

United States Army Warfighting Center
Fort Rucker, Alabama
NOVEMBER 2005



STUDENT HANDOUT

TITLE: CH-47D POWER TRAIN SYSTEM

FILE NUMBER: 011-2110-3

PROPONENT FOR THIS STUDENT HANDOUT IS:

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CH-47D POWER TRAIN SYSTEM

STUDENT HANDOUT

TERMINAL LEARNING OBJECTIVE (TLO):

Action: Describe components, operational characteristics, functions, limitations, and emergency procedures of the CH-47D Power Train System.

Conditions: In a classroom, given a CH-47D Aft Vertical Shaft Cutaway, CH-47 Engine Transmission Cutaway, and a student handout.

Standards: Correctly answer in writing, without reference, seven of nine questions pertaining to components, operational characteristics, limitations, functions, and emergency procedures of the CH-47D Power Train System, In Accordance With (IAW) TM 1-1520-240-10 and the student handout.

Safety Requirements: None.

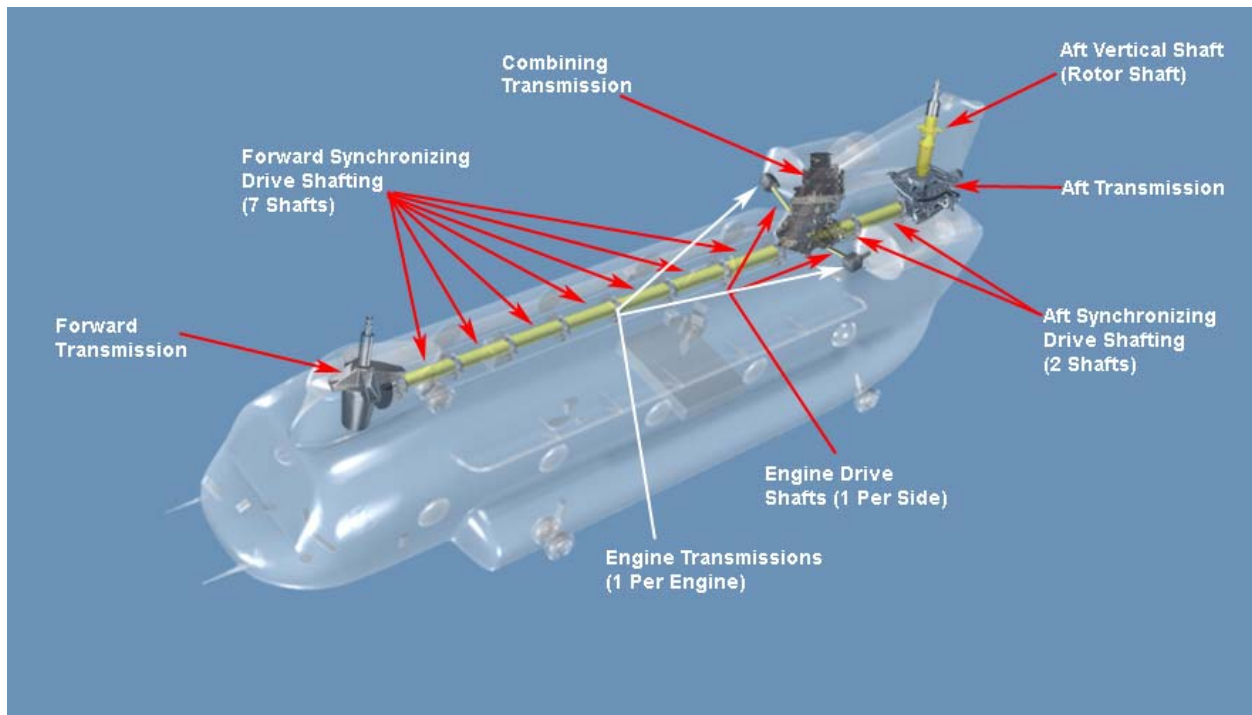
Risk Assessment Level: Low.

Environmental Considerations: None.

Evaluation: Each student will be evaluated on this block of instruction during the first written examination. This will be a criterion type examination requiring a GO on each scored unit. You will have 90 minutes for the exam.

