

PFN NUMBER 011-9770

SEPTEMBER 2004

STUDENT GUIDE

FOR

UH-60 INSTRUMENT WARNING



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Black Hawk (UH-60) Helicopter Maintenance Test Pilot Training Program

U.S. Army Maintenance Test Pilot School
Aviation Training Brigade ATTN: ATZQ-ATB-CA
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APRIL 2003

BLACK HAWK UH-60 INSTRUMENT WARNING

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SECTION I. -INTRODUCTION

TERMINAL LEARNING OBJECTIVE:

At the completion of this lesson you will:

ACTION: Identify the characteristics of the Instrument Warning System

CONDITIONS: As a UH-60 Maintenance test pilot.

STANDARD: In Accordance with (IAW) TM 1-1520-237-10, TM 11-1520-237-23-3, TM 1-1520-237-23-4, TM 1-1520-237-23-5 and TM 1-1520-237-MTF.

SAFETY REQUIREMENTS: Will be addressed as NOTES, CAUTIONS, and WARNINGS throughout the lesson outline.

RISK ASSESSMENT LEVEL: Low

ENVIRONMENTAL CONSIDERATIONS: There are no environmental concerns for this lesson.

EVALUATION: None

SECTION II. -PRESENTATION

A. ENABLING LEARNING OBJECTIVE (ELO) No.1

ACTION: Identify the function of the Instrument Display System.

CONDITION: As a UH-60 Maintenance test pilot.

STANDARD: Using TM 1-1520-237-10, TM 1-1520-237-23-2, TM 1-1520-237-MTF, and TM 11-1520-237-23-2

a. Instrument Display System Menu

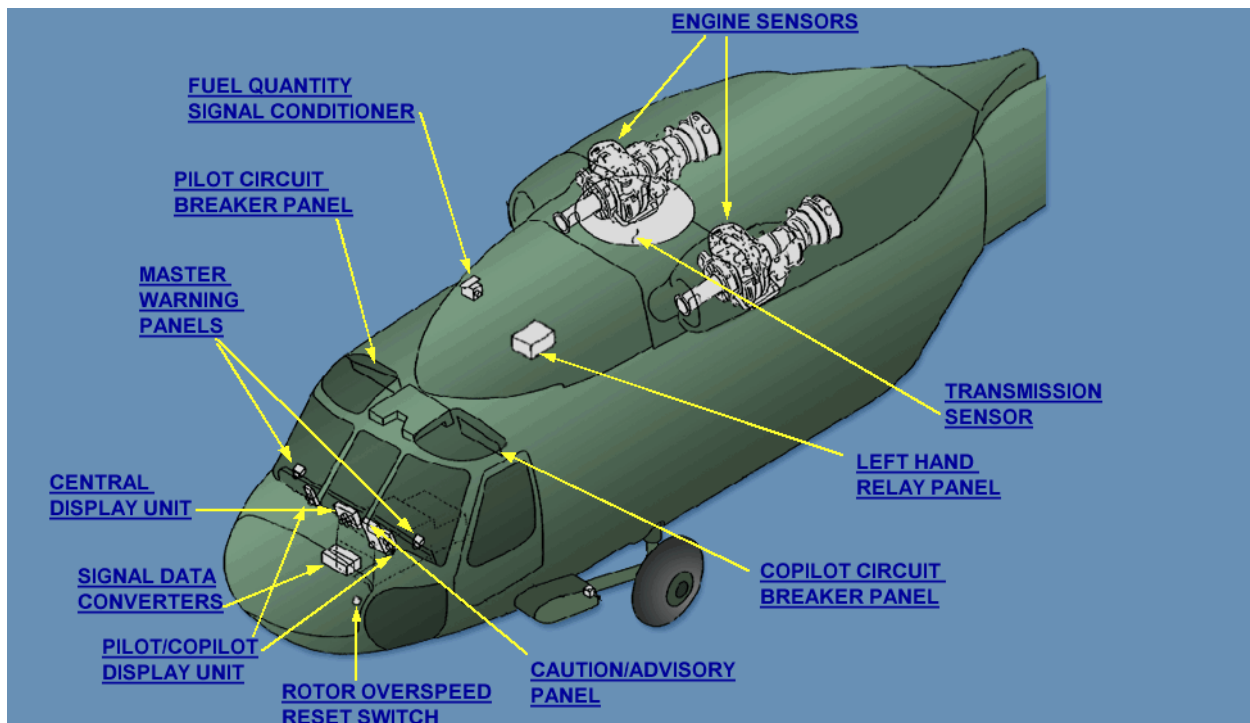
Frame #1002 (Instrument Display System Menu)



- (1) The instrument display system (IDS), used in conjunction with engine and subsystem sensors (temperature, pressure, torque, fuel and RPM), provides the pilots with engine and subsystem monitoring.
- (2) The IDS gives continuous indications of the parameters on vertical scales, digital readouts, and status lights.

(a) Component Location

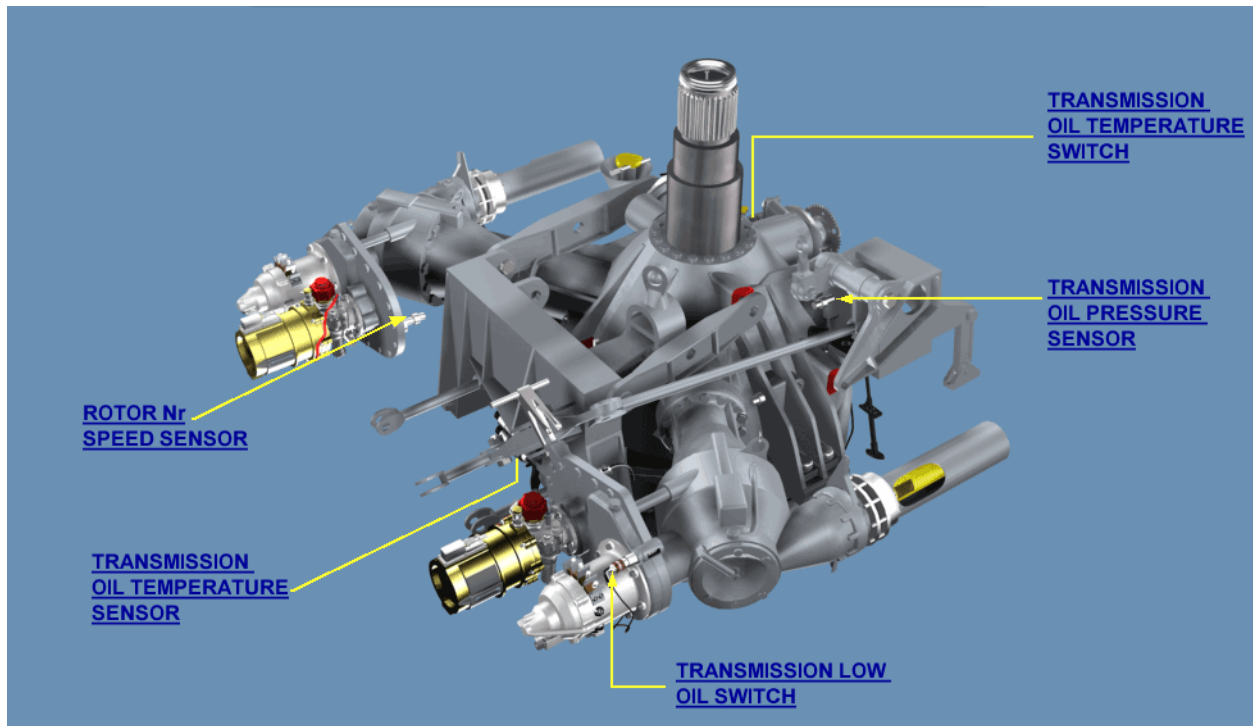
Frame #1005 (Instrument Display System Component Menu)



- (1) The IDS consists of a Pilot Display Unit (PDU), CoPilot Display Unit (CPDU), and Central Display Unit (CDU), on the instrument panel.
- (2) In the center console shelf under the instrument panel, you have the No. 1 Signal Data Converter (No. 1 SDC) and No. 2 Signal Data Converter (No. 2 SDC), and a rotor overspeed reset switch.
- (3) Since the PDU and CPDU are identical and the No. 1 and No. 2 SDCs are identical, the IDS consists of three basic units: PDUs, SDCs, and the CDU.

a) Transmission Sensors

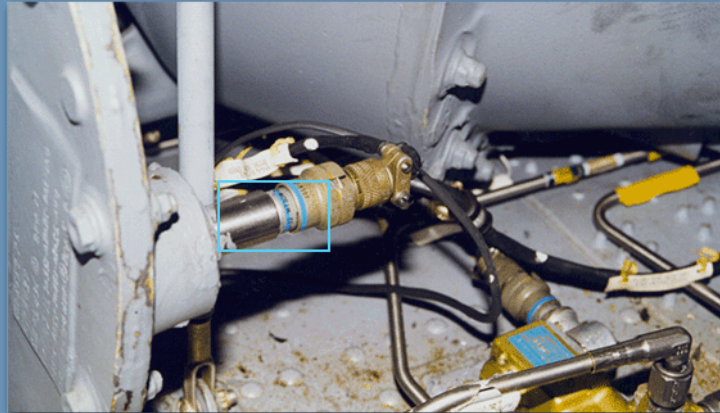
Frame #1040 (Transmission Sensors)



- 1 Transmission mounted sensors include the rotor Nr speed sensor, the transmission low oil pressure switch, the transmission oil temperature sensor, the transmission oil pressure sensor and the transmission oil temperature switch.

a Rotor NR Speed Sensor

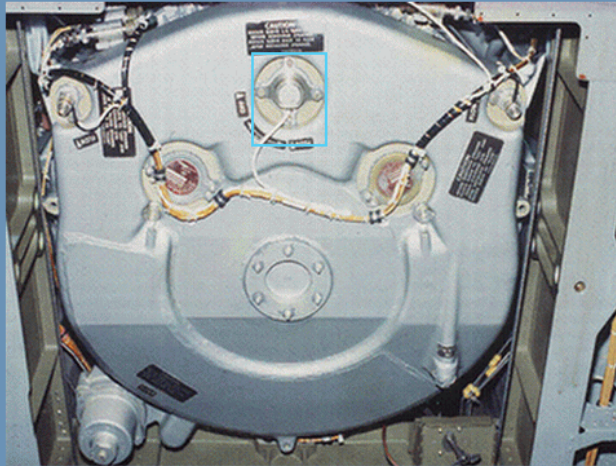
Frame #1045 (Rotor NR Speed Sensor)



- i) A rotor Nr speed sensor is mounted on the right accessory module.
- ii) The rotor Nr speed sensor senses main rotor RPM.
- iii) This signal is sent to both engine ECUs, for engine speed control, and to both SDCs, for instrument displays.

b Transmission Oil Temperature
Sensor

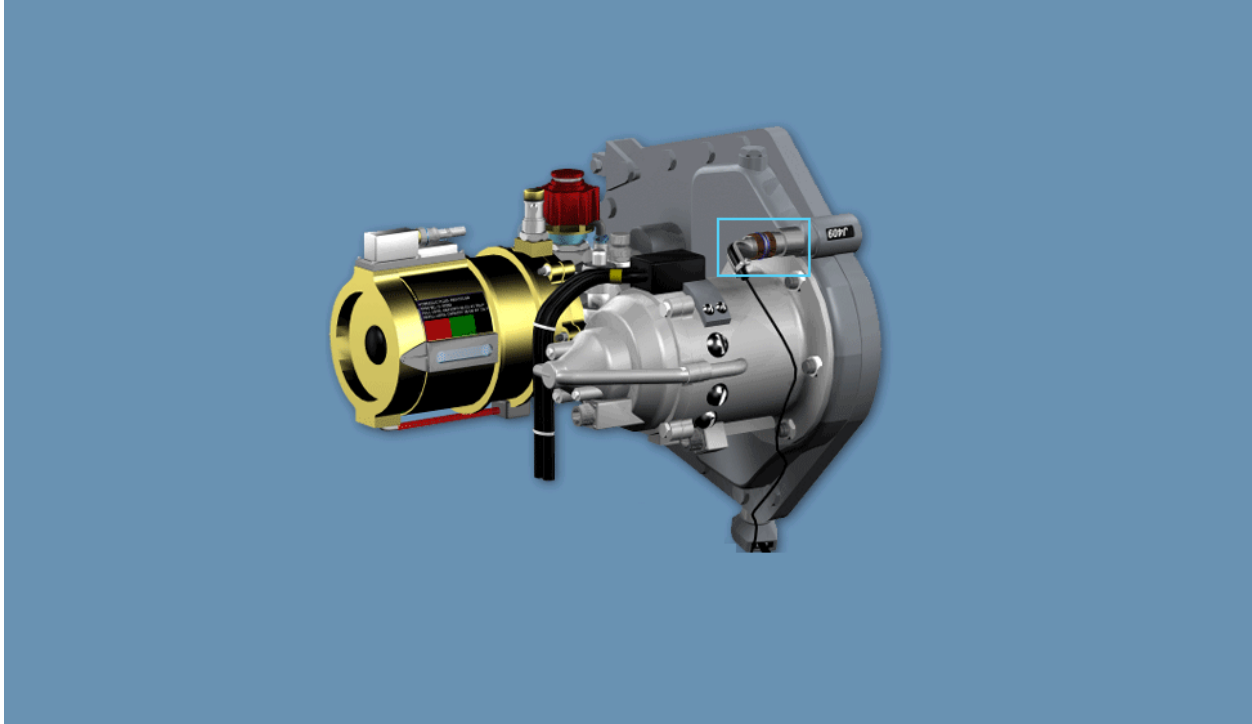
Frame #1051 (Transmission Oil Temperature Sensor)



- i) The oil temperature indicating system has an oil temperature sensor and MAIN XMSN OIL TEMP indicator in the central display unit.
- ii) The MAIN XMSN OIL TEMP indicator gives a main transmission temperature in degrees Celsius. Indicator ranges are:
 - GREEN -50° to 105 °C
 - AMBER 105° to 120 °C
 - RED 120° to 170 °C

c Transmission Low Oil Pressure Switch

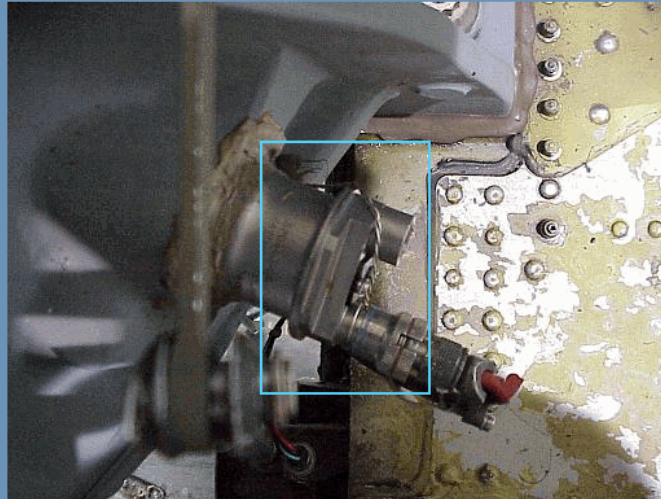
Frame #1060 (Transmission Low Oil Pressure Switch)



- i) When the oil pressure in the left accessory module falls below 14 psi, the transmission low oil switch turns on the MAIN XMSN OIL PRESS capsule on the caution/advisory panel

d Transmission Oil Pressure
Sensor

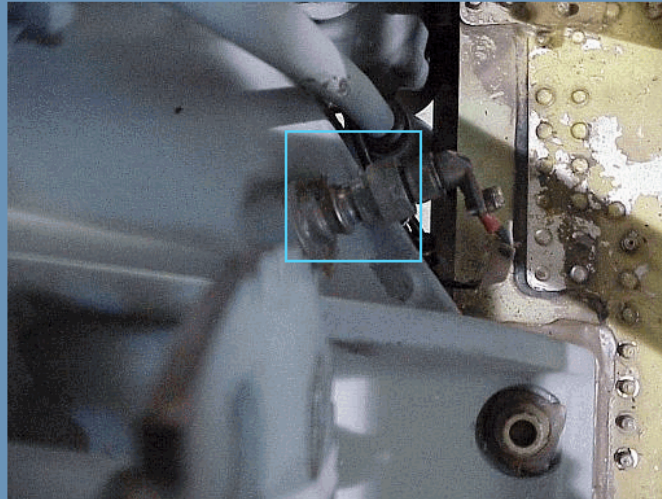
Frame #1055 (Transmission Oil Pressure Sensor)



- i) The oil pressure sensor transmits main transmission oil pressure to the central display unit (CDU).
- ii) The CDU displays main transmission oil pressure in psi. The ranges are:
 - AMBER 20 psi to 30 psi
 - GREEN 30 psi to 65 psi
 - AMBER 65 psi to 130 psi
 - RED 130 psi to 190 psi

e Transmission Oil Temperature Switch

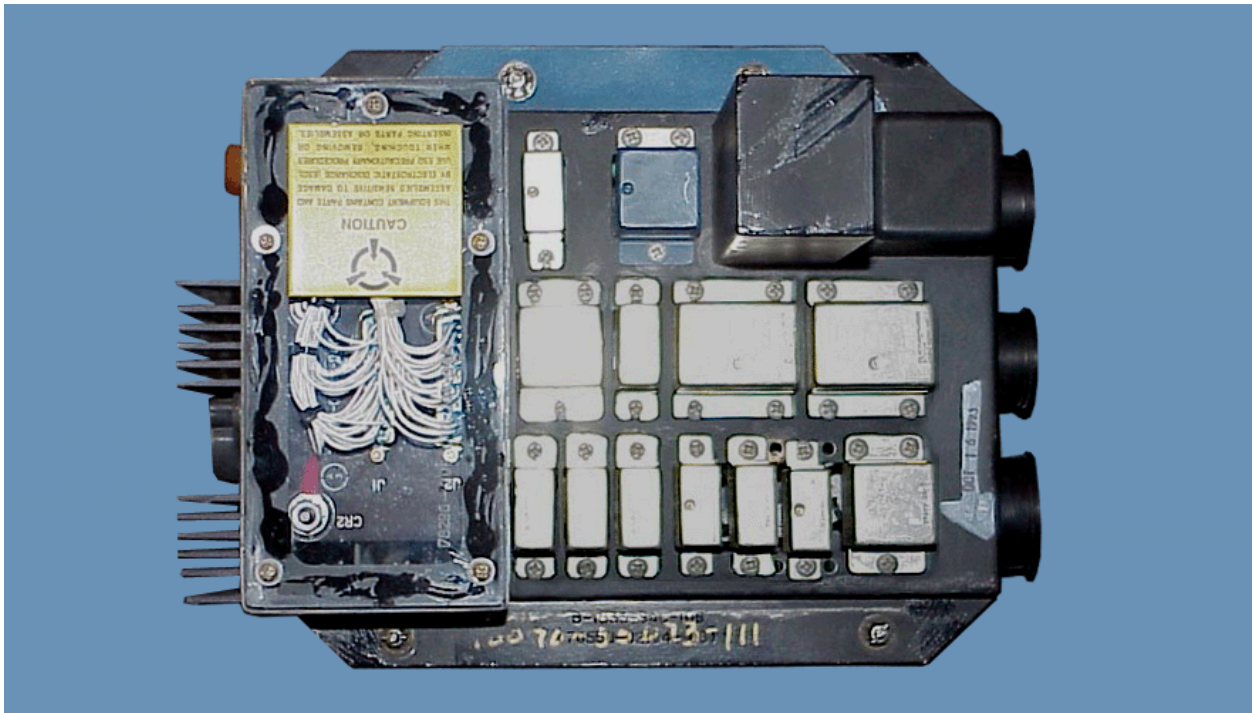
Frame #1050 (Transmission Oil Temperature Switch)



- i) The transmission oil temperature warning system is triggered by an oil temperature switch at the oil cooler input to the main module, near the tail takeoff drive shaft flange.
- ii) The MAIN XMSN OIL TEMP caution appears when transmission oil temperature reaches 120°C.

b) Left Hand Relay Panel

Frame #1070 (Left Hand Relay Panel)



- 1 The IDS signals energize relays in the left relay panel that controls an audible warning circuit.

