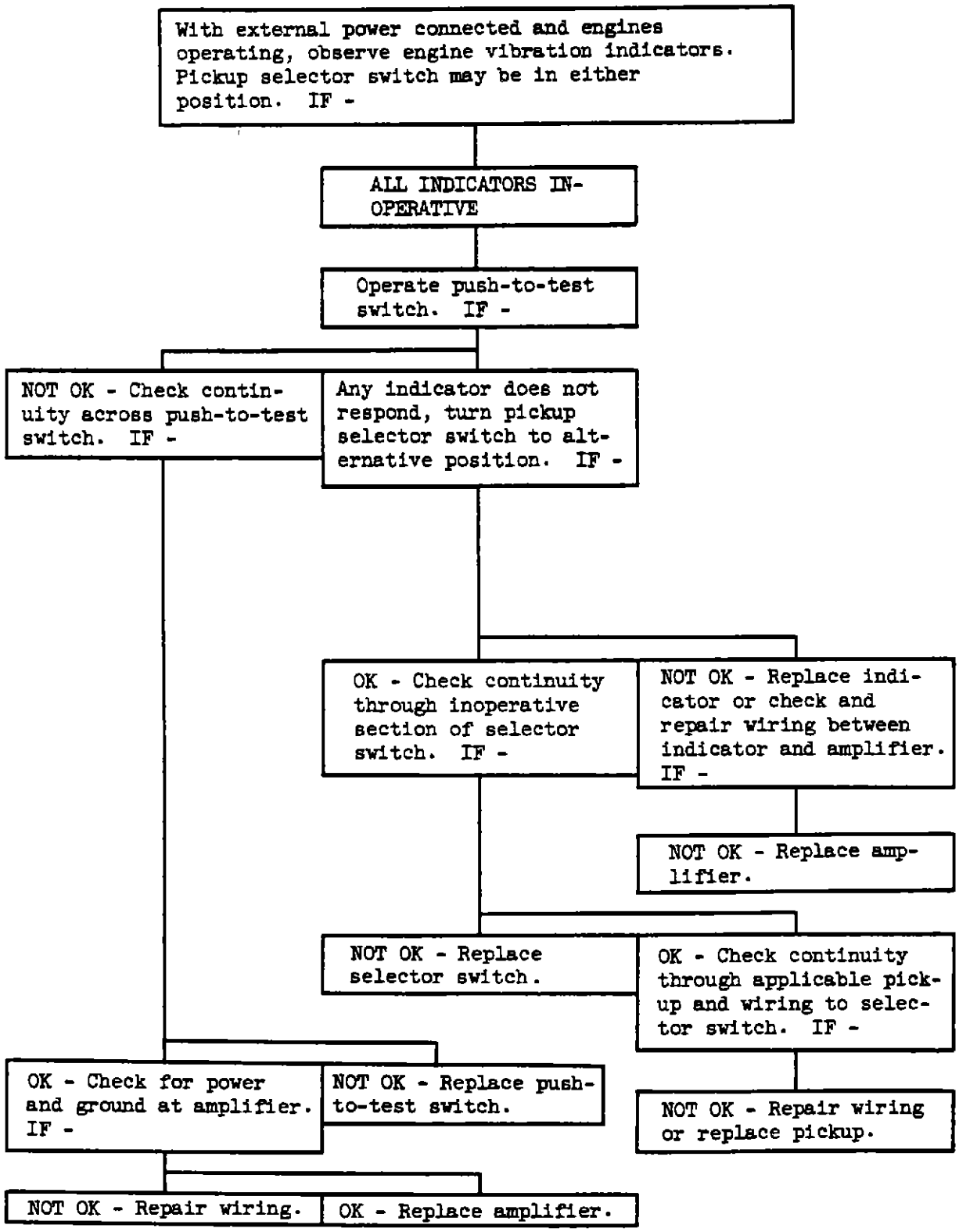
B. The engine vibration indicator is located in the lower right corner of the flight engineer's lower instrument panel.

5. Operation

A. The controls for the engine vibration indicating system are located on the flight engineer's lower panel. The high or low pass filter switch selects the frequency range registered by the system. Low frequency engine vibrations extend approximately from 45 cps up, high frequency rotor vibrations from 135 cps upwards. The pickup selector switch permits a choice of signals from a pickup located on the diffuser case or a pickup attached to the engine turbine case. Electrical power is 115 volt a-c. (See figure 2.)