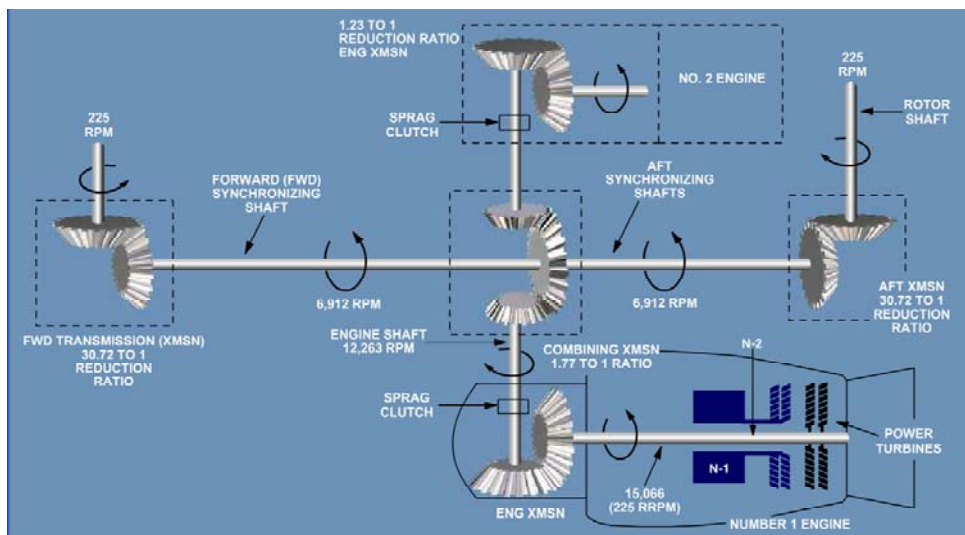
- 1. Learning Step/Activity 1-Describe components of the Power Train.**

a. Transmissions.



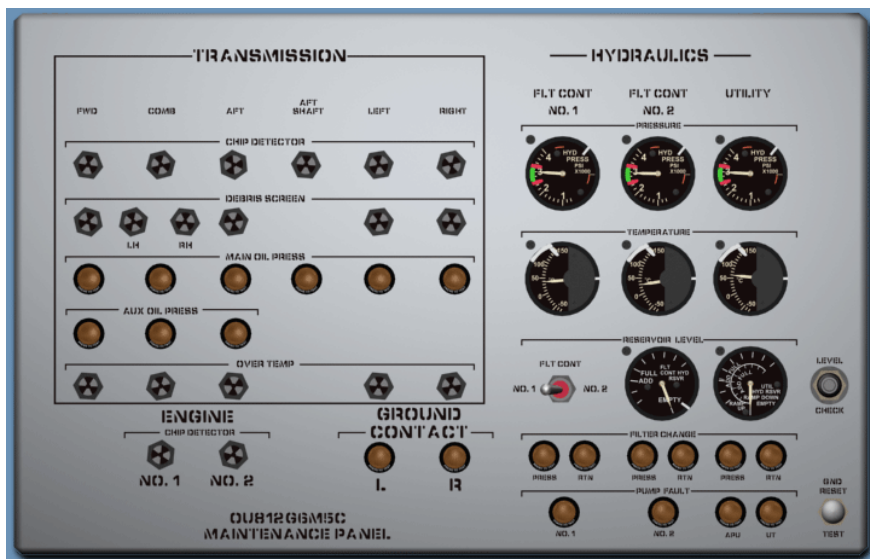
- (1) Forward.
- (2) Combining.
- (3) Aft.
- (4) Engines.

b. Drive and synchronizing shafting.