Frame #1075 (Copilot Circuit Breaker Panel)



1 Power for the No. 1 engine indicating systems is supplied by the No. 1 DC PRI BUS and No. 1 AC PRI BUS through the No. 1 DC INST and No. 1 AC INST circuit breakers.

d) Caution/Advisory Panel

Frame #1085 (Caution/Advisory Panel)



- 1 The caution/advisory panel receives 28 V dc and ground signals from helicopter systems to light the caution and advisory capsules.
- 2 For most of the caution capsules and all of the advisory capsules, a 28 V dc signal from the monitored system is applied directly to the capsule circuit to light the capsule.
- 3 These capsules will remain on until the input signal is removed.
- 4 The caution/advisory panel contains a BRT/DIM TEST switch that enables testing and changing the light intensity of all caution, advisory, and warning capsules.

e) Rotor Overspeed Reset Switch

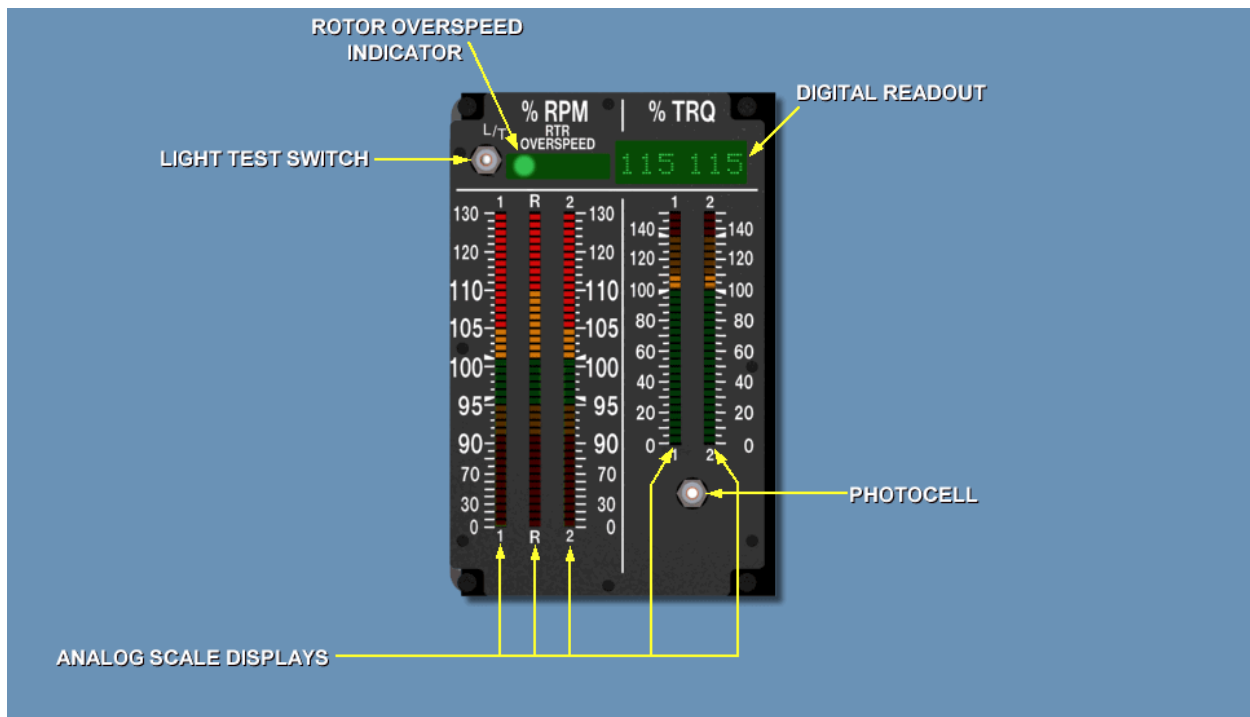
Frame #1095 (Rotor Overspeed Reset Switch)



- 1 The rotor overspeed reset switch is the only means of resetting either of the three rotor overspeed warning lamps (127%, 137%, and 142%), on both pilot display units (PDU).
- 2 The rotor overspeed reset switch is located on the canted bulkhead, left side, in the nose electronics compartment.

f) Pilot Display Unit

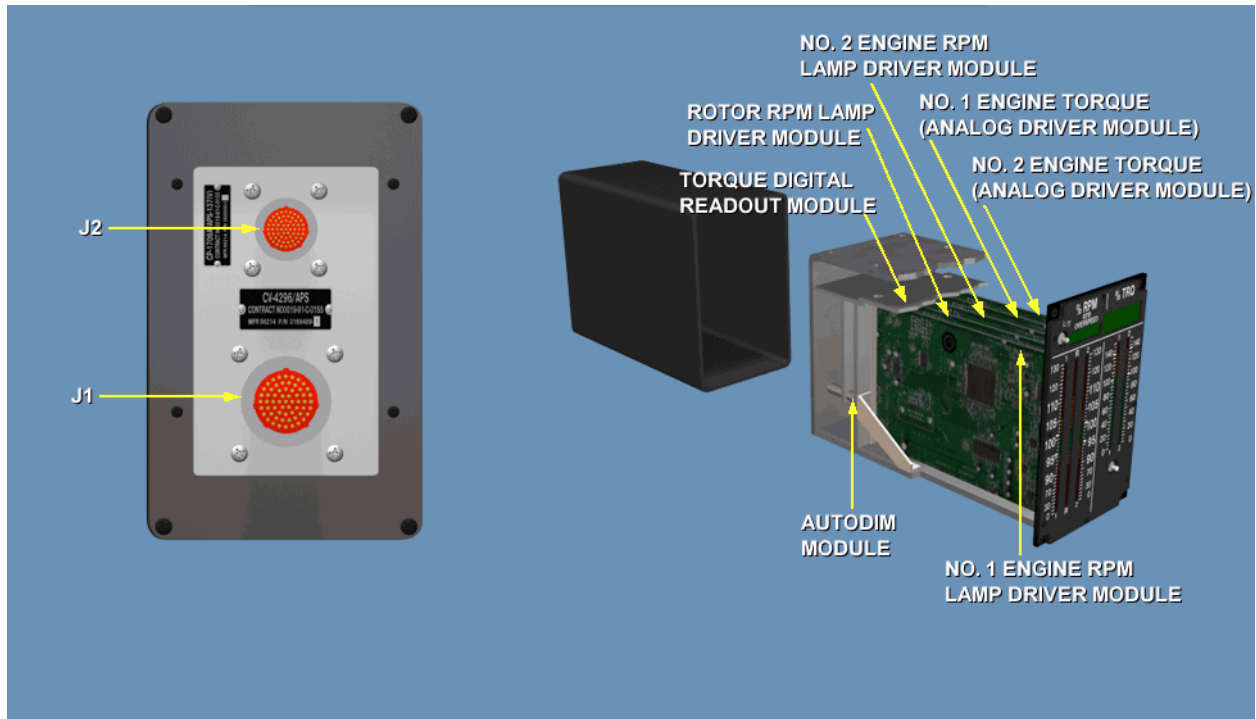
Frame #1020 (Pilot Display Unit)



- 1 The Pilot Display Unit (PDU) receives signal and power inputs from an associated Signal Data Converter (SDC) and Central Display Unit (CDU).
- 2 The PDU contains five analog vertical scale displays, two digital displays, three indicator lights and a photocell.
- 3 The PDU receives the following multiplexed data signals from the SDC: percentage of RPM speed for No. 1 and No. 2 engines and main rotor, and percentage of torque for the No. 1 and No. 2 engines.
- 4 These parameters are displayed on the PDU analog scales.
- 5 The percentage of torque for the No. 1 and No. 2 engines are also displayed on the digital readouts.
- 6 The PDU also contains a Light Test switch which, when pressed, illuminates the vertical displays and digital readouts.

- 7 Both PDUs along with the CDU contain photocells that automatically adjust lighting of the indicators with respect to ambient light.
- 8 The Rotor Overspeed illuminates individually to indicate overspeeds of 127%, 137%, and 142%.

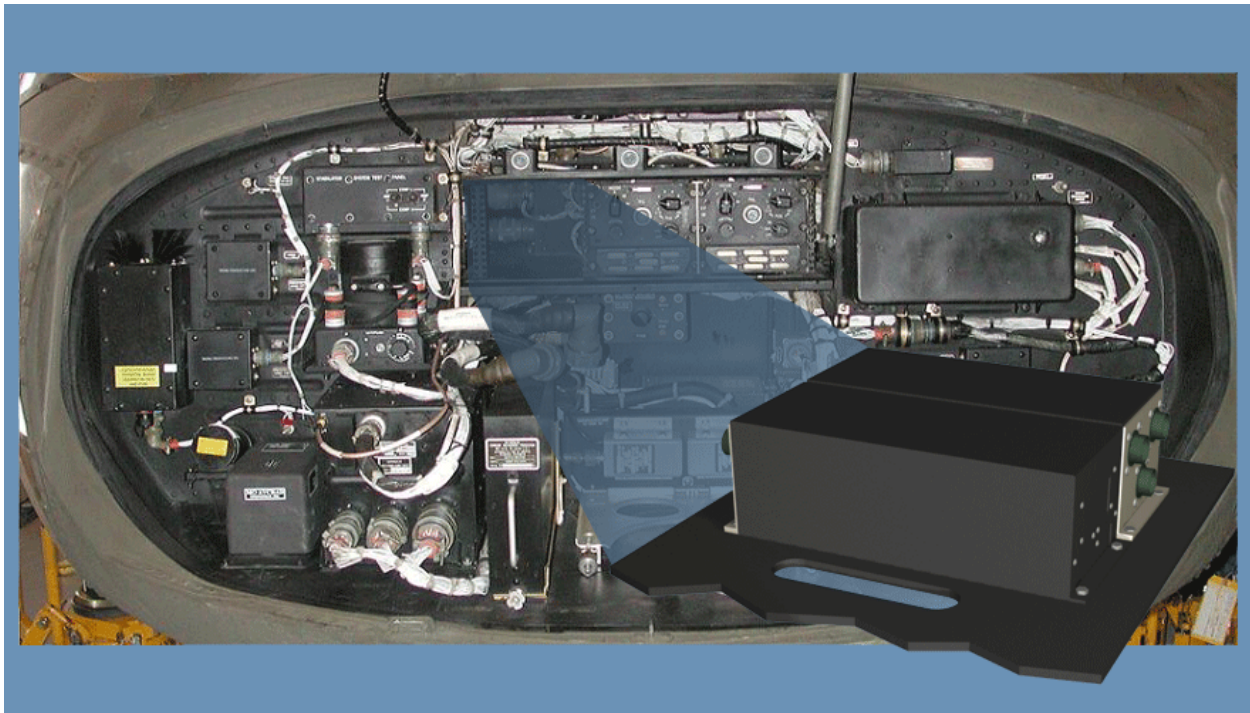
Frame #1022 (Pilot Display Unit Breakdown)



- 9 The PDU contains the following modules:
- 10 No. 1 engine RPM lamp driver module, No. 2 engine torque (analog) lamp driver module, No. 1 engine torque (analog) lamp driver module, No. 2 engine RPM lamp driver module, Rotor RPM lamp driver module, torque digital readout module, and an autodim module.
- 11 The PDU also has 2 electrical connectors (J1 and J2) on the rear panel.

g) Signal Data Converters

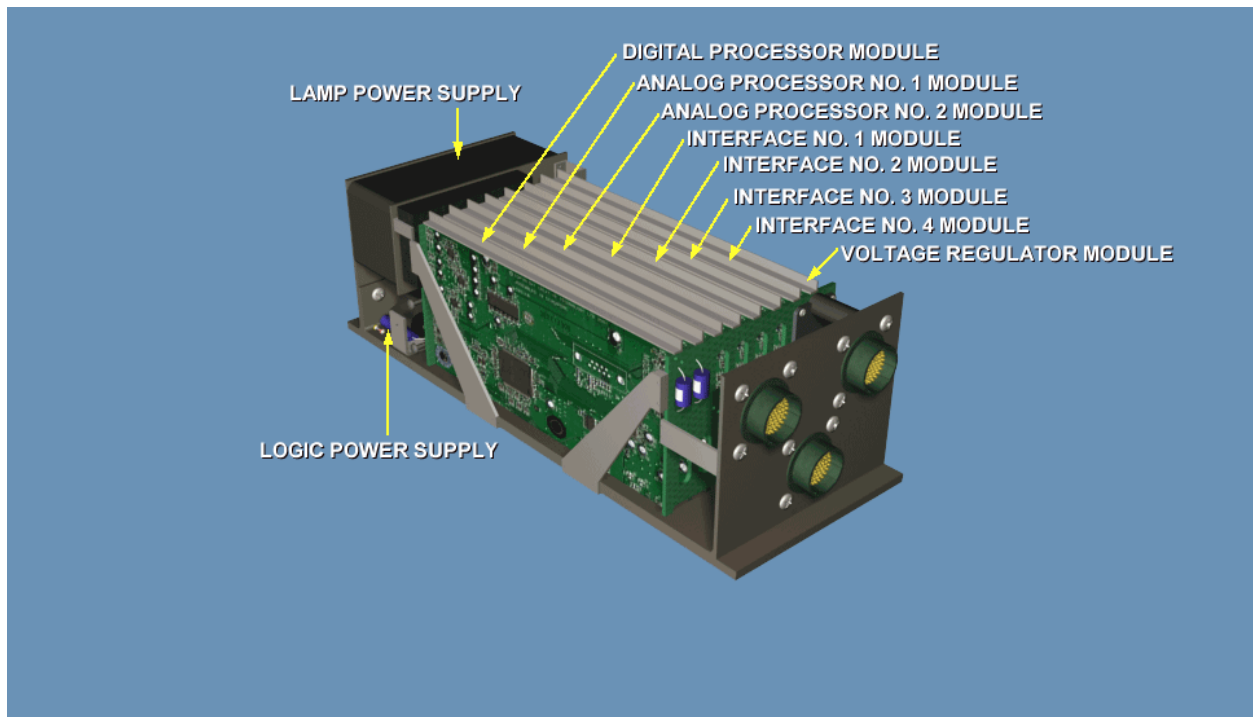
Frame #1015 (Signal Data Converter)



- 1 There are two signal data converters located on the avionics shelf in the nose electronics compartment.
- 2 The Signal Data Converter (SDC) processes sensor signals and provides proportional digital signals in a multiplexed format to the Central Display Unit (CDU) and the Pilot Display Unit (PDU).
- 3 These sensor signals include: engine oil pressure, engine oil temperature, No. 1 and No. 2 engine torque, engine Turbine Gas Temperature (TGT), No. 1 and No. 2 engine power turbine tachometer (% RPM), engine gas generator tachometer (Ng), and rotor RPM.
- 4 The SDC updates this data twice per second.
- 5 The fuel quantity, main transmission oil temperature and main transmission oil pressure signals are also routed through the SDC and processed in the CDU.

- 6 The signals are processed through redundant circuits for reliability and monitoring circuits are used to ensure the validity of the displayed data.
- 7 The SDC also provides output voltages to the caution/advisory warning system when any of the following conditions exists: low engine oil pressure, high engine oil temperature, low engine gas generator tachometer (Ng), and low rotor speed.

Frame #1017 (SDC Modules)



- 8 The SDC contains the following modules: Lamp power supply, Logic power supply, Interface No. 4 module, Interface No. 3 module, Interface No. 2 module, Interface No. 1 module, Analog processor No. 2 module, Analog processor No. 1 module, Digital processor module, Voltage regulator module.

h) Central Display Unit

Frame #1025 (Central Display Unit)

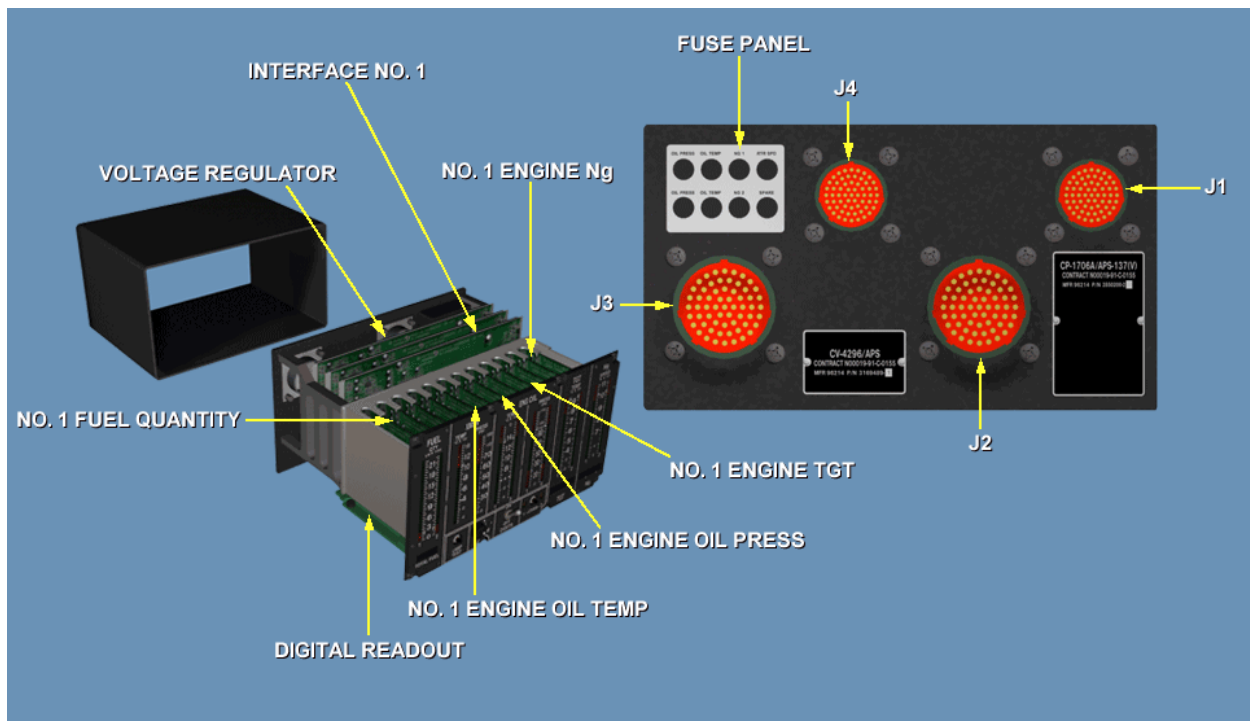


- 1 The CDU contains instruments that display fuel quantity, transmission oil temperature and pressure, engine oil temperature and pressure, turbine gas temperature (TGT), and gas generator speed (Ng) readings.
- 2 Those readings are shown by ascending and descending columns of multicolored lights (red, yellow, and green) measured against vertical scales.
- 3 If the instrument contains low range turnoff (red or yellow lights below green lights) they will go off when the system is operating within the normal range (green).
- 4 If the instrument contains yellow or red lights above the green range, the green as well as the yellow or red will stay on when operating above the green range.
- 5 Digital readouts are also installed on the TOTAL FUEL quantity, TGT, and Ng gages.

- 6 The No. 1 and No. 2 fuel quantity is displayed on the analog scales and the total fuel is displayed on a digital readout.
- 7 Also, the fuel limits are: AMBER (or YELLOW) 0-200 lbs, GREEN 200-1500 lbs.
- 8 The main transmission oil temperature is displayed on the analog scale, normal indicator ranges are: GREEN -50° to 105 °C, AMBER 105° to 120 °C, RED 120° to 170 °C.
- 9 The main transmission oil pressure is displayed on the analog scale and the normal indicator ranges are: AMBER 20 to 30 psi, GREEN 30 to 65 psi, AMBER 65 to 130 psi, RED 130 to 190 psi.
- 10 The No. 1 and No. 2 engine oil temperature sensor wired through the signal data converter to a vertical scale on the CDU, marked ENG OIL TEMP.
- 11 The limitations are: CONTINUOUS -50 - 135 °C, 30-MINUTE LIMIT 135 - 150° C.
- 12 The No. 1 and No. 2 engine oil pressure. RED below 20 psi, GREEN 20 to 100 psi, RED above 100 psi, with 35 psi minimum at 90% Ng or above.
- 13 The No. 1 and No. 2 engine turbine gas temperature are also displayed on CDU digital readouts.
- 14 The ranges are GREEN 0 to 775 °C, AMBER 775 to 850 °C, above 850 °C is RED.
- 15 No. 1 and No. 2 engine gas generator tachometer information are also displayed on CDU digital readouts.
- 16 The normal range are GREEN 0 - 99%, AMBER 99 - 102%, RED 102 - 105%.
- 17 Lamp Test System. The lamp test provides a means of electrically checking all CDU scale lamps and digital readouts.