B. With engines operating, a zero indication is not abnormal. If an unusually high signal is registered, the amplifier and indicator may be tested by actuating the push-to-test switch. This switch energizes a relay which removes engine vibration signals from the input circuit and substitutes a signal of predetermined value. When the test switch is operated the indicator should read between three and four and one half with the filter selector in either low or high range selection.

ENGINE VIBRATION INDICATING SYSTEM - TROUBLE SHOOTING



ENGINE VIBRATION INDICATING SYSTEM - ADJUSTMENT/TEST

1. Test System Operation (Engines Shut Down)

A. Connect external electrical power to airplane.

B. Pull 115V a-c and 28V d-c engine vibration indicating system circuit breakers on circuit breaker panel P2 and P5 respectively.

C. Open applicable engine left cowl panel.

D. Disconnect turbine section vibration pickup electrical plug. (Pickup located at approximately 7 o'clock position.)

E. Close 115V a-c and 28V d-c engine vibration indicating system circuit breakers.

F. With pickup selector switch in "TURB" (No. 1) position and filter selector switch in "LOW" frequency position, push test switch.

G. Observe that applicable engine indicator scale reading is zero, then release test switch.

H. With pickup selector switch in "TURB" (No. 1) position and filter selector switch in "HIGH" frequency position, push test switch.

I. Observe that applicable engine indicator scale reading is zero; then release test switch.

J. Pull 115V a-c and 28V d-c engine vibration indicating system circuit breakers.

K. Connect electrical plug to pickup.

L. Disconnect diffuser section vibration pickup electrical plug. (Pickup located at approximately 9 o'clock position.)

M. Close 115V a-c and 28V d-c engine vibration indicating system circuit breakers.

N. With pickup selector switch in "DIFF" (No. 1) position and filter selector switch in "LOW" frequency position, push test switch.

O. Observe that applicable engine indicator scale reading is zero, then release test switch.

P. With pickup selector switch in "DIFF" (No. 1) position and filter selector switch in "HIGH" frequency position, push test switch.

Q. Observe that applicable engine indicator scale reading is zero, then release test switch.

R. Pull 115V a-c and 28V d-c engine vibration indicating system circuit breakers.

S. Connect electrical plug to pickup.

T. Close engine cowl panel.

U. Close 115V a-c and 28V d-c engine vibration indicating system circuit breakers.

V. With pickup selector switch in "TURB" (No. 1) position and filter selector switch in "LOW" frequency position, push test switch.

W. Observe that applicable engine indicator scale reading is between 3.3 and 3.7.

X. Release test switch, indicator scale reading shall become zero.

Y. Repeat steps V. through X. with selector switches in following positions

(1) Pickup selector switch in "TURB" (No. 1) position and filter selector switch in "HIGH" frequency position.

(2) Pickup selector switch in "DIFF" (No. 2) position and filter selector switch in "HIGH" frequency position.

(3) Pickup selector switch in "DIFF" (No. 2) position and filter selector switch in "LOW" frequency position.

Z. Repeat steps B. through Y. for other engines.

AA. Check that No. 1 and No. 2 VHF transmitter circuit breaker on circuit breaker panel P5 is closed.

AB. With pickup selector switch in "TURB" (No. 1) position and filter selector switch in "LOW" frequency position, operate No. 1 and No. 2 VHF transmitters. If indicator scale reading for any one engine is greater than 0.25, replace engine vibration amplifier.

AC. Repeat step AB. with pickup selector switch in "DIFF" (No. 2) position.

AD. Determine whether there is any further need for electrical power on airplane, if not remove external power.

2. Test System Operation (engines running)

A. With engine running at "IDLE," check that 115V a-c and 28V d-c engine vibration indicating system circuit breakers are closed.

B. Set pickup selector switch to "TURB" (No. 1) position and filter selector switch to "LOW" frequency position.

C. Slowly advance engine thrust lever to maximum thrust position, while observing indicator corresponding scale reading. Pointer shall move a minimum of half a pointer width at some instant during engine operation.

NOTE Movement of thrust lever should take at least 60 secords.

D. Return thrust lever to "IDLE" position and record maximum observed vibration reading and corresponding engine N2 percent rpm in log book.

NOTE This test is not intended for establishing warning limits, but only to test functioning of system, and therefore obtained data can be used only as guide when warning limits are established for particular engine during first few flights after engine change.