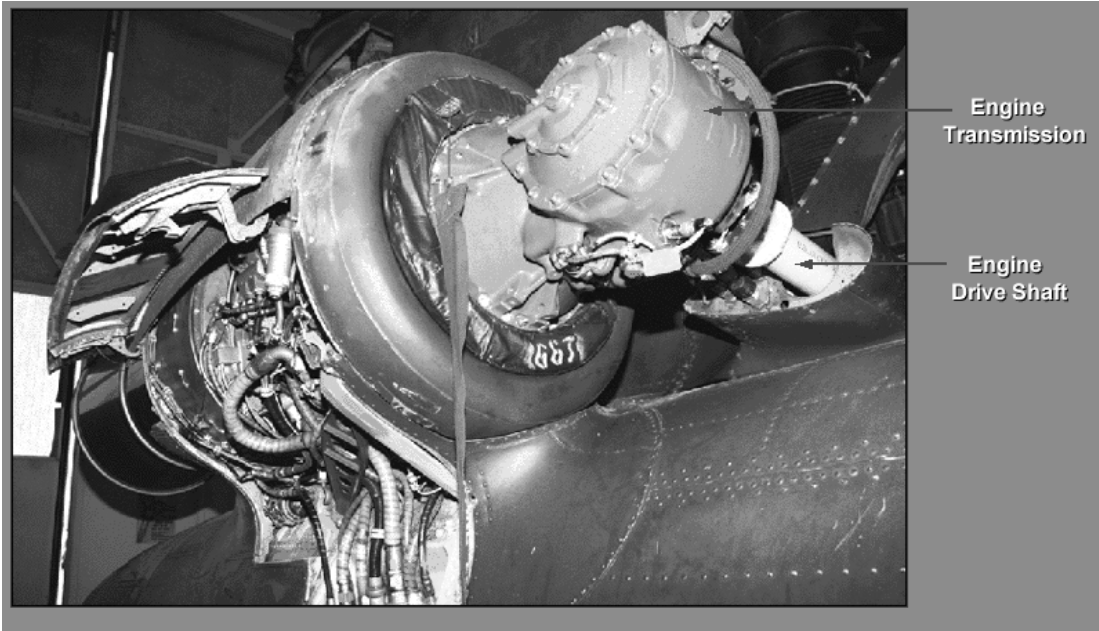


c. Main and auxiliary lubrication for the following transmissions.

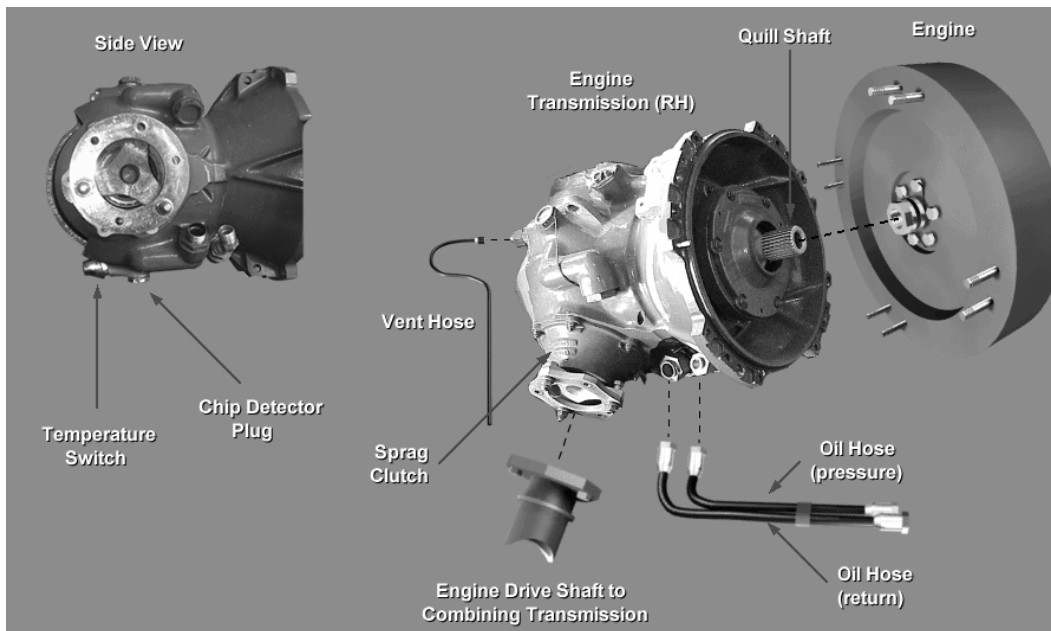
- (1) Forward.
 - (2) Combining.
 - (3) Aft.
- d. Main lubrication only for:
- (1) Engine transmissions.
 - (2) Aft vertical shaft.
 - (3) Main generators.
- e. Oil coolers are located on each transmission except the engine transmissions.
- f. Maintenance panel has magnetic latch indicators for chip detectors, debris screens, over-temp, and indicator lights for main and aux oil pressure.