- 18 When the PUSH TO TEST switch on the CDU is pressed, all CDU scale lamps should illuminate and the digital readouts should display 888.
- 19 The DIM control allows the pilot to set a desired display light level of the CDU and PDUs in accordance with the ambient light, or override the auto-dim sensors.
- 20 If the auto-dim circuitry should fail or malfunction, turn the DIM control fully clockwise to regain illumination of the CDU and PDUs.
- 21 An ON/OFF DIGITS control switch located on the CDU is used to turn on or off the digital readout displays on the CDU and PDUs.
- 22 If a digital processor fails, all digital displays will go off.
- 23 The CDU and PDUs contain photocells that automatically adjust the lighting of the indicators with respect to ambient light.
- 24 If any one of the three photocells should fail, the lights on the vertical scales of the PDUs or CDU may not be at the optimum brightness for the ambient conditions.
- 25 The CDU failure lights, CHANNEL 1 and CHANNEL 2, are part of the Instrument Display System (IDS) fault detection circuit.
- 26 A failure of any SDC or CDU processing circuit, display driver module, or logic power supply, will cause the associated display channel to turn off or switch to the backup processor, and will light the associated CHANNEL failure light.
- 27 Failure of the lamp power supply within an SDC, will cause every second display light on the CDU to go off.

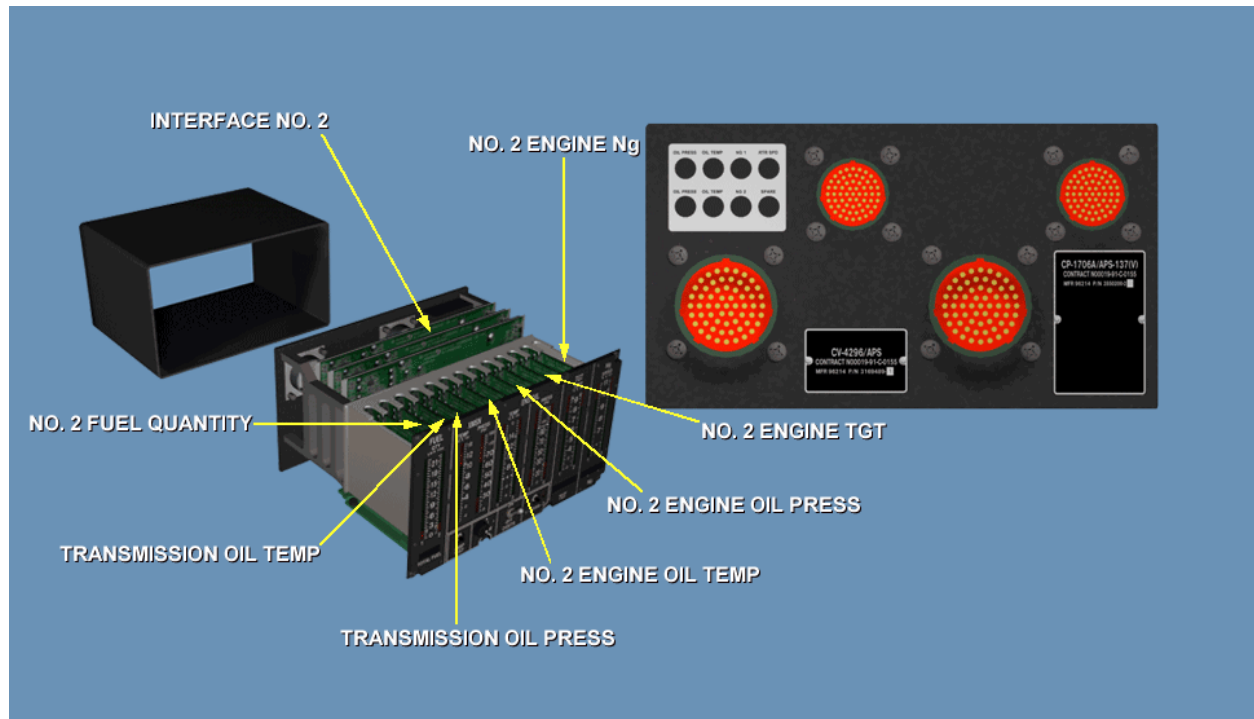
Frame #1026 (Central Display Unit)



28 On the back panel of the CDU there are four electrical connectors (J1, J2, J3, and J4), and eight fuses (seven used, one spare).

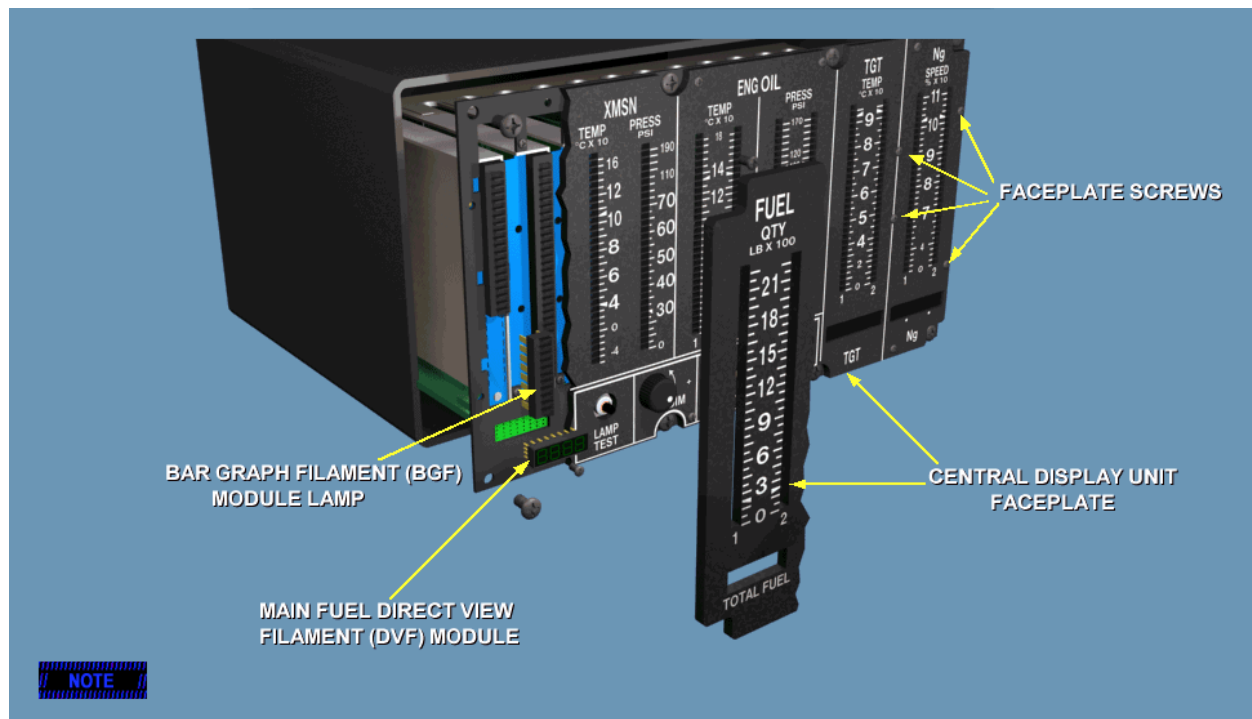
29 The CDU contains the following modules: No. 1 fuel quantity lamp driver module, No. 1 engine oil temperature lamp driver module, No. 1 engine oil pressure lamp driver module, No. 1 engine TGT lamp driver module, No. 1 Ng speed lamp driver module, Interface No. 1 module, Voltage regulator, and digital readout module.

Frame #1026A (Central Display Unit)



- 30 The CDU also contains the following modules: No. 2 fuel quantity lamp driver module, transmission oil temperature lamp driver module, transmission oil pressure lamp driver module, No. 2 engine oil temperature lamp driver module, No. 2 engine oil pressure lamp driver module, No. 2 engine TGT lamp driver module, No. 2 engine Ng speed lamp driver module, Interface No. 2 module.

Frame #1027 (CDU Lamp Replacement)



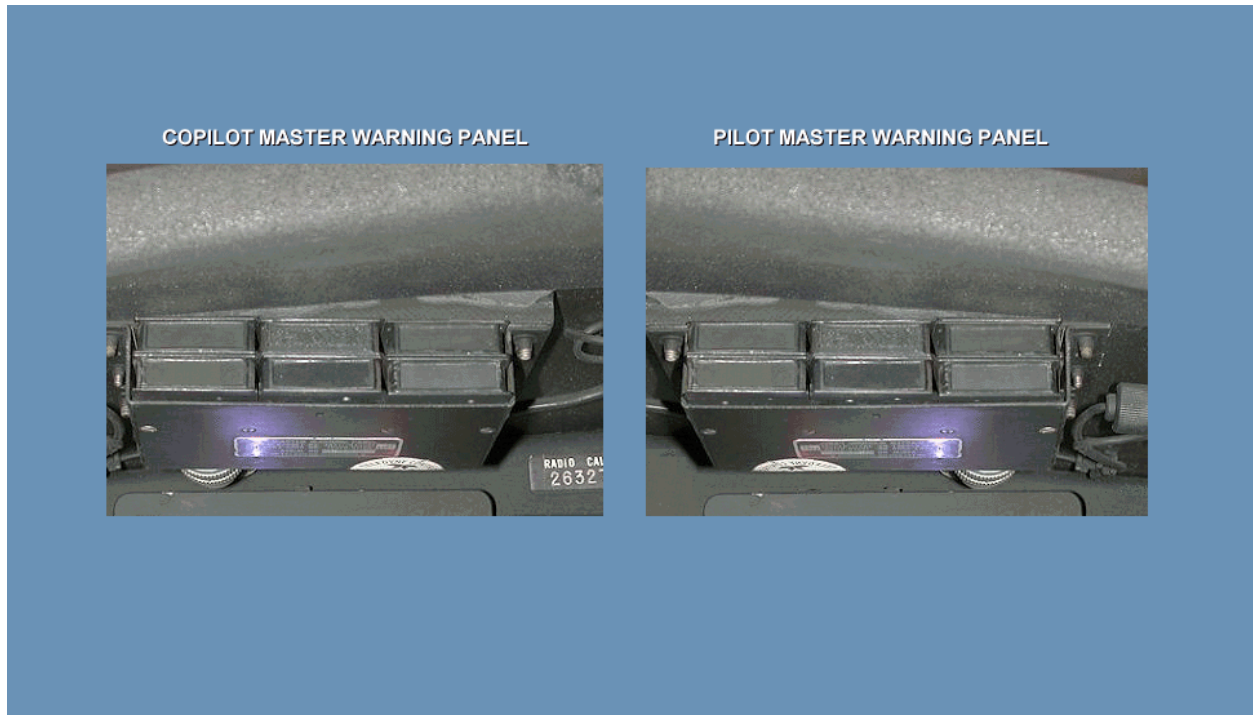
NOTE: These modules are interchangeable: Transmission oil temperature, No. 1 engine oil temperature, No. 2 engine oil temperature, No. 1 TGT, No. 2 TGT, No. 1 Ng speed, No. 2 Ng speed, No. 1 fuel quantity and No. 2 fuel quantity, No. 1 engine oil pressure and No. 2 engine oil pressure.

- 31 Prior to beginning the removal of the lamps for the CDU, turn off all electrical power.
- 32 Remove screws and washers from the faceplate on the central display unit (CDU).
- 33 Starting at lower right corner, carefully pull faceplate straight outward to disconnect lighting jack at rear, and remove faceplate.
- 34 Carefully remove Bar Graph Filament (BGF) lamp or Direct View Filament (DVF) module.
- 35 For reinstallation position lamp or module in required space and install.
- 36 Install faceplate on CDU using screws and washer.
- 37 Make sure area is clean and free of foreign material.

38 After all of the replacement is complete, perform an operational check of instrument display system.

i) Master Warning Panels

Frame #1090 (Master Warning Panel)



- 1 Two master warning panels, one on each side of the instrument panel glare shield.
- 2 The master warning panels receive 28 V dc signals from the instrument display system and the fire detection system to illuminate their associated warning capsules.
- 3 The IDS provides warning signals for low engine gas turbine speed and low rotor RPM.
- 4 The No. 1 and No. 2 ENG OUT capsules light steady when activated.
- 5 The LOW ROTOR RPM capsules flash at 3 to 5 flashes per second when activated.

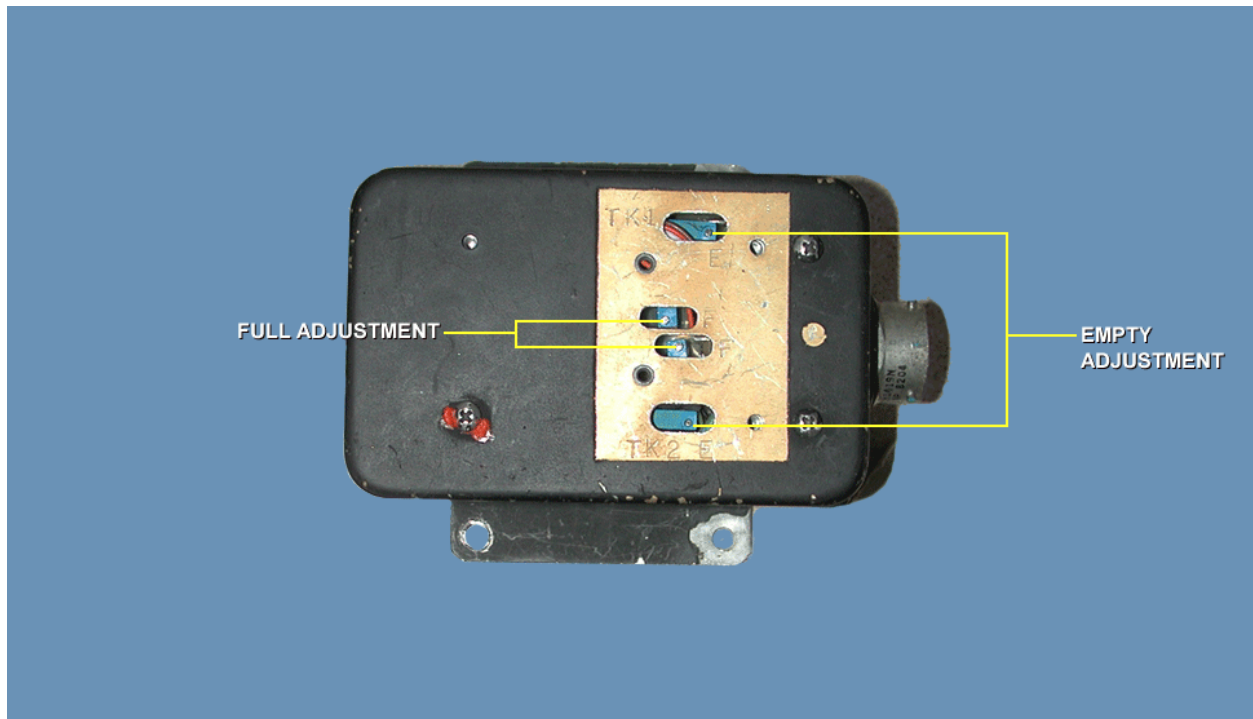
k)

Frame #1065 (Fuel Quantity Signal Conditioner)



- 1 The fuel quantity signal conditioner supplies dc current to the fuel low-level sensor circuitry.
- 2 The 28 V dc from the FUEL LOW WARN circuit breaker is then supplied through the fuel quantity signal conditioner, to the caution/advisory panel, causing the No. 1 FUEL LOW or No. 2 FUEL LOW caution light(s) to flash, as well as the pilot and copilot MASTER CAUTION lights on both Master Warning Panel.
- 3 Each light flashes when about a 20-minute fuel supply (172 pounds of fuel) remains in its tank.

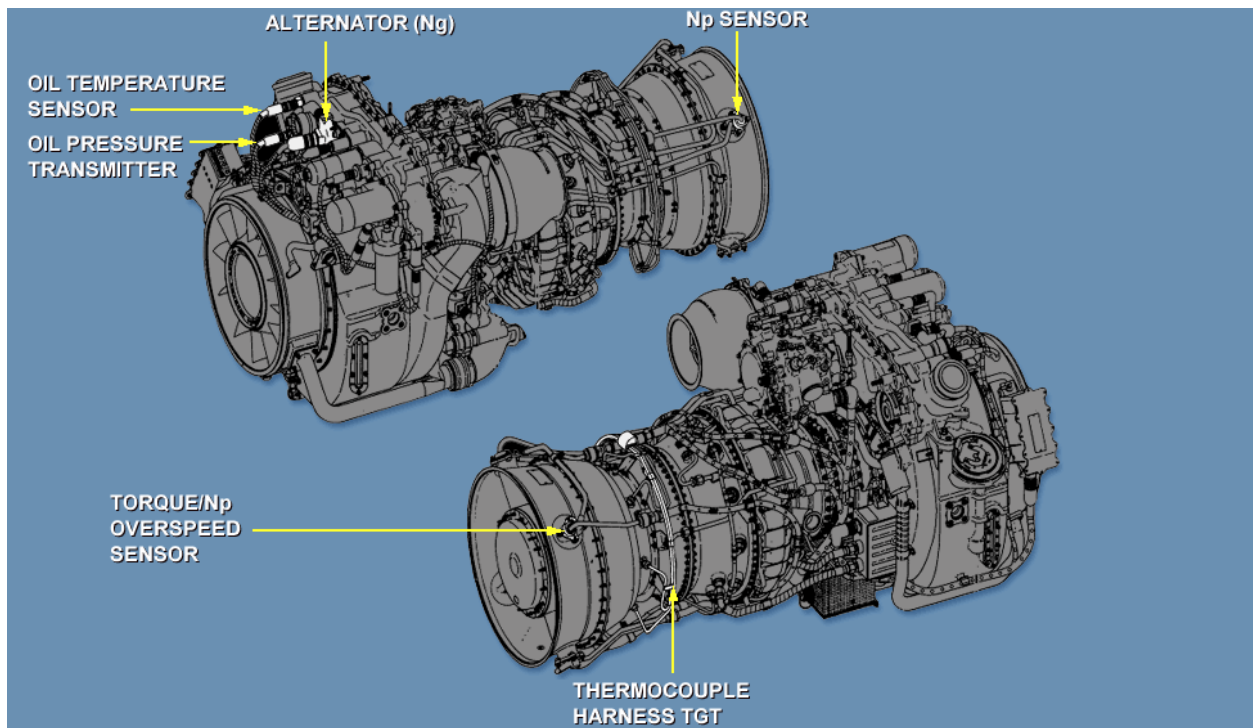
Frame #1067 (Fuel Quantity Signal Conditioner)



- 4 The signal conditioner has empty and full adjustments for each fuel cell.

I) Engine Sensors

Frame #1035 (Engine Sensors)



- 1 Engine mounted sensors include the Engine Power Turbine Speed (Np) sensor, alternator (Ng), engine oil temperature sensor, engine oil pressure transmitter, engine torque overspeed sensor, and Turbine Gas Temperature (TGT) inputs from the thermocouple harness.