E. Repeat steps B. through D. with pickup selector switch in "DIFF" (No. 2) position.

F. Shut down engine.

G. Repeat steps A. through F. on other engines.

ENGINE VIBRATION PICKUP - MAINTENANCE PRACTICES

1 Removal/Installation Engine Vibration Pickup

A. Remove Engine Vibration Pickup

(1) Open left side cowl panel to gain access to vibration pickups.

(2) Cut lockwire and disconnect electrical plug from vibration pickup. (See figure 201.)

(3) Cut and remove lockwire from mounting screws.

(4) Remove mounting screws and lift vibration pickup free of bracket.

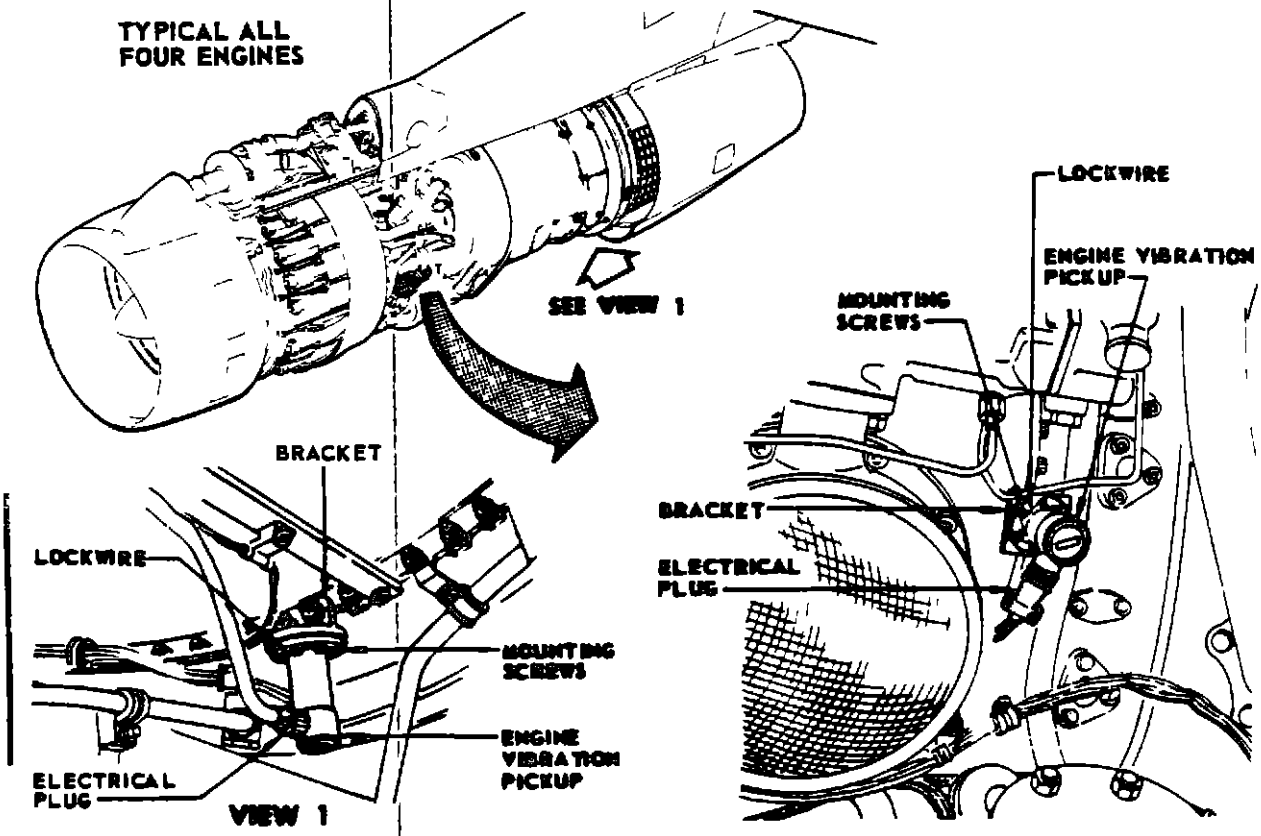
B. Install Engine Vibration Pickup

(1) Place vibration pickup on bracket and align holes. (See figure 201.)

(2) Install and lockwire mounting screws.

(3) Connect electrical plug to vibration pickup and lockwire.

(4) Close left side cowl panel.



Engine Vibration Pickup Installation
Figure 201