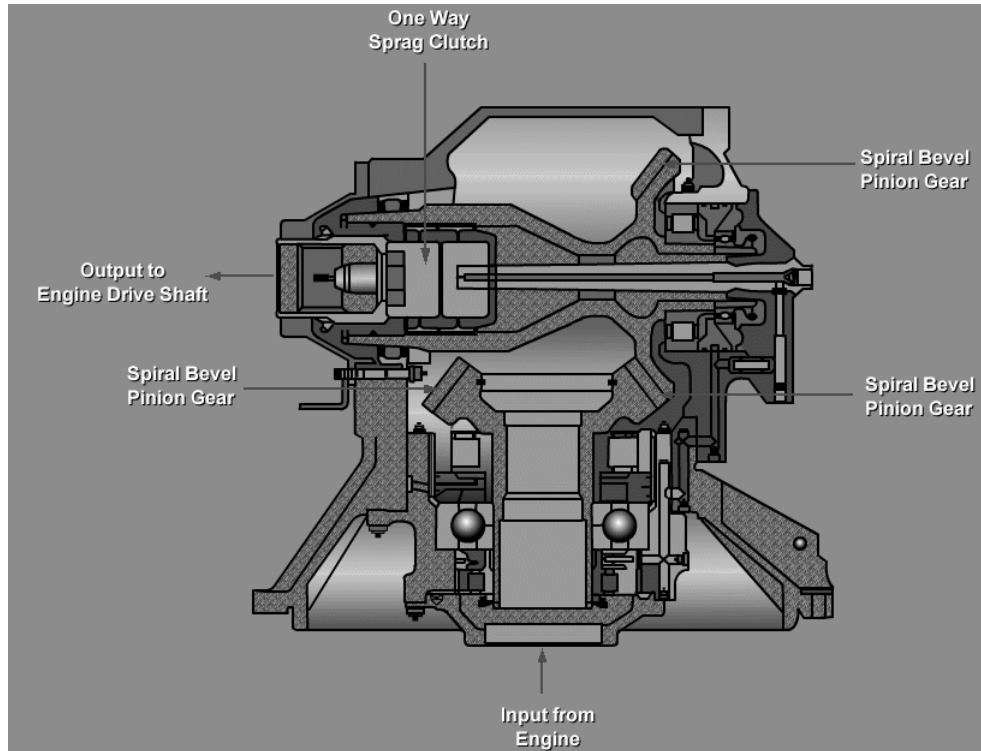
2. Learning Step/Activity 2—Describe components and operational characteristics, limitations, and functions of Transmissions and Drive Shafting.



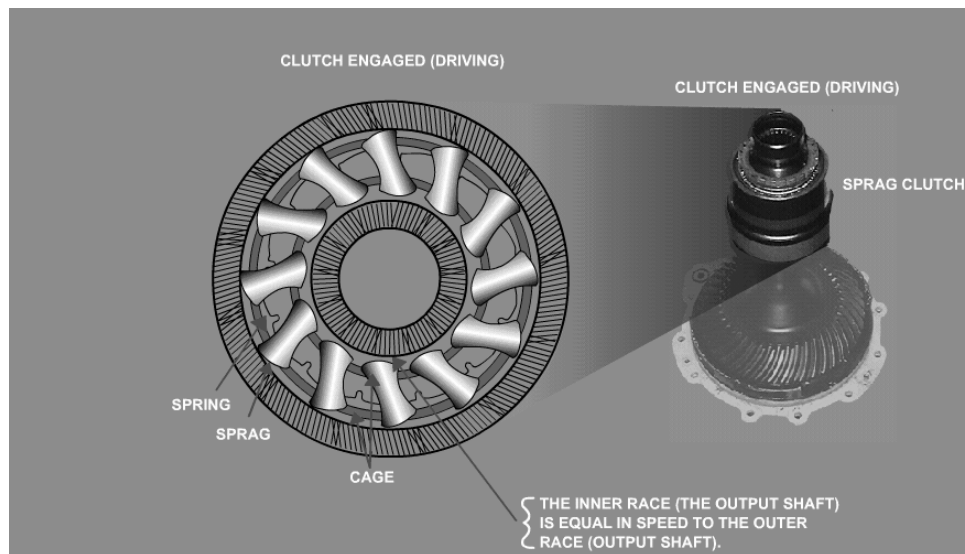
a. Engine transmissions.