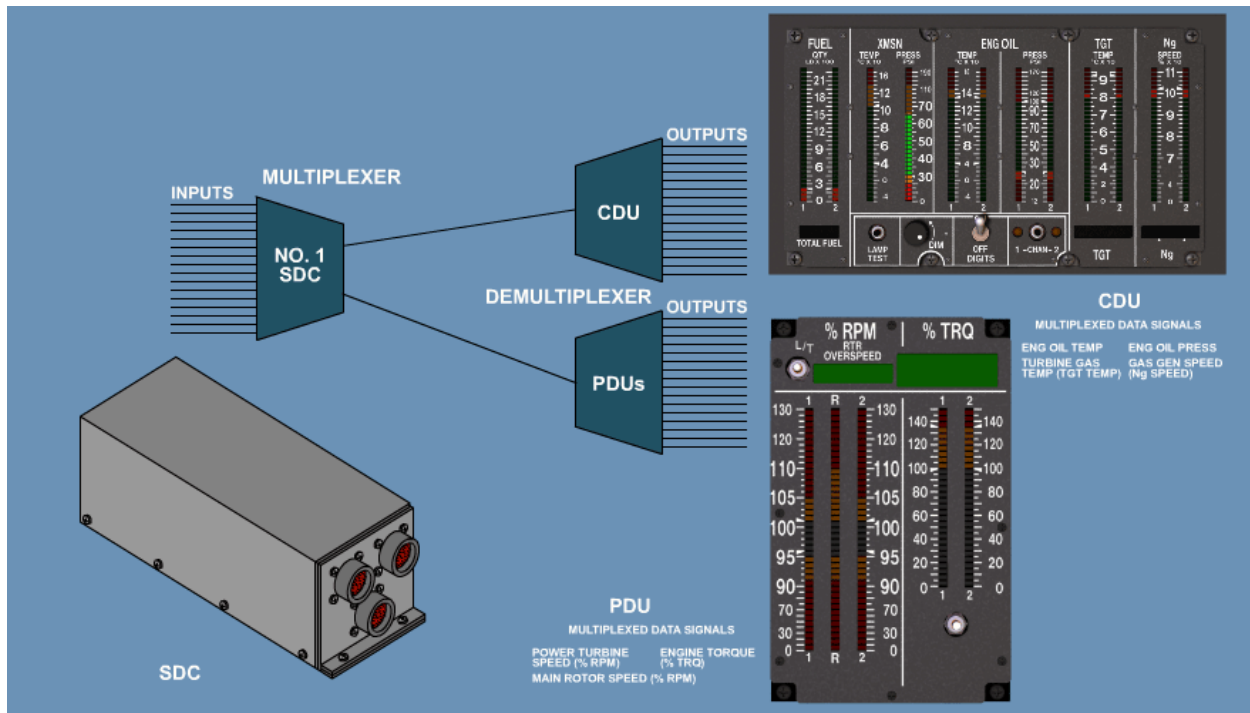
b. Operation

Frame #2000 (Instrument Display Operational Menu)



(1) Engine

Frame #2020 (Multiplexing)



- (a) Multiplexing is the combining of two or more signals for transmission over a shared wire, the signals are combined at the transmitter by a multiplexer and split up at the receiver by a demultiplexer.
- (b) The No. 2 SDC operates identical to the No. 1 SDC.

Frame #2015 (Engine Instrument Display System Operation Menu)

NO. 1 or NO. 2 ENG OIL PRESS SENSOR SIGNAL

NO. 1 or NO. 2 ENG PWR TURB TACH SIGNAL

NO. 1 or NO. 2 ENG OIL TEMP SENSOR SIGNAL

MAIN ROTOR SPEED SENSOR SIGNAL

NO. 1 or NO. 2 TURB GAS TEMP SENSOR SIGNAL

MAIN XMSN OIL TEMP SENSOR SIGNAL

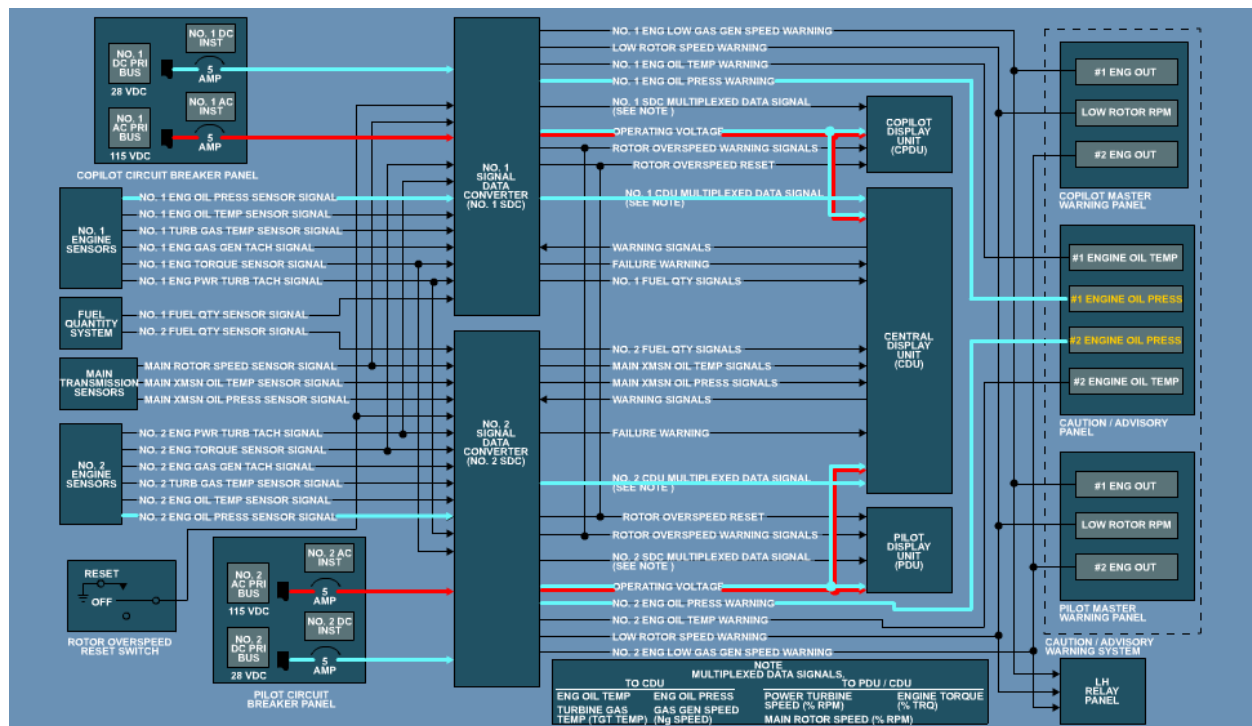
NO. 1 or NO. 2 ENG GAS GEN TACH SIGNAL

MAIN XMSN OIL PRESS SENSOR SIGNAL

NO. 1 or NO. 2 ENG TORQUE SENSOR SIGNAL

FUEL QUANTITY SYSTEM

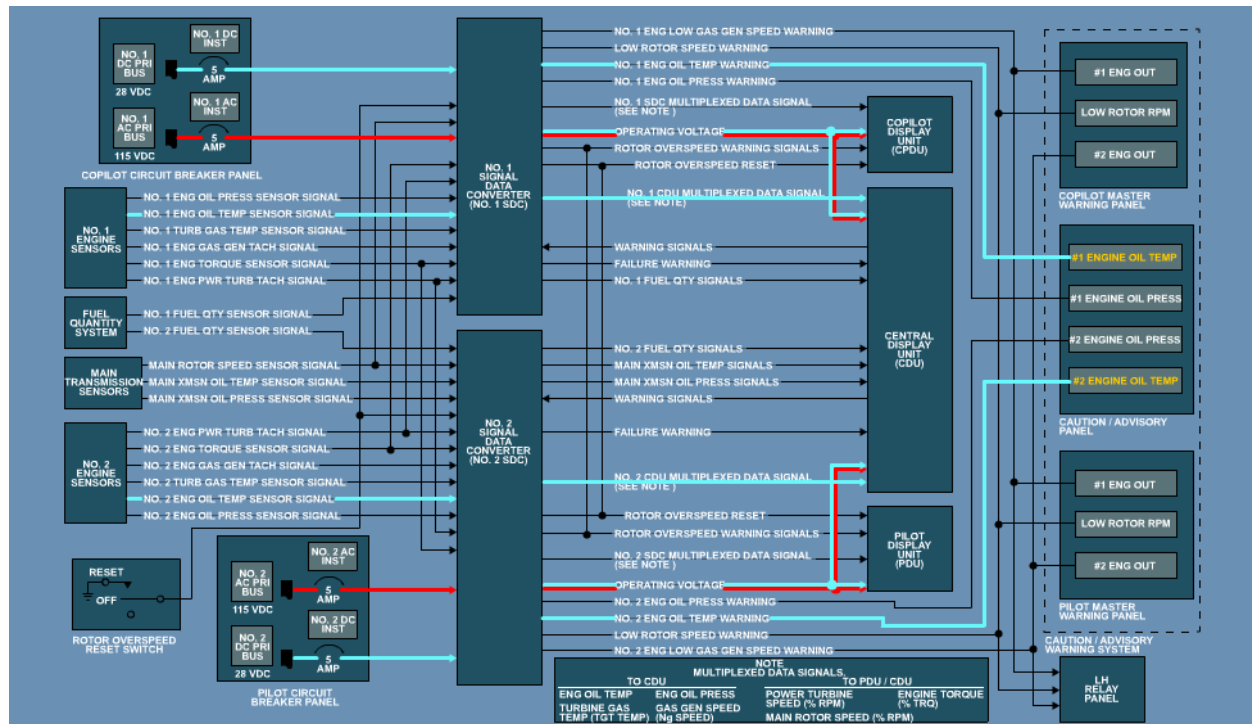
Frame #4105 (NO.1 or NO. 2 ENG OIL PRESS SENSOR SIGNAL FLASH)



(c) No.1 or No. 2 Engine Oil Pressure Sensor Signal Operation

- 1) Each SDC contains a lamp power supply that limits the light intensity of the IDS displays.
- 2) The No. 1 SDC lamp power supply provides voltage to all copilot PDU displays, alternate lamps on the CDU analog displays, and No. 1 engine and total fuel CDU digital displays.
- 3) The No. 2 SDC lamp power supply provides voltage to all PDU displays and alternate lamps on the CDU analog display; and No. 2 engine CDU digital displays.
- 4) The #1 or the #2 ENGINE OIL PRESS capsule will illuminate whenever the No. 1 or the No. 2 engine oil pressure is less than 20 psi for UH-60A, and 22 psi for UH-60L.

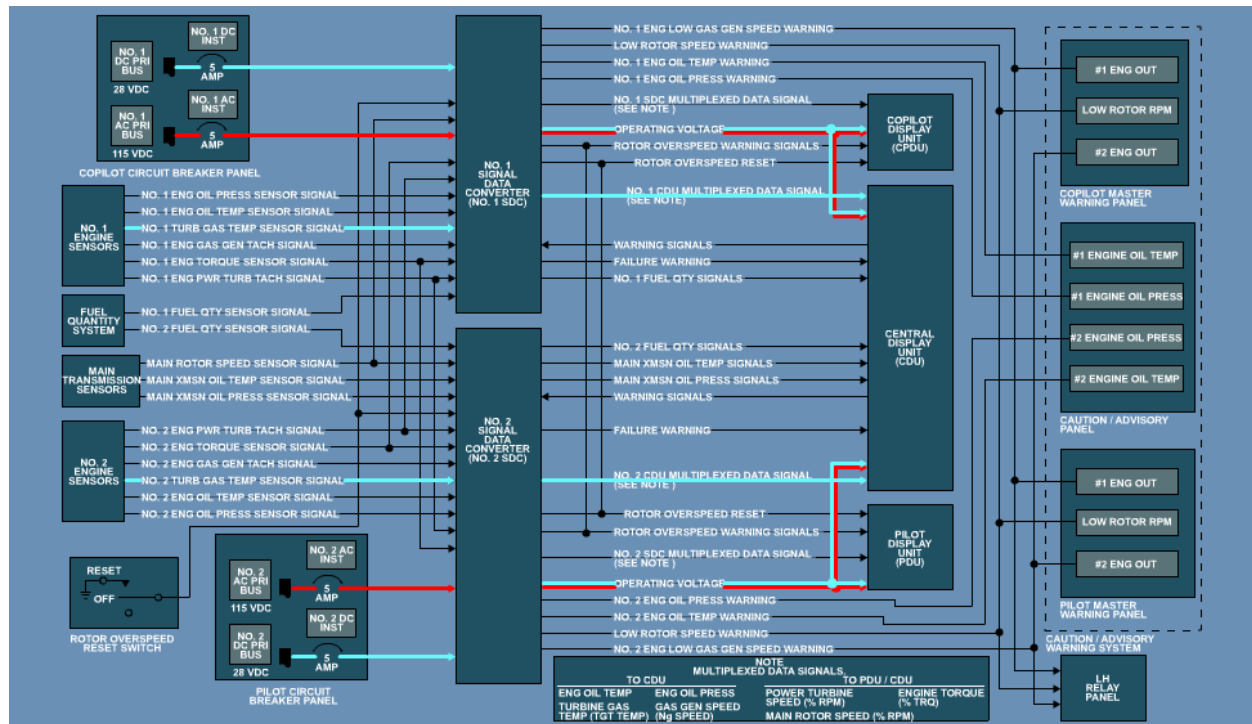
Frame #4110 (NO.1 or NO. 2 ENG OIL TEMP SENSOR SIGNAL FLASH)



(d) No.1 or No. 2 Engine Oil Temperature Sensor Signal Operation

- 1) The #1 or the #2 ENGINE OIL TEMP capsule will be on whenever the No. 1 or the No. 2 engine oil temperature is more than 150 °C.

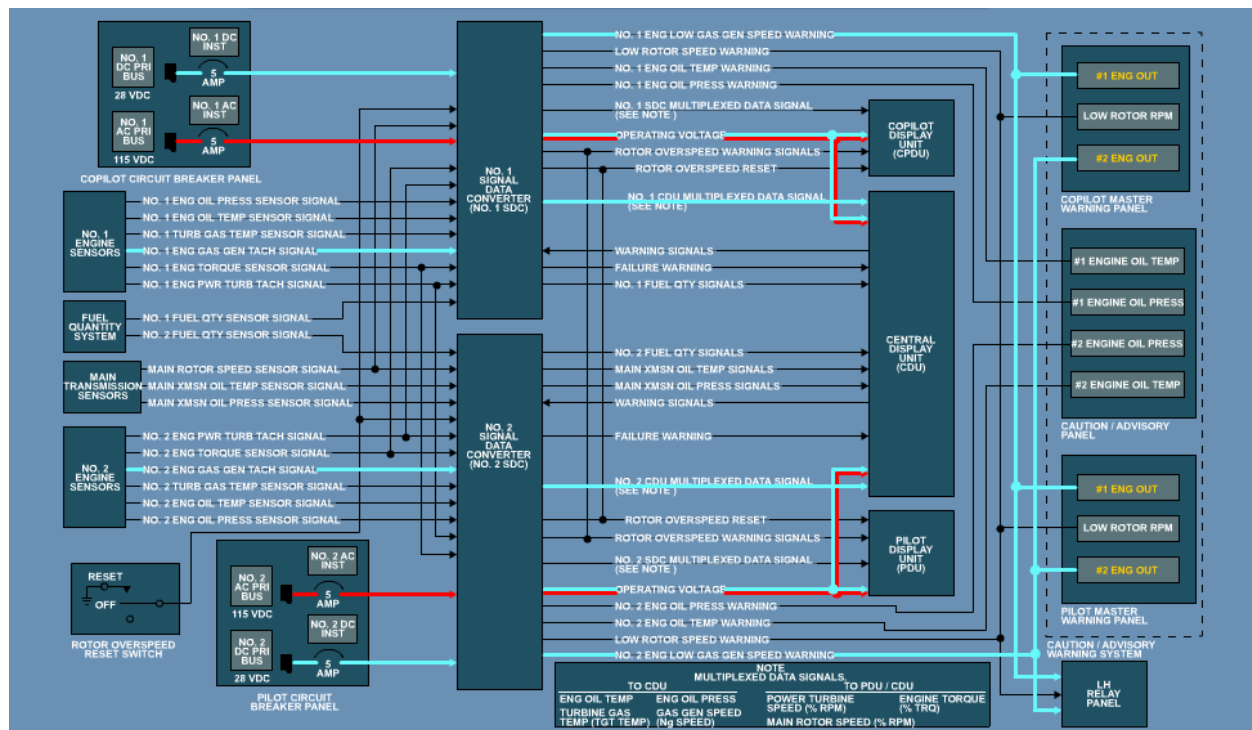
Frame #4115 (NO.1 or NO.2 TURB GAS TEMP SENSOR SIGNAL FLASH)



(e) No.1 or No. 2 Turbine Gas Temperature Sensor Signal Operation

- 1) The #1 or the #2 TGT sensor sends a signal through the No. 1 and the No. 2 SDC to display on the CDU.
- 2) The normal parameters of the TGT signal are 538 °C to 775 °C.

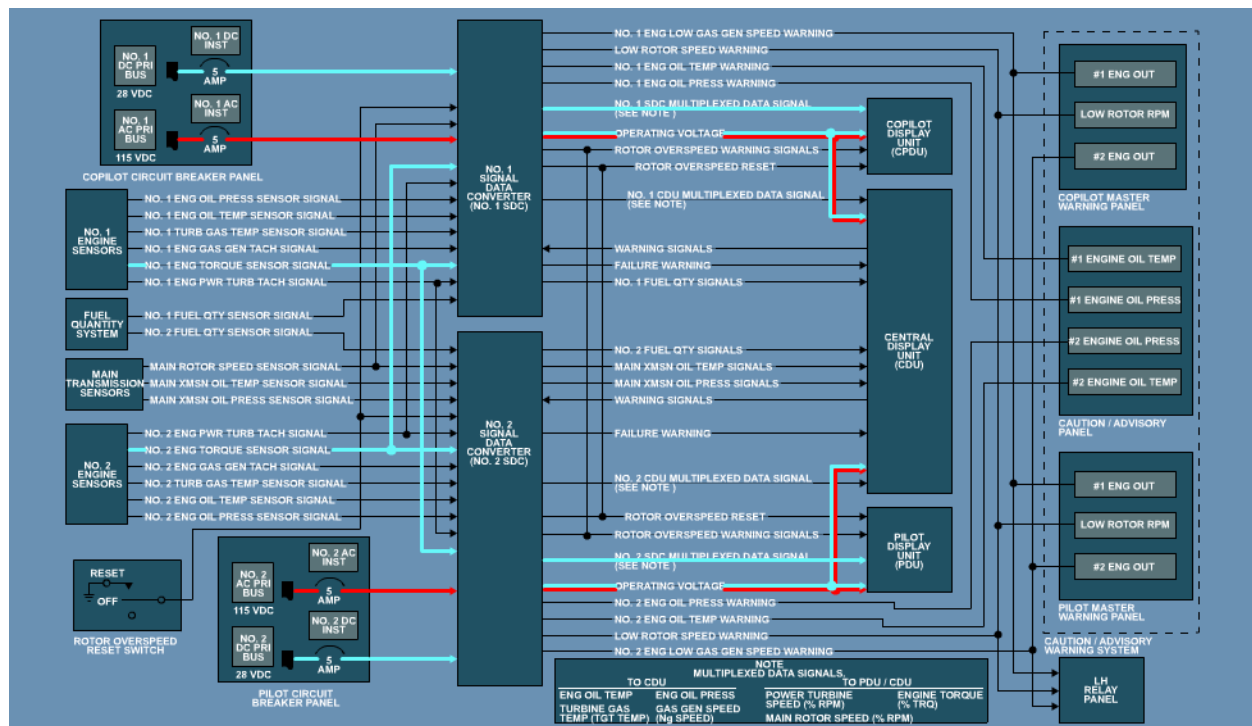
Frame #4120 (NO.1 or NO.2 ENG GAS GEN TACH SIGNAL FLASH)



(f) No.1 or No.2 Engine Gas Generator Tach Signal Operation

- 1) The No. 1 and No. 2 eng gas generator speed indicating signal (Ng) is sent from the alternator to the No. 1 and No. 2 SDC's.
- 2) The #1 ENG OUT capsules will be illuminated whenever the No. 1 or the No. 2 engine gas generator tachometer is less than 55%.
- 3) The normal range is 0% - 102%.