(1) Quill shaft connects the engine power output shaft to the transmission.

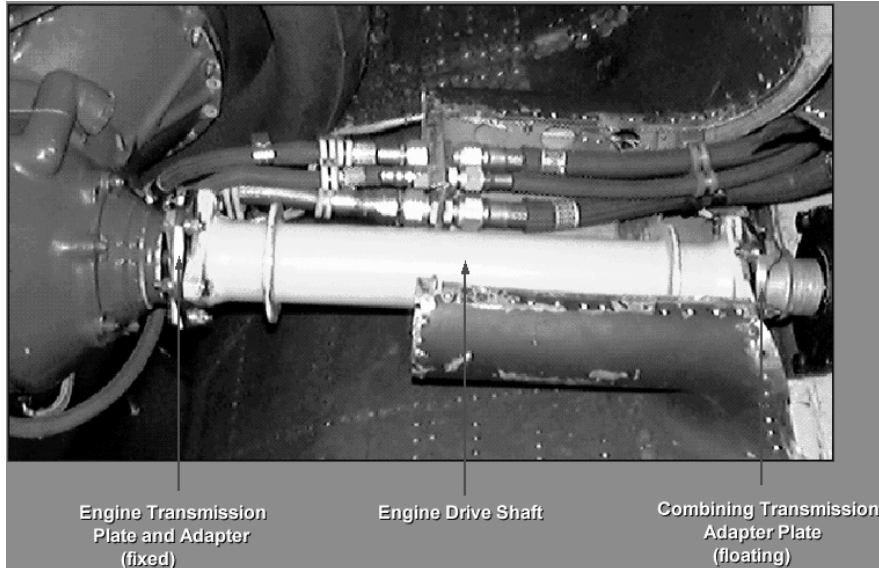


- (2) Sprag clutch. The clutch allows the rotor system to overrun the engine during single engine operation or autorotation.



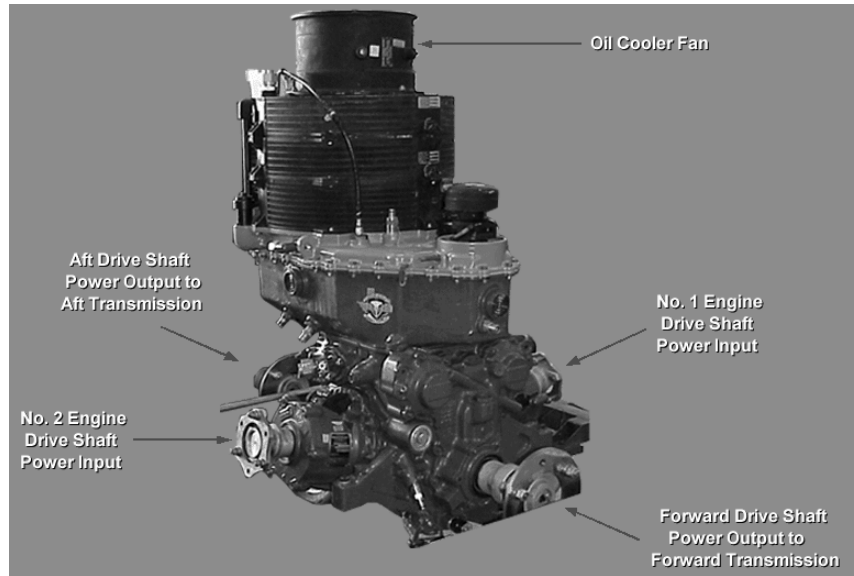
- (a) Clutch engages when the engine supplies power to drive the rotor system.
- (b) Clutch disengages when the engine is not providing power (torque) to the rotors.

NOTE: The transmission requires lubrication even when the engine is shutdown.