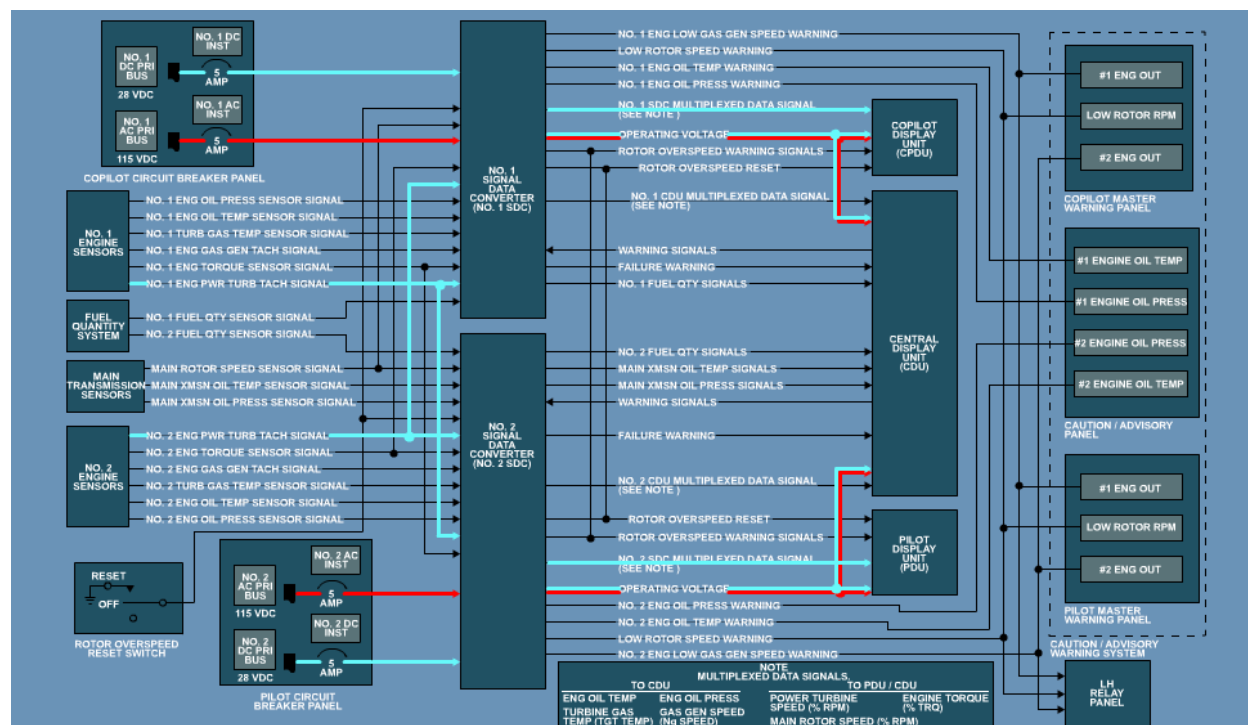
Frame #4125 (NO.1 or NO.2 ENG TORQUE SENSOR SIGNAL FLASH)



(g) No.1 or No.2 Engine Torque Sensor Signal Operation

- 1) A torque sensor on each power turbine drive shaft senses the amount of power the engine is supplying to the main transmission by measuring the twist of the shaft.
- 2) The signal is sent from the sensor to the No. 1 and No. 2 SDC.
- 3) The SDC sends the signal to the CPDU and the PDU.
- 4) Normal range is 0% to 100%.

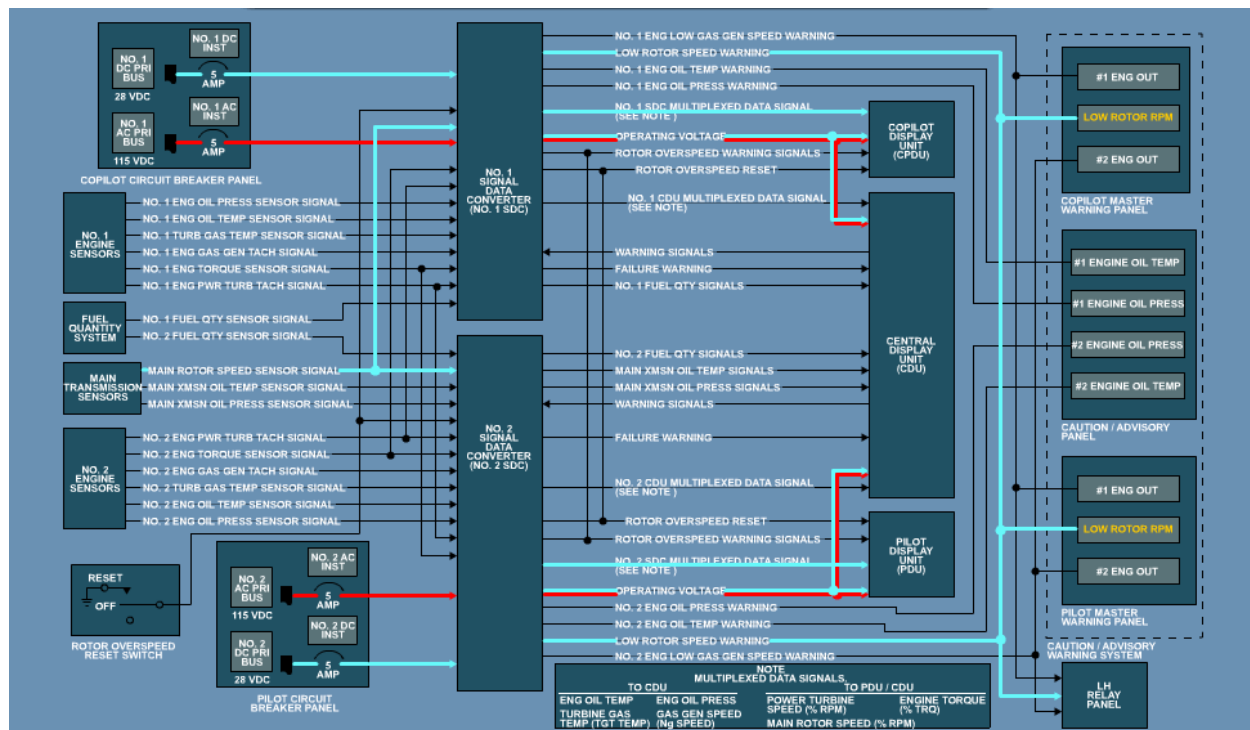
Frame #4130 (NO.1 or NO.2 ENG PWR TURB TACH SIGNAL FLASH)



(h) No.1 or No.2 Engine Power Turbine Tach Signal Operation

- 1) Power turbine speed is indicated in percentage Np, on the pilot display units.
- 2) The power turbine speed indicating system consists of electrical sensors on each engine drive shaft, and vertical scale indicators marked % RPM 1 and 2 on each PDU.
- 3) The power turbine speed indicator scale is 0 to 130% RPM.
- 4) Normal range is 96% to 101%.

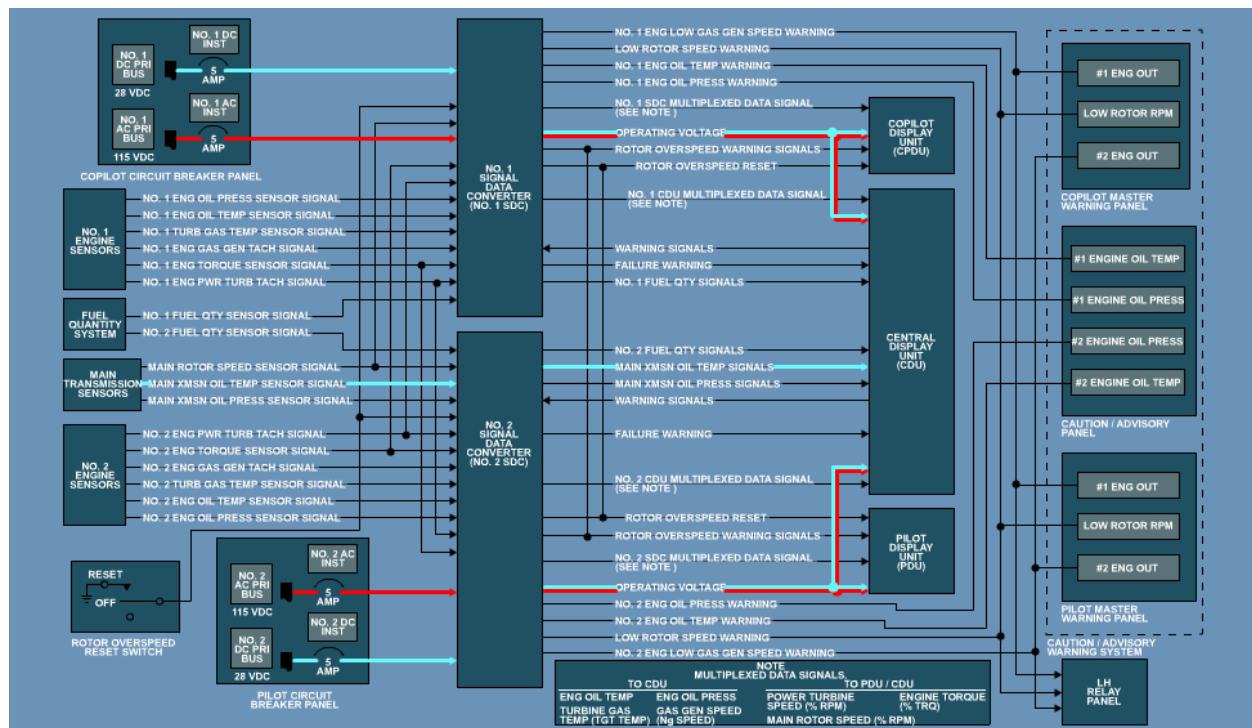
Frame #4135 (MAIN ROTOR SPEED SENSOR SIGNAL FLASH)



(i) Main Rotor Speed Sensor Signal Operation

- 1) The main Rotor speed signal is sent from the speed sense pickup on the rear of the right accessory input module of each engine to No. 1 and No. 2 SDC.
- 2) The signal from the SDC is sent to the CPDU and the PDU for display.
- 3) If low rotor speed is sensed within the SDC a low rotor speed warning signal is sent to the Pilot and Copilot Warning Panel and the Low Rotor RPM capsule will illuminate. In flight a low rotor audible signal will also be heard in the ICS.
- 4) The LOW ROTOR RPM capsule will be illuminated whenever the main rotor speed is less than 96%. Normal range is 96%-105%.

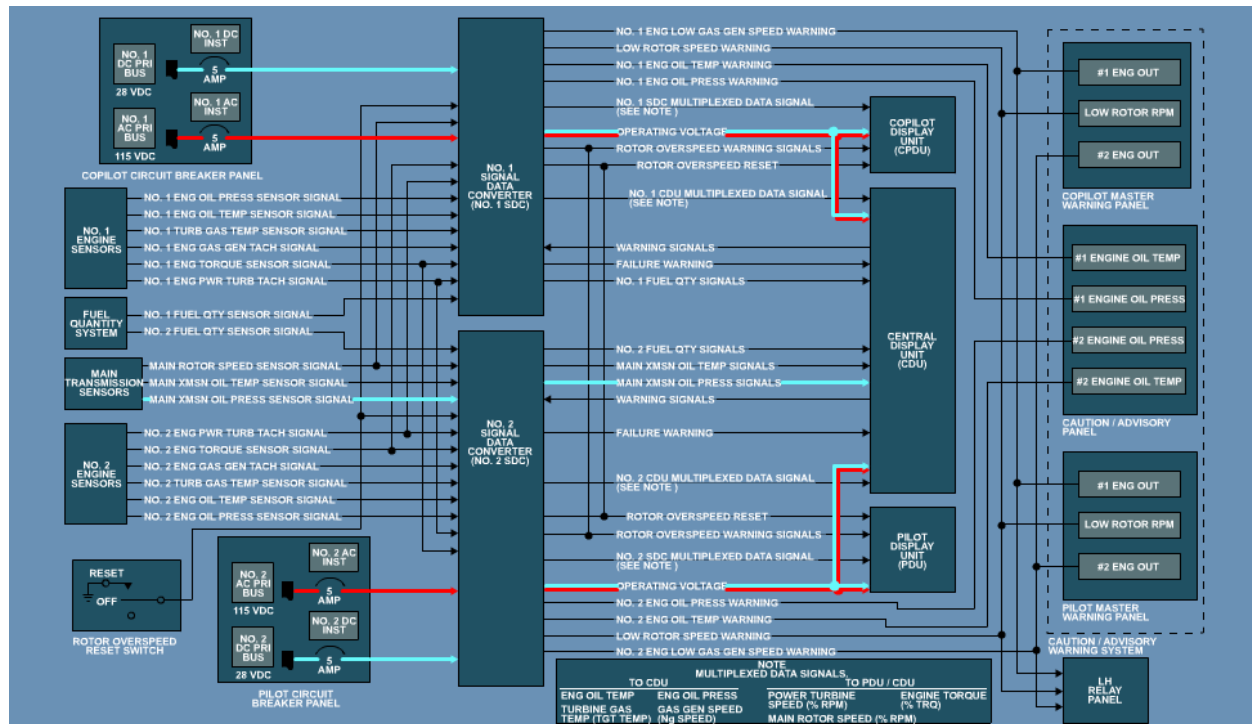
Frame #4140 (MAIN XMSN OIL TEMP SENSOR SIGNAL FLASH)



(j) Main Transmission Oil Temperature Sensor Signal Operation

- 1) The MAIN XMSN OIL TEMP indicator gives a main transmission temperature in degrees Celsius.
- 2) The Signal is sent from the Main Transmission Sensor to the No. 2 SDC.
- 3) From the No. 2 SDC the signal is sent to the CDU.
- 4) The indicator ranges are GREEN 50° to 120 °C, AMBER 120° to 140 °C, RED 140° to 170 °C.

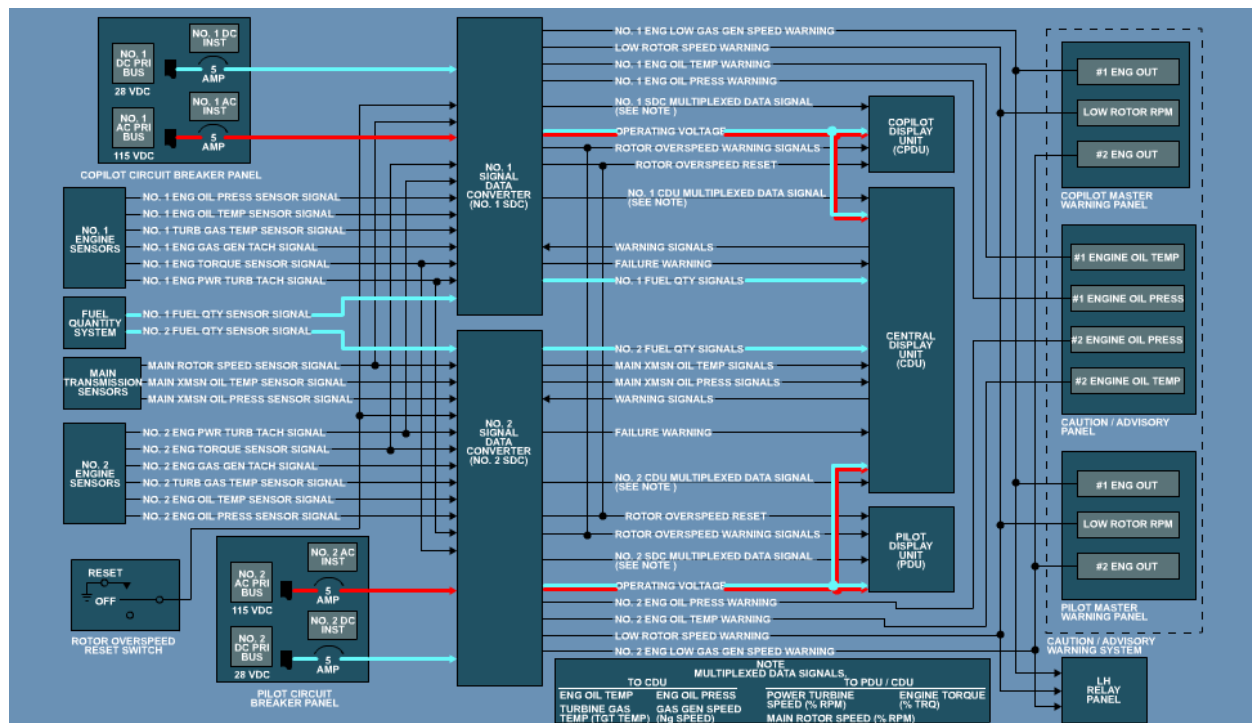
Frame #4145 (MAIN XMSN OIL PRESS SENSOR SIGNAL FLASH)



(k) Main Transmission Oil Pressure Sensor Signal Operation

- 1) The MAIN XMSN OIL PRESS indicator gives main transmission oil pressure in psi.
- 2) The MAIN XMSN OIL PRESS signal is sent from the sensor to the No. 2 SDC and from the No. 2 SDC the signal is sent to the CDU for display.
- 3) Indicator ranges are GREEN 30 to 65 psi, AMBER 65 to 130 psi, RED 130 to 190 psi.

Frame #4150 (FUEL QUANTITY SYSTEM FLASH)



(I) Fuel Quantity System Operation

- 1) The No. 1 and No. 2 fuel quantity signals are routed through the No. 1 and the No. 2 SDC and processed in the CDU.
- 2) Total fuel quantity is displayed on a digital readout.
- 3) Additional information on CDU analog displays is given in tabular data.

Frame #2025 (Engine Instrument Display System Operation Menu)

NO. 1 or NO. 2 ENG GAS GEN TACH SIGNAL

NO. 1 or NO. 2 ENG OIL PRESS SENSOR SIGNAL

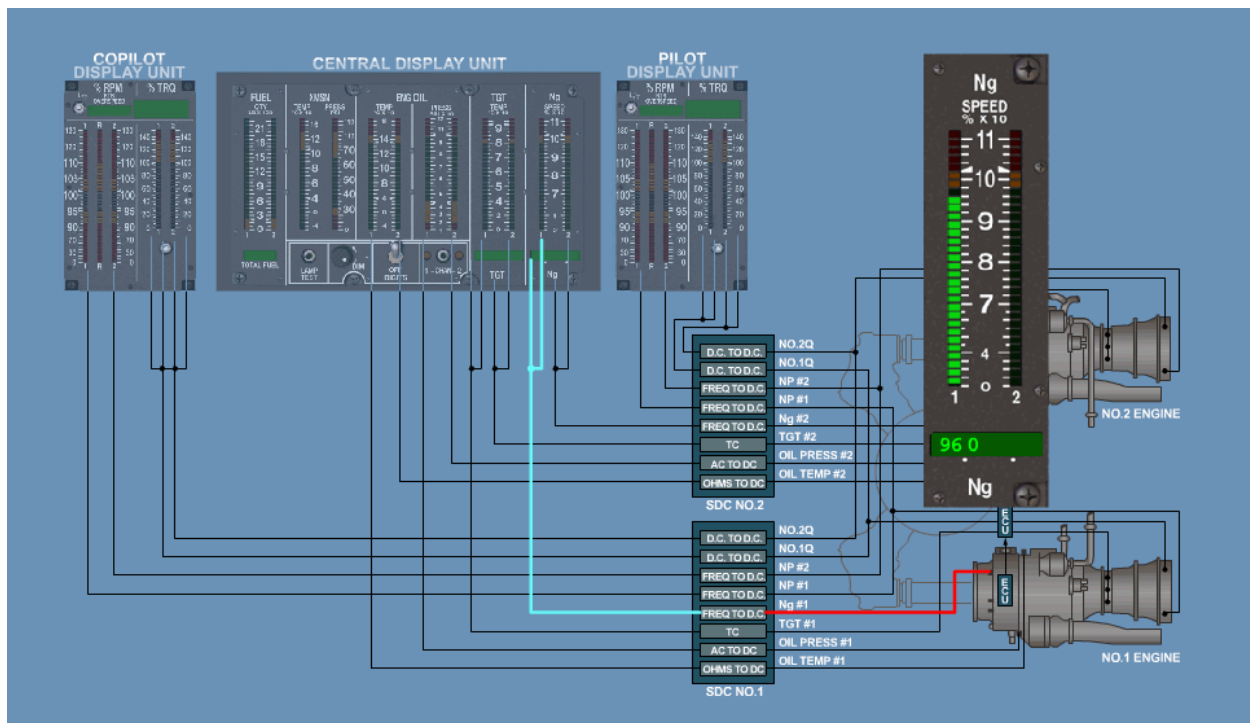
NO. 1 or NO. 2 ENG OIL TEMP SENSOR SIGNAL

NO. 1 or NO. 2 TURB GAS TEMP SENSOR SIGNAL

NO. 1 or NO. 2 ENG TORQUE SENSOR SIGNAL

MAIN ROTOR SPEED SENSOR SIGNAL

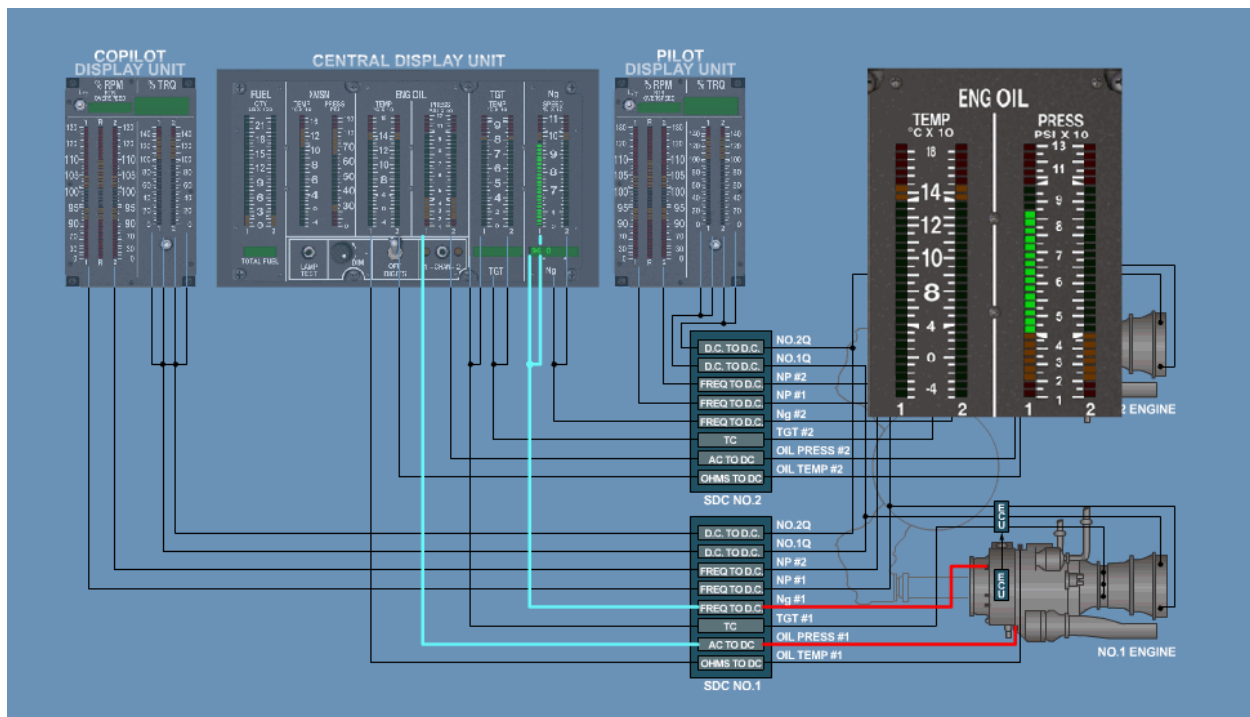
Frame #4075 (NO.1 or NO. 2 ENG GAS GEN TACH SIGNAL FLASH)



(m) No.1 or No. 2 Engine Gas Generator Tach Signal Operation

- 1) The indication systems for No. 1 and No. 2 engines are identical, so only the number one will be covered.
- 2) The engine mounted alternator produces a frequency based signal, which is converted to a Vdc signal by the No.1 SDC.
- 3) This signal is then routed to the Ng SPEED indicator on the CDU.

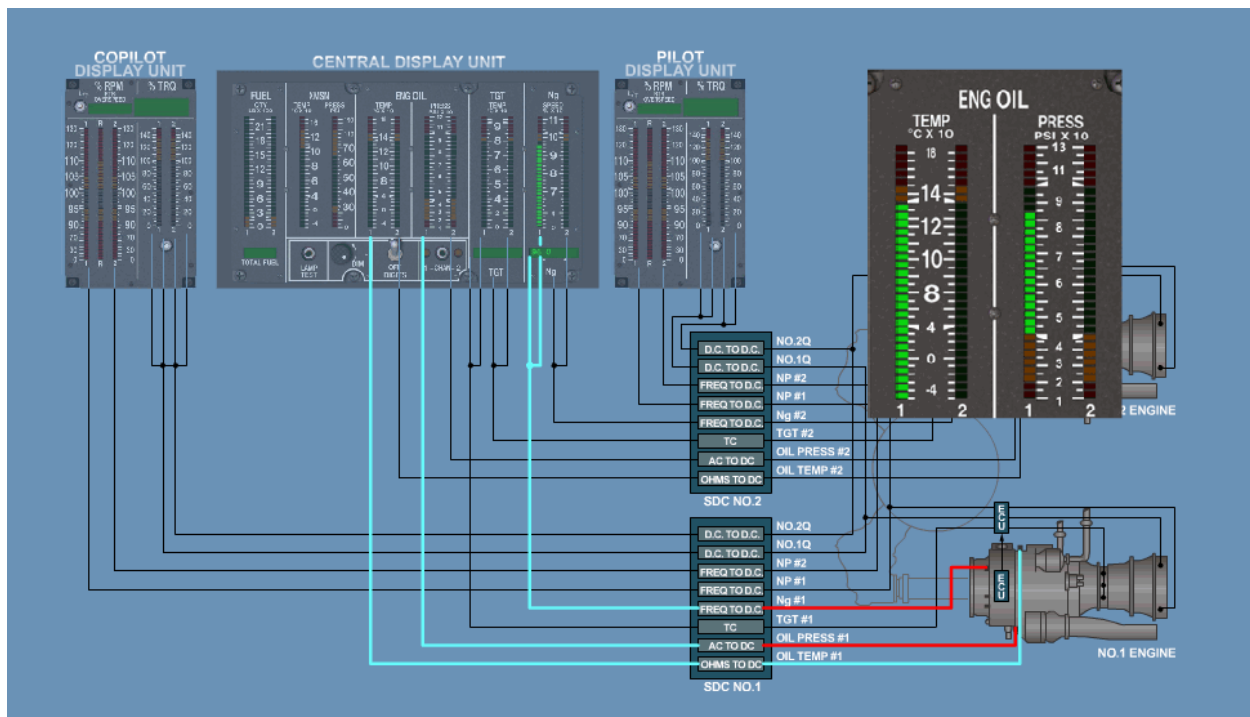
Frame #4080 (NO.1 or NO. 2 ENG OIL PRESS SENSOR SIGNAL FLASH)



(n) No.1 or No. 2 Engine Oil Pressure Sensor Signal Operation

- 1) The No. 1 engine oil pressure sensor produces a Vac signal, which is converted to a Vdc signal by the No.1 SDC.
- 2) This signal is then routed to the ENG OIL PRESS indicator on the CDU.

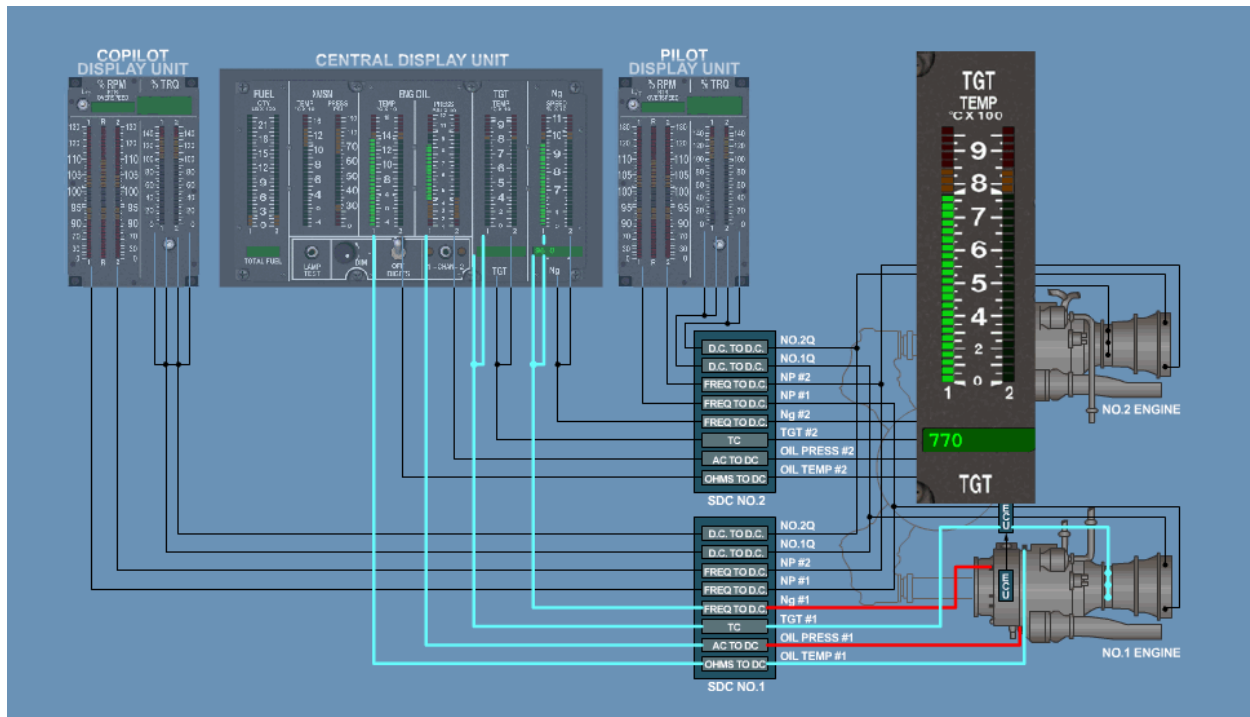
Frame #4085 (NO.1 or NO. 2 ENG OIL TEMP SENSOR SIGNAL FLASH)



(o) No.1 or No. 2 Engine Oil Temperature Sensor Signal Operation

- 1) The No. 1 engine oil temp sensor produces a ohms signal, which is converted to a Vdc signal by the No.1 SDC.
- 2) This signal is then routed to the ENG OIL, TEMP indicator on the CDU.

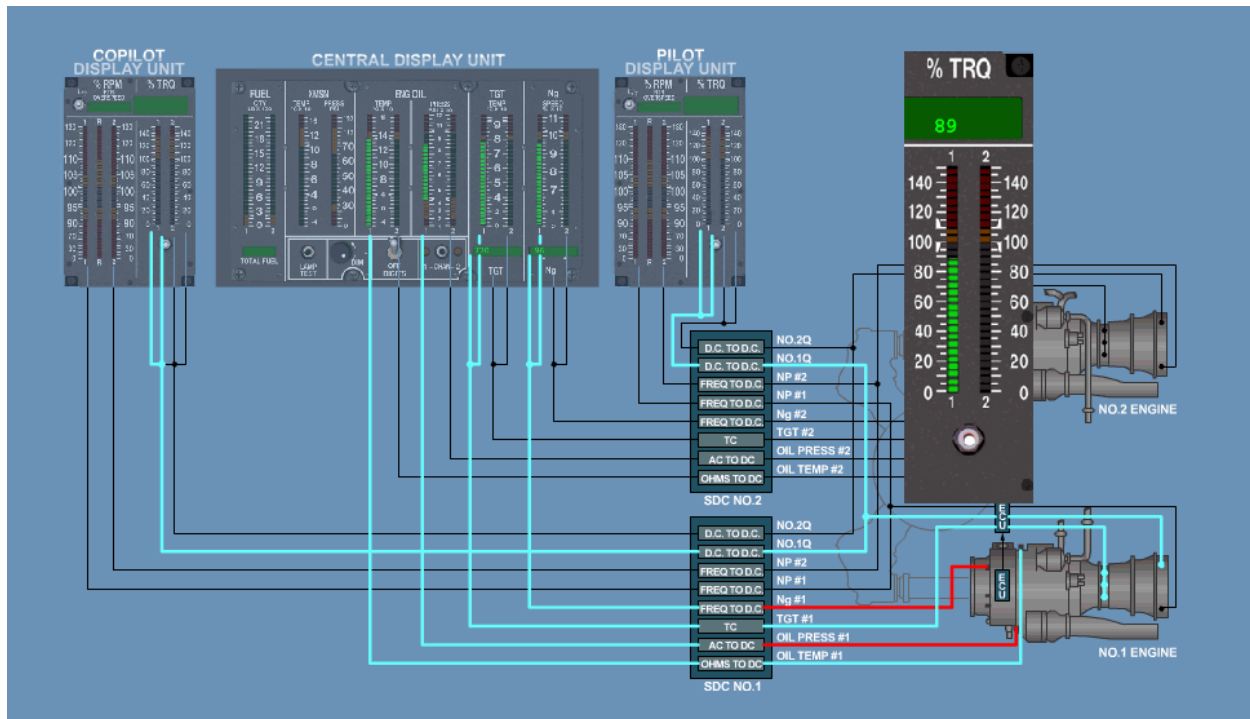
Frame#4090 (NO.1 or NO.2 TURB GAS TEMP SENSOR SIGNAL FLASH)



(p) No.1 or No. 2 Turbine Gas Temperature Sensor Signal Operation

- 1) The No. 1 engine thermocouple harness produces a Vdc signal, which is routed through the No.1 SDC.
- 2) This signal is then routed to the TGT TEMP indicator on the CDU for the No.1 engine.

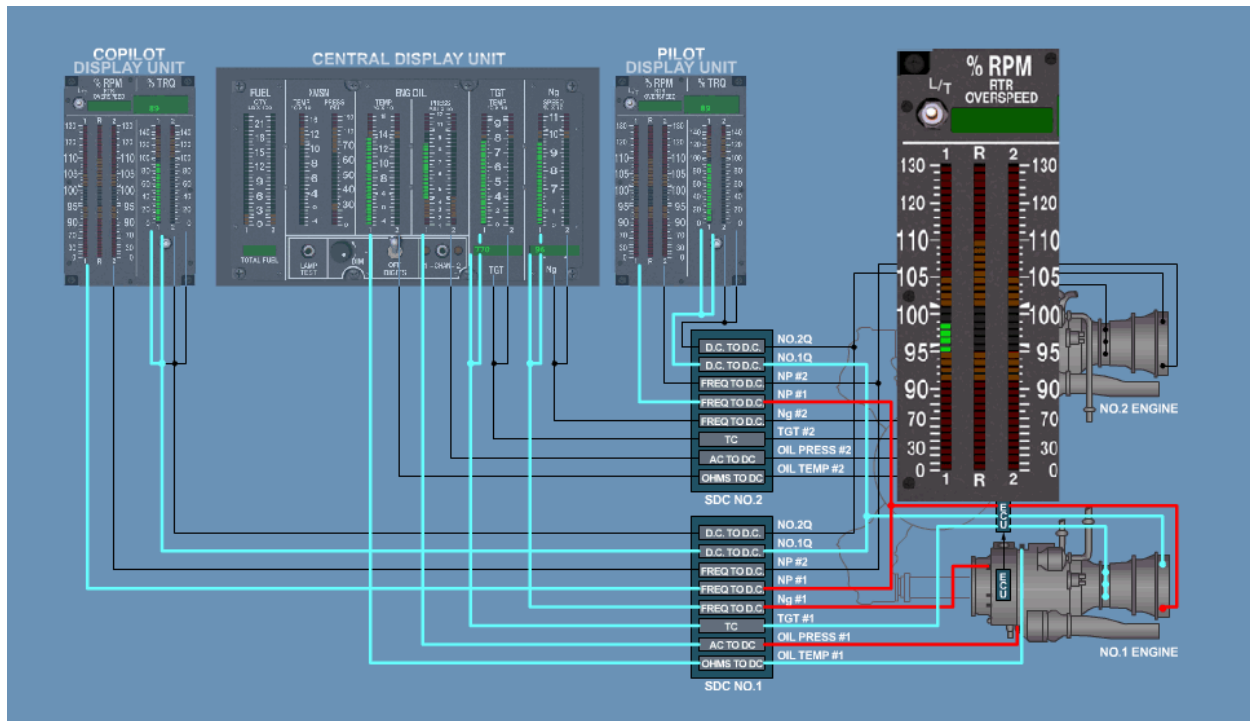
Frame #4095 (NO.1 or NO.2 ENG TORQUE SENSOR SIGNAL FLASH)



(q) No.1 or No.2 Engine Torque Sensor Signal Operation

- 1) The No. 1 engine torque sensor produces a Vdc signal, which is routed through the No.1 SDC.
- 2) This signal is then routed to the % TRQ indicator on both PDUs, for the No.1 engine.

Frame #4100 (MAIN ROTOR SPEED SENSOR SIGNAL FLASH)

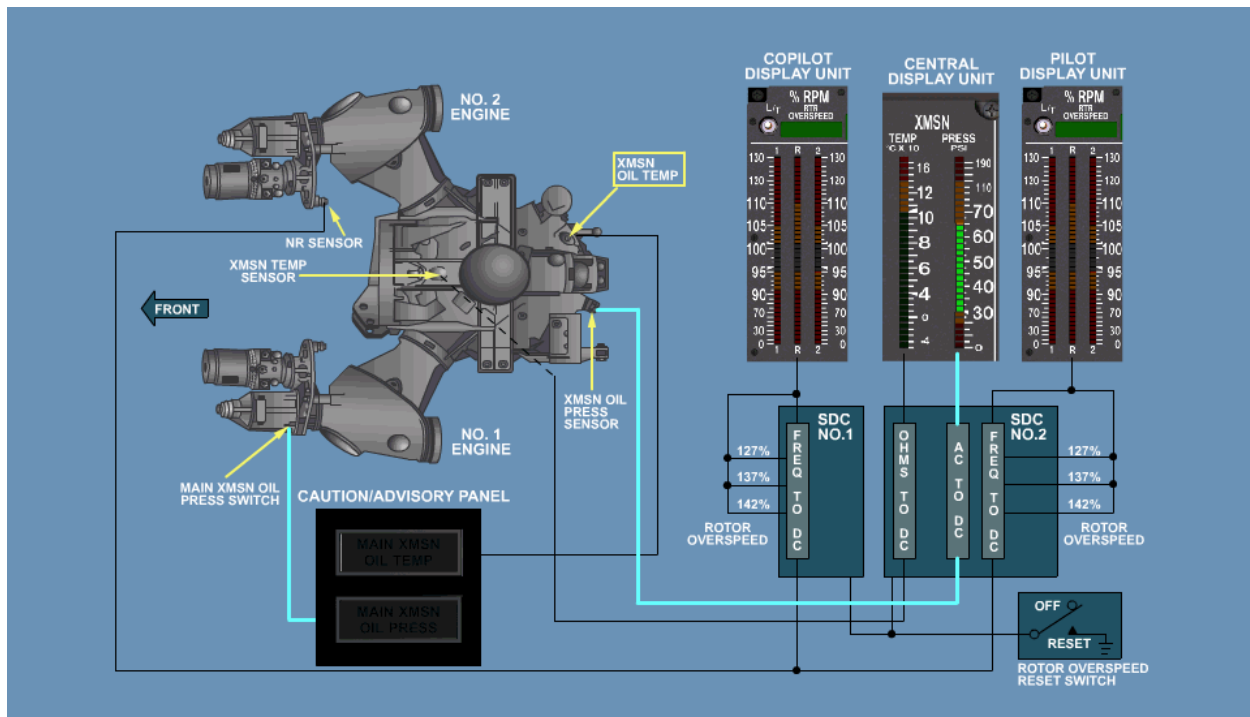


(r) Main Rotor Speed Sensor Signal Operation

- 1) The No. 1 engine Np sensor produces a frequency based signal Vdc signal, which is converted to a Vdc signal routed through both SDCs.
- 2) This signal is then routed to the % RPM indicator on both PDUs, for the No. 1 engine.