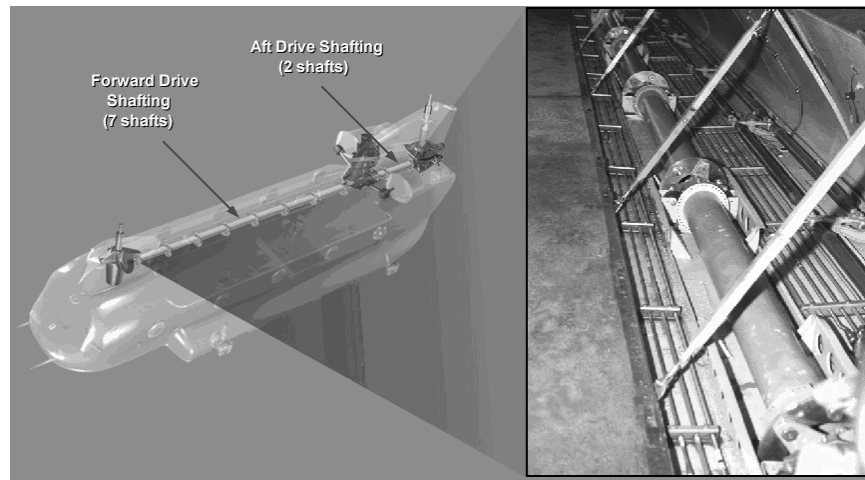
OPERATOR'S MANUAL CAUTION: The N₂ section of the second engine starts turning when the first engine is started; however, the lubrication system of the second engine is driven by the N₁ section which does not begin to turn until the start sequence is initiated. Delay in starting the second engine will result in excessive wear on the N₂ bearing packages and seal. **Start the second engine within three minutes of the first.**

- b. Engine drive shaft.
 - (1) Transmits torque from the engine transmission to the combining transmission.
 - (2) Consists of shaft and two plate and adapter assemblies.
 - (3) Balanced assembly.
 - (4) Locked to the engine transmission.
- c. Combining transmission.

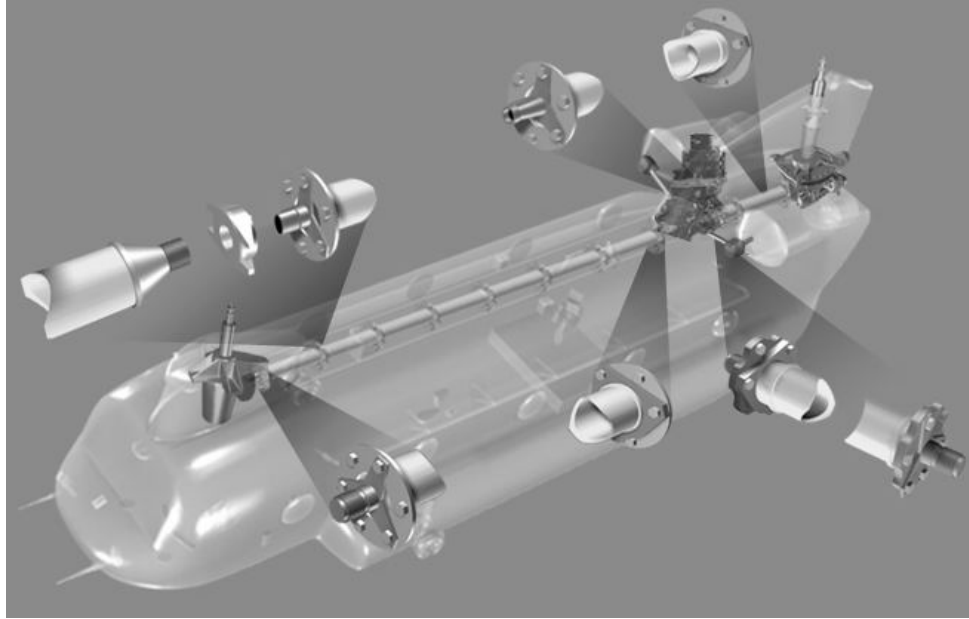


- (1) Power input is from the engine transmission.
- (2) Power output is to the forward and aft transmissions.
- (3) Drives the oil cooler blower.