(2) Main Transmission

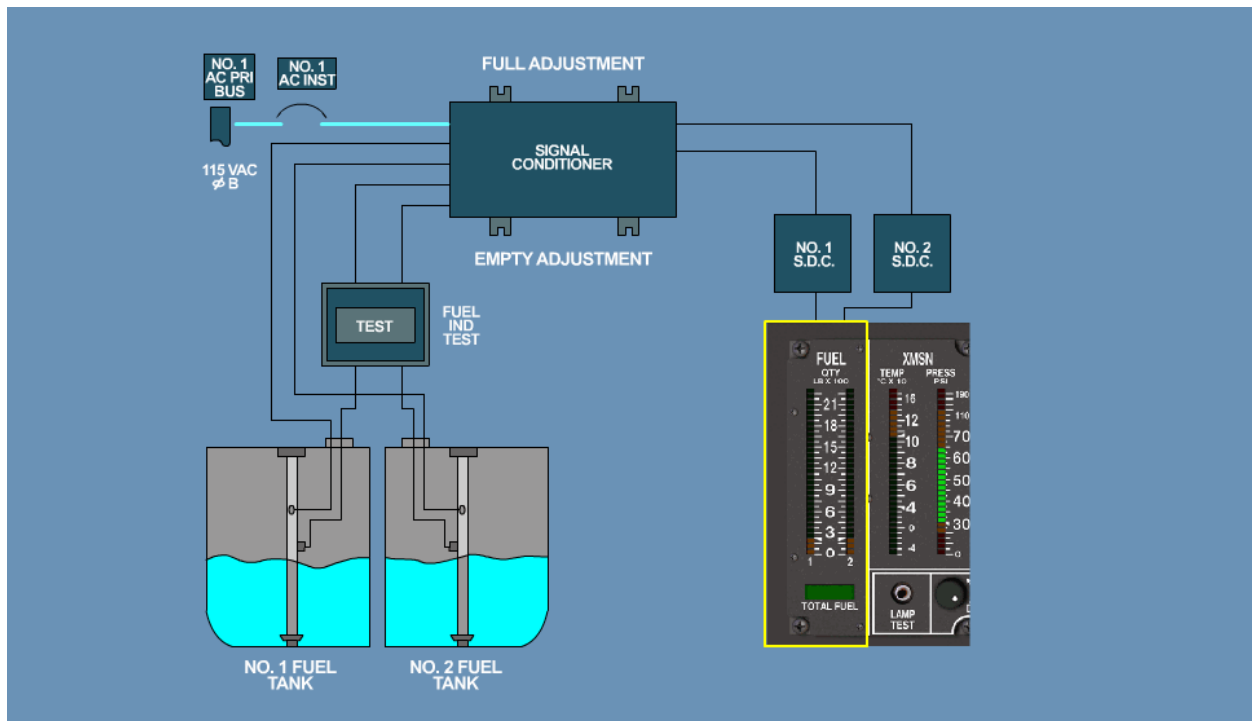
Frame #2010 (Transmission Indicating System FLASH)



- (a) The warning and indicating systems indicate possible troubles in the transmission system.
- (b) They cover oil pressure and oil temperature indications on the main transmission.
- (c) The MAIN XMSN OIL TEMP caution appears, in the caution/advisory panel CDU and caution/advisory panel, when transmission oil temperature reaches 120 °C.
- (d) The oil pressure warning system has an oil pressure switch in the left accessory module connected to the MAIN XMSN OIL PRESS light in the caution/advisory panel.
- (e) When the oil pressure in the left accessory module falls below 14 PSI, the switch turns on the MAIN XMSN OIL PRESS light.
- (f) The NR sensor sends a signal to the No. 1 and No. 2 SDCs, which converts it to a dc signal and sends it to the respective PDU.

(3) Fuel Quantity

Frame #2030 (Fuel Quantity Indicating System FLASH)



- (a) The No. 1 and No. 2 fuel quantity signals are routed through the signal conditioner to the No. 1 SDC and No. 2 SDC, which route the signals to the CDU
- (b) Total fuel quantity is displayed on a digital readout.

CHECK ON LEARNING

1. How many analog displays does the Central Display Unit contain?
2. Where does the No. 1 and No. 2 Engine Gas Generator speed signal (Ng) originate?
3. What is the temperature that will cause the No. 1 or No. 2 ENG OIL TEMP capsule to illuminate?

SECTION III. - SUMMARY

1. REVIEW/SUMMARIZE:

You have completed the function of the Instrument Display system topic for the UH-60 helicopter

The key points to remember are:

- The instrument display system (IDS), used in conjunction with engine and subsystem sensors (temperature, pressure, torque, fuel and RPM), provides the pilots with engine and subsystem monitoring.
- The Signal Data Converter (SDC) processes sensor signals and provides proportional digital signals in a multiplexed format to the Central Display Unit (CDU) and the Pilot Display Unit (PDU).
- The Pilot Display Unit (PDU) receives signal and power inputs from an associated Signal Data Converter (SDC) and Central Display Unit (CDU). The PDU contains five analog vertical scale displays, two digital displays, three indicator lights and a photocell.
- The Central Display Unit (CDU), receives signal and power inputs from both the No. 1 and No. 2 Signal Data Converter (SDC). The CDU contains twelve analog displays, five digital displays, and two failure lights.
- Engine mounted sensors include the Engine Power Turbine Speed (Np) sensor, alternator, engine oil temperature sensor, engine oil pressure transmitter, engine torque overspeed sensor, and Turbine Gas Temperature (TGT) inputs from the thermocouple harness.
- The No. 1 and No. 2 eng gas generator speed indicating signal (Ng) is sent from the alternator to the No. 1 and No. 2 SDC panel. The #1 ENG OUT capsules will be illuminated whenever the No. 1 or the No. 2 engine gas generator tachometer is less than 55%. The normal range is 0% - 102%.
- Multiplexing is the combining of two or more signals for transmission over a shared wire. The signals are combined at the transmitter by a multiplexer and split up at the receiver by a demultiplexer.
- The #1 or the #2 ENGINE OIL TEMP capsule will be on whenever the No. 1 or the No. 2 engine oil temperature is more than 150 °C.

B. ENABLING LEARNING OBJECTIVE ELO No.2

ACTION: Identify the function of the Caution/Advisory Warning System.

CONDITIONS: As a UH-60 Maintenance Test Pilot.

STANDARDS: Using TM 1-1520-237-10, TM 1-1520-237-23-2, TM 1-1520-237-MTF, and TM 11-1520-237-23-2.

a. Caution/Advisory Warning System Menu

Frame #3002 (Caution/Advisory Warning System Menu)

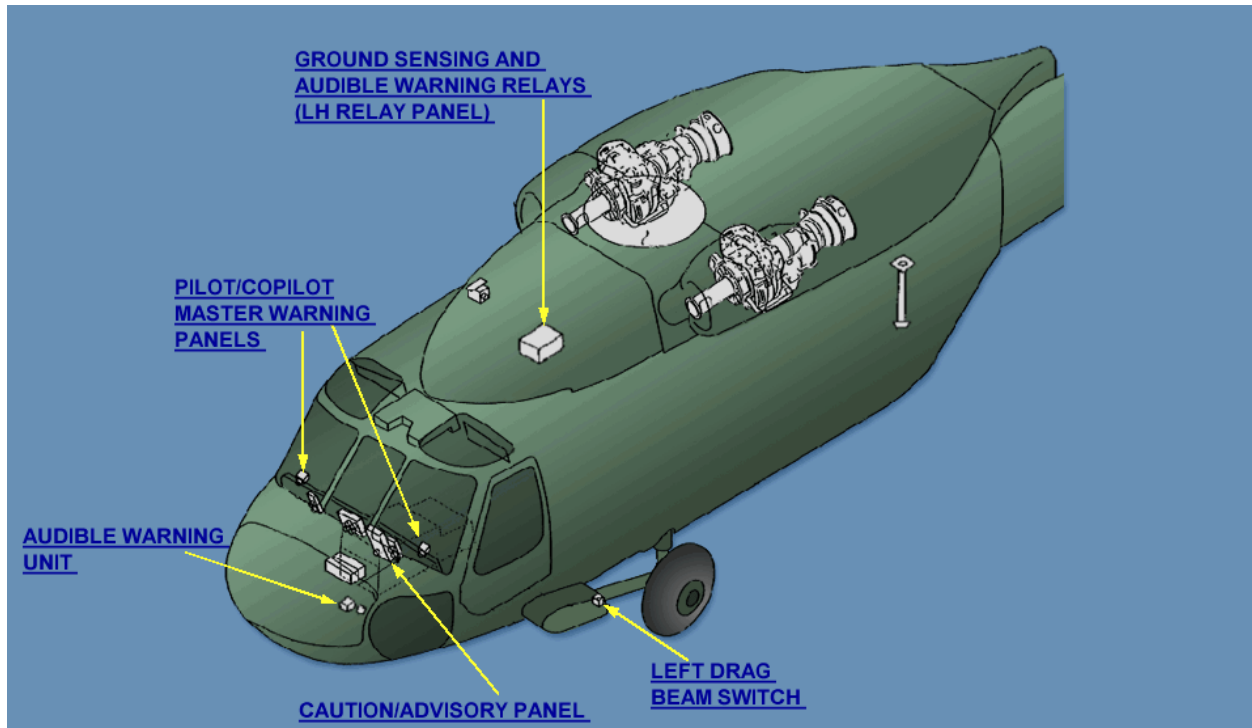


- (1) The caution/advisory warning system gives visual capsule indications for up to 82 helicopter subsystem conditions, and aural indications for three of these conditions.
- (2) Each indicator capsule has a colored legend that is visible when the capsule lights, to indicate the condition monitored.
- (3) Green advisory capsules indicate actuation and normal operation of helicopter equipment.
- (4) Yellow caution capsules indicate system failures.
- (5) Red warning capsules indicate unsafe flight conditions requiring immediate action.

- (6) When an advisory, caution, or warning condition exists, the related capsule goes on and remains on until the condition is removed or the trouble is corrected.

(a) Components

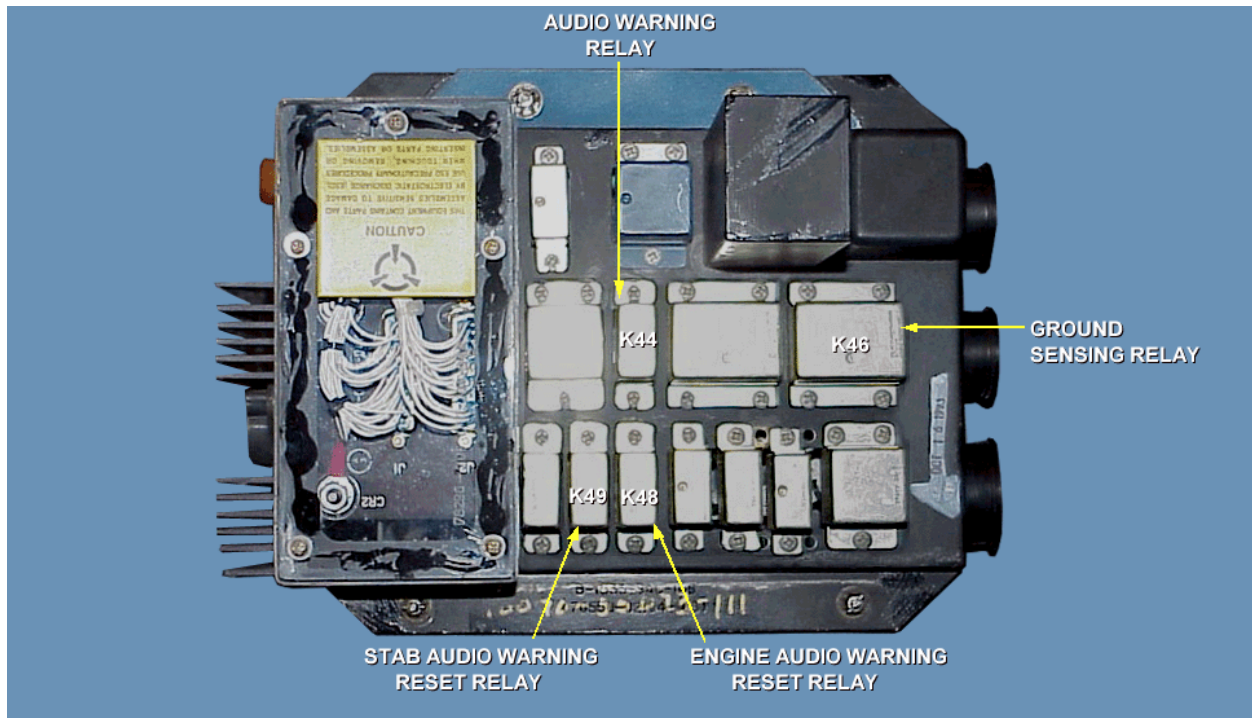
Frame #3005 (Caution/Advisory Warning Menu)



- 1) The caution/advisory warning system consists of a caution/advisory panel on the center of the instrument panel, two master warning panels; one on each side of the instrument panel glare shield, an audible warning unit on the canted bulkhead on the left side of the avionics compartment.

a) Ground Sensing and Audible Warning Relays (LH Relay Panel)

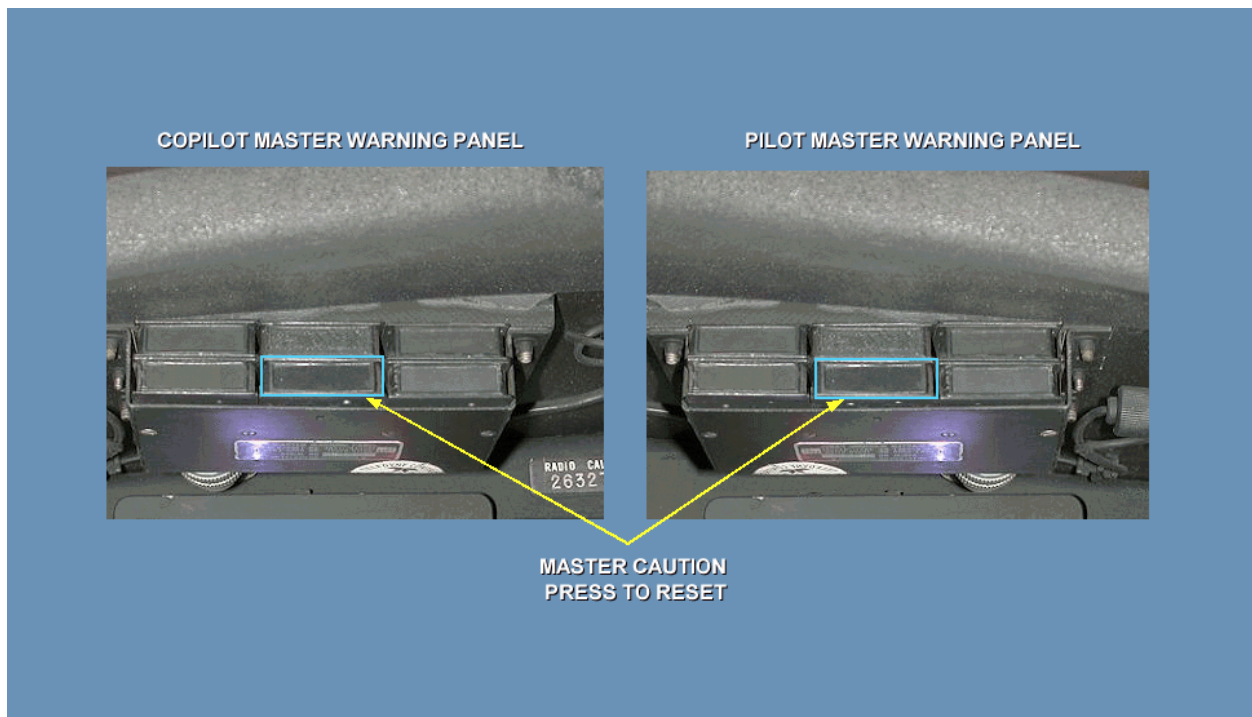
Frame #3040 (Left Hand Relay Panel)



- 1 The audible warning function is controlled by the left relay panel.

b) Pilot/Copilot Master Warning Panels

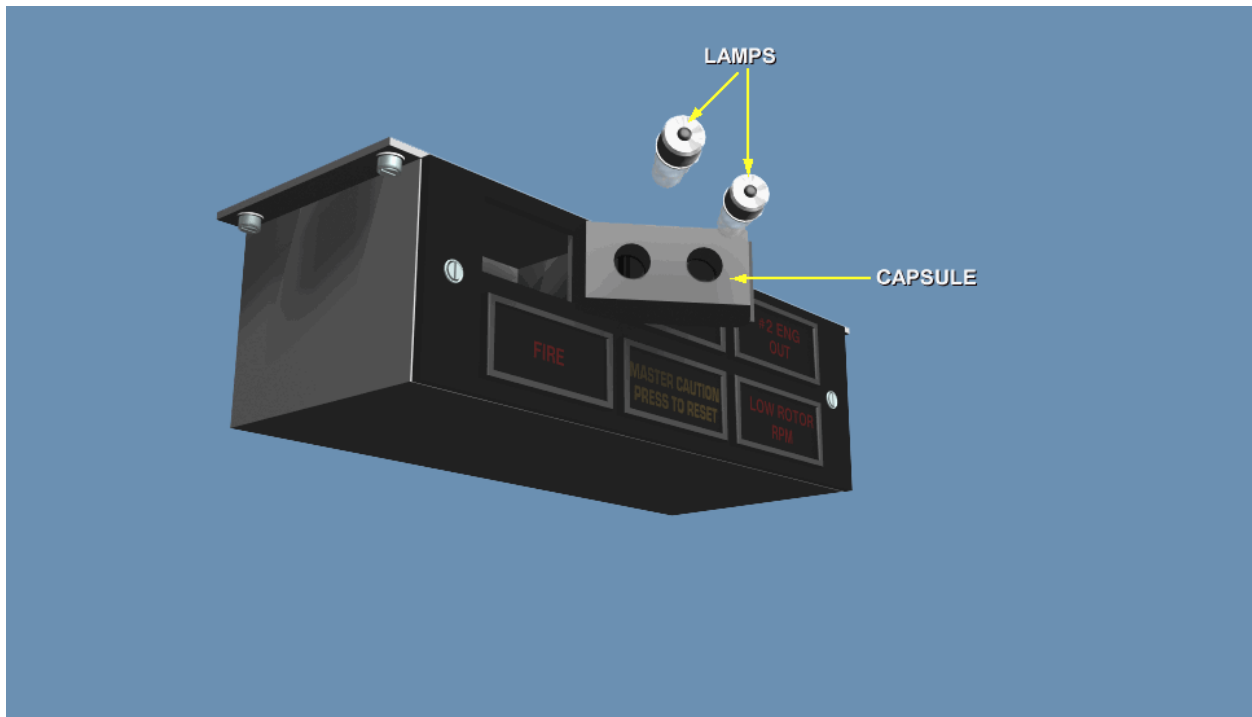
Frame #3025 (Master Warning Panels)



- 1 There are two master warning panels, one on each side of the instrument panel glare shield.
- 2 When a caution capsule goes on, two MASTER CAUTION PRESS TO RESET capsules also go on to attract the attention of the pilot and copilot to the caution condition.
- 3 The MASTER CAUTION PRESS TO RESET capsules will remain on until the trouble is corrected or until either capsule is pressed to reset both capsules for another caution condition.