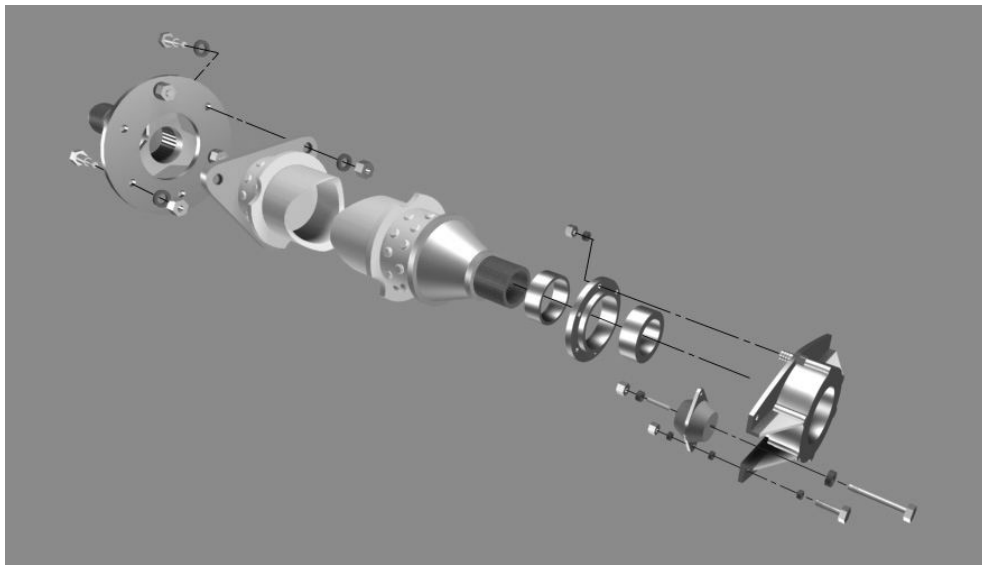
d. Forward and aft synchronizing shafting.



- (1) Seven sections between the combining and forward transmissions.
- (2) Two sections between the combining and aft transmissions.
- (3) Bearing and support assemblies support the drive shafting.

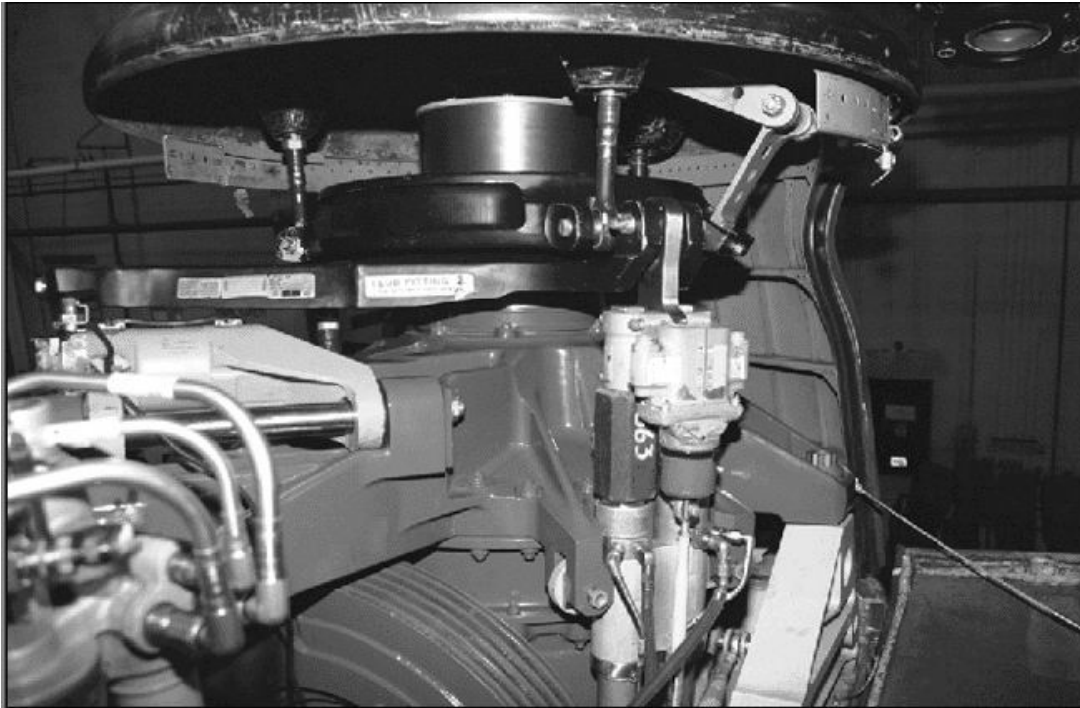


- (4) Adapter and plate assemblies allow the shafts to flex.
- (5) Shock mounts allow the shafts to move longitudinally.



- (6) During your preflight you should check for:
 - (a) Foreign objects in the tunnel area.
 - (b) Damaged shock mounts.
 - (c) Damage to drive shafting.
 - (d) Freedom of movement longitudinally.

e. Forward transmission.