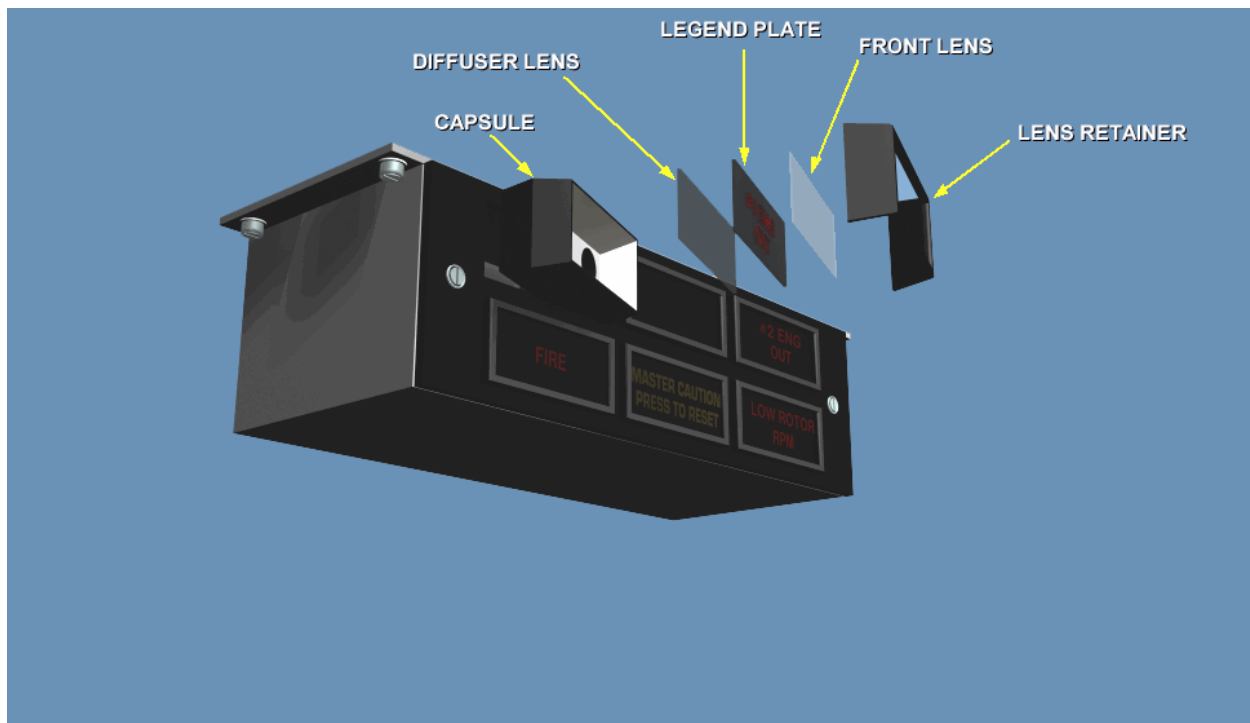
c) Master Warning Panel Lamps

Frame #3030 (Master Warning Panel Lamps)



- 1 During the replacement of the Master Warning Panel lamps ensure that all electrical power is off, push on right side of capsule to unlatch, pivot capsule to expose lamps.
- 2 Remove lamp(s) from the capsule and install the new lamp(s) in capsule.
- 3 Push the capsule back into master warning panel to latch.
- 4 Turn on the electrical power, and make sure the LIGHTS CAUT ADVSY, and LIGHTS ADVSY circuit breakers are in.
- 5 Perform an operational check of master warning system.

Frame #3035 (Master Warning Panel)



- 6 During the replacement of any Master Warning Panel capsule parts, ensure that all electrical power is off.
- 7 Push on the right side of the capsule to turn the capsule from master warning panel and expose end of lens retainer.
- 8 Lift the exposed end of the lens retainer away from capsule and remove lens retainer, lenses, and legend plate.
- 9 If the lens retainer is damaged, replace it.
- 10 Position lenses and legend plate on the capsule, snap the lens retainer on the capsule, and push the capsule back into master warning panel.
- 11 Turn on electrical power, place caution/advisory panel BRT/DIM-TEST switch to TEST, and make sure that capsule lights evenly.
- 12 Perform an operational check of master warning system.

d) Audible Warning Unit

Frame #3020 (Audible Warning Unit)



- 1 The audible warning unit is located on the canted bulkhead, left side in the nose electronics compartment.
- 2 It generates both beeping and steady warning tones and is controlled by the left relay panel.

e) Caution/Advisory Panel

Frame #3015 (Caution/Advisory Panel)



- 1 The caution/advisory panel gives visual indications, on aviation yellow or green color-coded capsules, that show the status of as many as 82 helicopter subsystem conditions.
- 2 Each capsule has a legend that becomes visible when a capsule lights.
- 3 Sixty four capsules are yellow, while eighteen are green.
- 4 The 64 yellow capsules are caution capsules that indicate flight condition system failures.
- 5 The 18 green capsules are advisory capsules that indicate actuation or normal operation of various helicopter subsystems.

- 6 The caution/advisory panel also consists of: a three position momentary-type contact toggle switch with panel markings of BRT/DIM and TEST, a frame assembly, two side covers, four circuit channel cards, and one control card, which plug into mating connectors within the frame, two input/output signal and power connectors, and chassis mounted electronic components.

f) Left Drag Beam Switch

Frame #3010 (Left Drag Beam Weight on Wheels Switch)



- 1 The low rotor RPM warning function is disabled on the ground, by the left drag beam weight on wheels switch.

(b) Operation

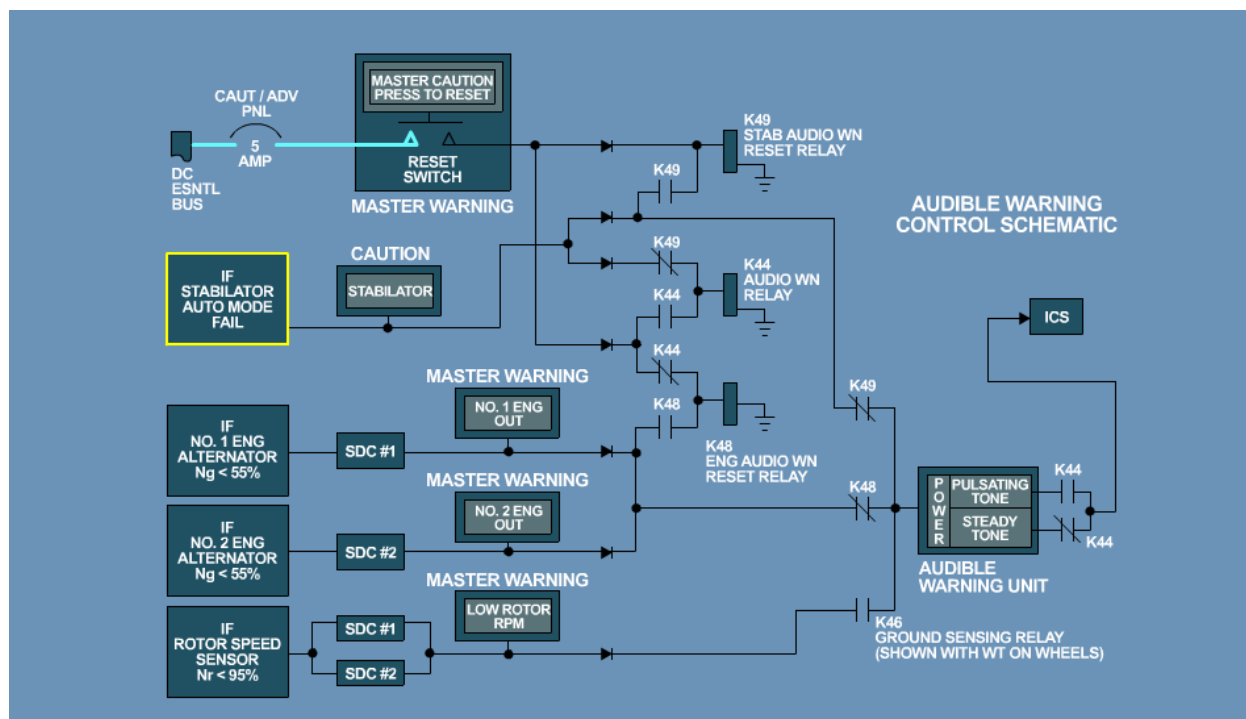
Frame #4000 (Caution/Advisory Operation Menu)

AUDIBLE WARNING

DIMMING

1) Audible Warning

Frame #4020 (Audible Warning FLASH)



- The audible warning function is controlled by the left relay panel.
- Warning signals from the IDS (low rotor RPM and No. 1 or No. 2 engine out) and the stabilator system, are routed through the left relay panel to activate the audible warning unit, which generates both beeping and steady warning tones.
- The stabilator system warning signal is given priority over both IDS warning signals.
- With a stabilator warning condition present, the 28 V dc stabilator warning signal is applied through the normally closed contacts of relay K49 to the audible warning unit and to the solenoid of relay K44.
- Relay K44 energizes, selecting the beeping warning tone output from the audible warning unit.
- The warning tone is fed from the left relay panel through the junction box assembly, to the pilot and copilot intercommunication system stations.

- g) With a No. 1 or No. 2 engine-out warning condition present, the 28 V dc signals are applied through the normally closed contacts of relay K48 to the audible warning unit.
- h) The steady warning tone is selected by the deenergized contacts of relay K44 and routed to the pilot and copilot stations.
- i) With a low rotor RPM warning condition present during flight, the 28 V dc signal is applied through energized contacts of relay K46 to the audible warning unit.
- j) The steady warning signal is applied to the pilot and copilot stations as described for engine-out warning condition.
- k) The low rotor RPM warning function is disabled on the ground, by the left drag beam weight on wheels switch, which controls relay K46.
- l) The audible warnings for stabilator shutdown and engine-out conditions may be cleared by pressing one of the MASTER CAUTION PRESS TO RESET capsules.
- m) Pressing a capsule applies 28 V dc to the left relay panel audio reset circuit consisting of relays K48 and K49.
- n) Relay K48 energizes to disable an engine-out warning and relay K49 energizes to disable a stabilator shutdown warning.

2) Audible Warning System Block Diagram

Frame #4030 (Audible Warning System Block Diagram FLASH)

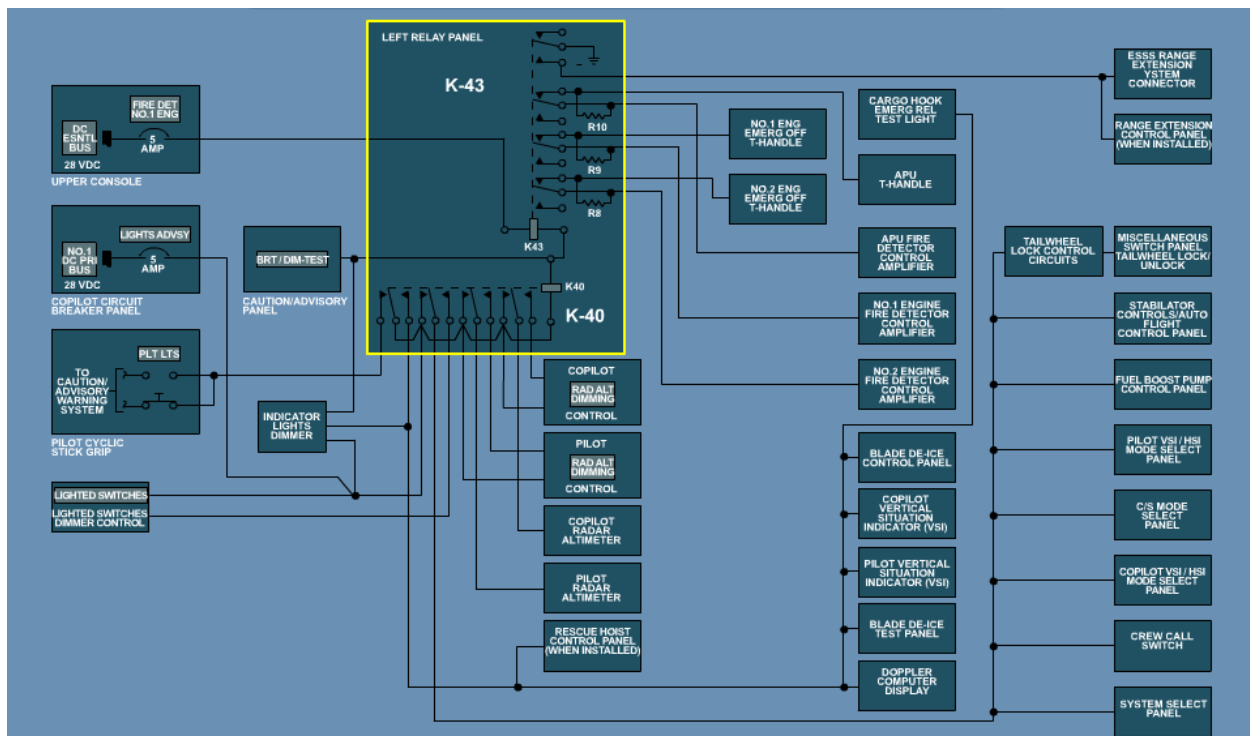


- a) The audible warning function is controlled by the left relay panel.
- b) Warning signals from the IDS (low rotor RPM and No. 1 or No. 2 engine out) and the stabilator system are routed through the left relay panel to activate the audible warning unit, which generates both beeping and steady warning tones.
- c) With a stabilator warning condition present, the 28 V dc stabilator warning signal is applied through the normally closed contacts of relay K49 to the audible warning unit and to the solenoid of relay K44.
- d) Relay K44 energizes, selecting the beeping warning tone output from the audible warning unit.
- e) The warning tone is fed from the left relay panel through the junction box assembly to the pilot and copilot intercommunication system stations.

- f) With a No. 1 or No. 2 engine-out warning condition present (N_g is less than 55%), the 28 V dc signals are applied through the normally closed contacts of relay K48 to the audible warning unit.
- g) The steady warning tone is selected by the de-energized contacts of relay K44 and routed to the pilot and copilot stations.
- h) With a low rotor RPM warning condition present during flight (N_r is less than 96 %), the 28 V dc signal is applied through energized contacts of relay K46 to the audible warning unit.
- i) The steady warning signal is applied to the pilot and copilot stations as described for engine out warning condition.
- j) The low rotor RPM warning is disabled with weight on wheels.

3) Dimming

Frame #4040 (Dimming Circuit)



- a) The instrument panel and consoles indicator lights dimming system provides control for decreasing the intensity of, or turning off indicator lights on the instrument panel, upper and lower consoles, engine, and APU fire T-handles.
- b) The dimming system consists of: relays K40 and K43, as well as dimming resistors R8, R9, and R10 in the left relay panel, a LIGHTED SWITCHES dimmer control on the upper console, indicator lights dimmer forward of the lower console, pilot and copilot RAD ALT DIMMING controls on the instrument panel, and the BRT/DIM-TEST switch on the caution/advisory panel.
- c) The system is electrically powered by 28 V dc in three different places.
- d) The major part of the system is powered from the No. 1 dc primary bus through the LIGHTS ADVSY circuit breaker on the copilot circuit breaker panel.

- e) In the bright mode of operation, relay K40 is de-energized and 28 V dc is applied through normally closed contacts of K40 to brighten all the lights.
- f) The dimming system also applies the 28 V dc to warning and display lights on the pilot and copilot radar altimeters.
- g) A second part of the system, relay K43, receives its power from the dc essential bus through the FIRE DET No. 1 ENG circuit breaker in the upper console.
- h) In the bright mode of operation, relay K43 is de-energized and 28 V dc is applied through normally closed contacts of K43 to brighten all the lights.
- i) A third part of the system, the T-handles for the #1 Engine, #2 Engine, and APU, are powered by their respective fire detector control amplifiers located in the cabin overhead.
- j) Normally closed contacts of relay K43 apply full output voltage of the No. 1 engine, No. 2 engine, and APU fire detector control amplifiers, directly to the respective fire warning T-handles.
- k) If MWO 50-78 is incorporated, the LIGHTED SWITCHES dimmer control provides 0 to 26 V dc to the auxiliary fuel management panel annunciators and displays.
- l) When the BRT/DIM-TEST switch is actuated to dim mode, a ground is applied to the left relay panel to energize relays K40 and K43.
- m) Then, dimming voltages are routed through energized contacts of relay K40 in the following way: from the indicator lights dimmer, 9 V dc is applied.
- n) Through the LIGHTED SWITCHES dimmer control, 26 V dc variable voltage is routed to energized contacts of relay K40.
- o) Also, through two RAD ALT DIMMING controls, 28 V dc variable voltage is directed to the pilot and copilot radar altimeters.

- p) While dimming is occurring through relay K40, a 28 V dc output of each of the fire detector control amplifiers is applied through the energized contacts of relay K43 via the dimming resistors R8, R9, and R10, to dim the T-handles should a fire warning occur.
- q) When the BRT/DIM-TEST switch is actuated again to select the bright mode, the ground is removed from the left relay panel.
- r) The loss of the ground de-energizes relays K40, K43, and all panel indicator lights mentioned above will brighten again.

(c) MTF Checks

Frame #4070 (MTF Checks)

- Bright/Dim Test
- Caution/Advisory panel dimming
- CDU/PDU test
- Photo cell sensitivity test
- Stabilator audio warning priority
- Engine oil pressure
- Low rotor off at 96% Nr
- Engine out light on below 55% Ng

- 1) Bright/Dim Test
- 2) Caution/Advisory panel dimming
- 3) CDU/PDU test
- 4) Photo cell sensitivity test
- 5) Stabilator audio warning priority
- 6) Engine oil pressure

- 7) Low rotor off at 96% Nr
- 8) Engine out light on below 55% Ng

CHECK ON LEARNING

1. What component controls the audible warning function?
2. When is the low rotor warning disabled?
3. When is the No. 1 or No. 2 Engine Out warning present?

SECTION IV. - SUMMARY

1. REVIEW/SUMMARIZE:

You have completed the function of the Caution/Advisory Warning System topic for the UH-60 helicopter.

The key points to remember are:

- The low rotor RPM warning is disabled with weight on wheels.
- The caution/advisory panel gives visual indications, on aviation yellow or green color-coded capsules, that show the status of as many as 82 helicopter subsystem conditions.
- The audible warning function is controlled by the left relay panel.
- Warning signals from the IDS (low rotor RPM and No. 1 or No. 2 engine out) and the stabilator system are routed through the left relay panel to activate the audible warning unit, which generates both beeping and steady warning tones.
- With a low rotor RPM warning condition present during flight (Nr is less than 96 %), a signal is applied through the contacts of relay K46 to the audible warning unit. The steady warning signal is then applied to the pilot and copilot stations.
- During the replacement of any Master Warning Panel capsule parts ensure that all electrical power is off.
- The dimming system consists of relays K40 and K43 as well as dimming resistors R8, R9, and R10 in the left relay panel, a LIGHTED SWITCHES dimmer control on the upper console, indicator lights dimmer forward of the lower console, pilot and copilot RAD ALT DIMMING controls on the instrument panel, and the BRT/DIM-TEST switch on the caution/advisory panel.
- MTF checks include Bright/Dim Test, Caution/Advisory panel dimming, CDU/PDU test, Photo cell sensitivity test, Stabilator audio warning priority, Engine oil pressure, Low rotor off at 96% Nr, Engine out light on below 55% Ng.

APPENDIX A

ILLUSTRATION LISTING

FRAME #	FRAME TITLE
1002	Instrument Display System Menu
1005	Instrument Display System Component Menu
1015	Signal Data Converters
1017	SDC Modules
1020	Pilot Display Unit
1022	Pilot Display Unit (Breakdown)
1025	Central Display Unit
1026	Central Display Unit (Exploded View)
1026A	Central Display Unit (Exploded View 2)
1027	CDU Lamp Replacement
1035	Engine Sensors
1040	Transmission Sensors
1045	Rotor NR Speed Sensor
1050	Transmission oil temperature Switch
1051	Transmission Oil Temperature Sensor
1055	Transmission Oil Pressure Sensor
1060	Transmission Low Oil Switch
1065	Fuel Quantity Signal Conditioner
1067	Fuel Quantity Signal Conditioner 2
1070	Left Hand Relay Panel
1075	Copilot Circuit Breaker Panel
1080	Pilot Circuit Breaker Panel
1085	Caution/Advisory Panel
1090	Master Warning Panels
1095	Rotor Overspeed Reset Switch
2000	Operation
2010	Transmission Indicating System FLASH
2015	Engine Instrument Display System FLASH
2020	Multiplexing
2025	Engine Instrument Display System FLASH
2030	Fuel Quantity Indicating System FLASH
3002	Caution/Advisory Warning System Menu
3005	Caution/Advisory Warning Menu
3010	Left Drag Beam Weight on Wheels Switch
3015	Caution/Advisory Panel
3020	Audible Warning Unit
3025	Master Warning Panels
3030	Master Warning Panel Lamps
3035	Master Warning Panel Exploded View
3040	Left Hand Relay Panel
4000	Caution/Advisory operation Menu
4020	Audible Warning FLASH
4030	Audible Warning System Block Diagram
4040	Dimming Circuit
4070	MTF Checks

APPENDIX B

TEST AND TEST SOLUTIONS

1. This appendix is only used when the test and solutions are internal to the POI file.
2. When the test and solutions are internal to the POI file, then the POI file becomes a FOR OFFICIAL USE ONLY document.