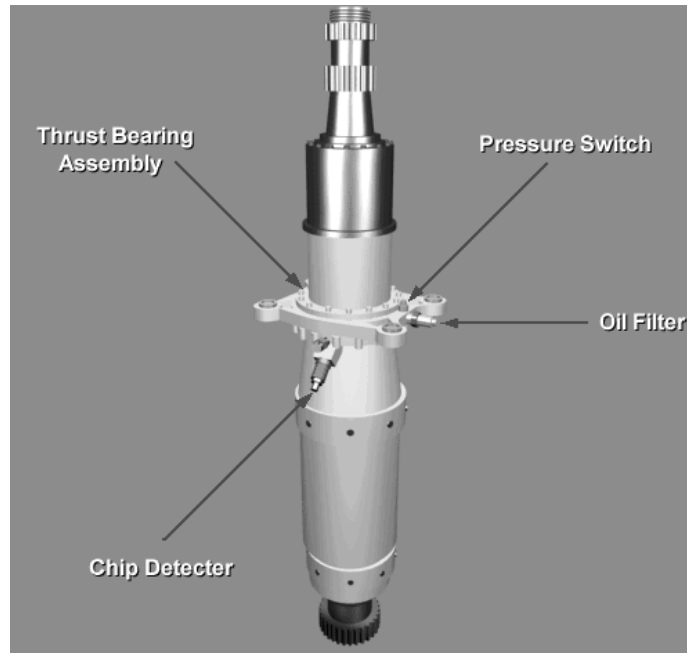
- (1) Power input from the combining transmission.
- (2) Mounted above the companion way.
- (3) Nine degree forward tilt.
- (4) Forward upper controls are attached.

- f. (5)
Aft transmission.



- (1) Power input from the combining transmission.
- (2) Mounted to the bottom of the aft pylon.
- (3) Four degree forward tilt.

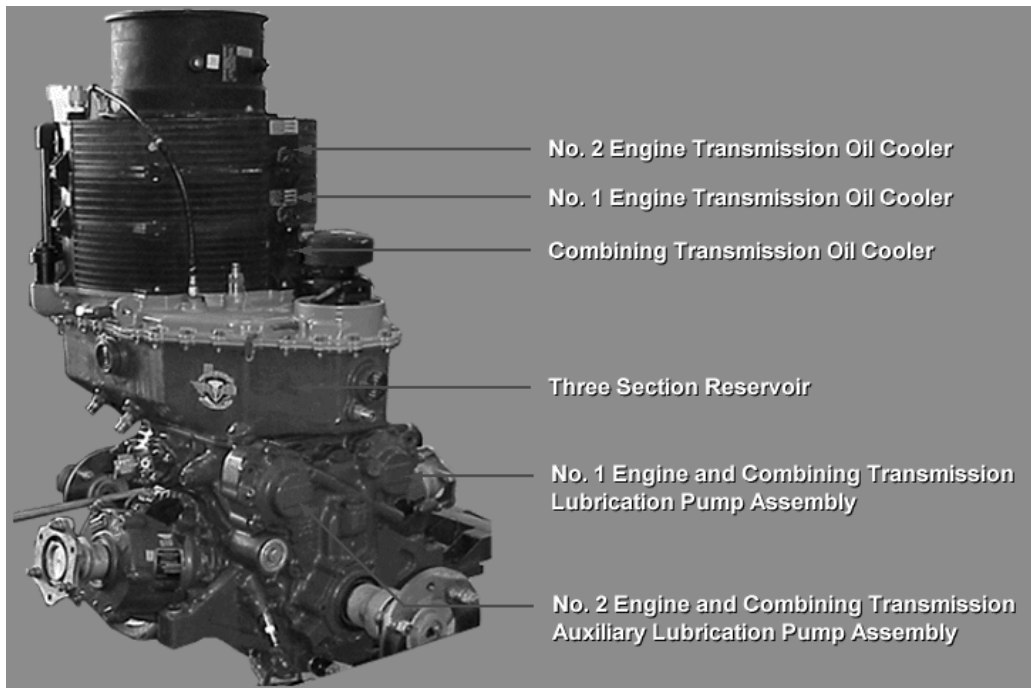
- g. Aft vertical shaft.



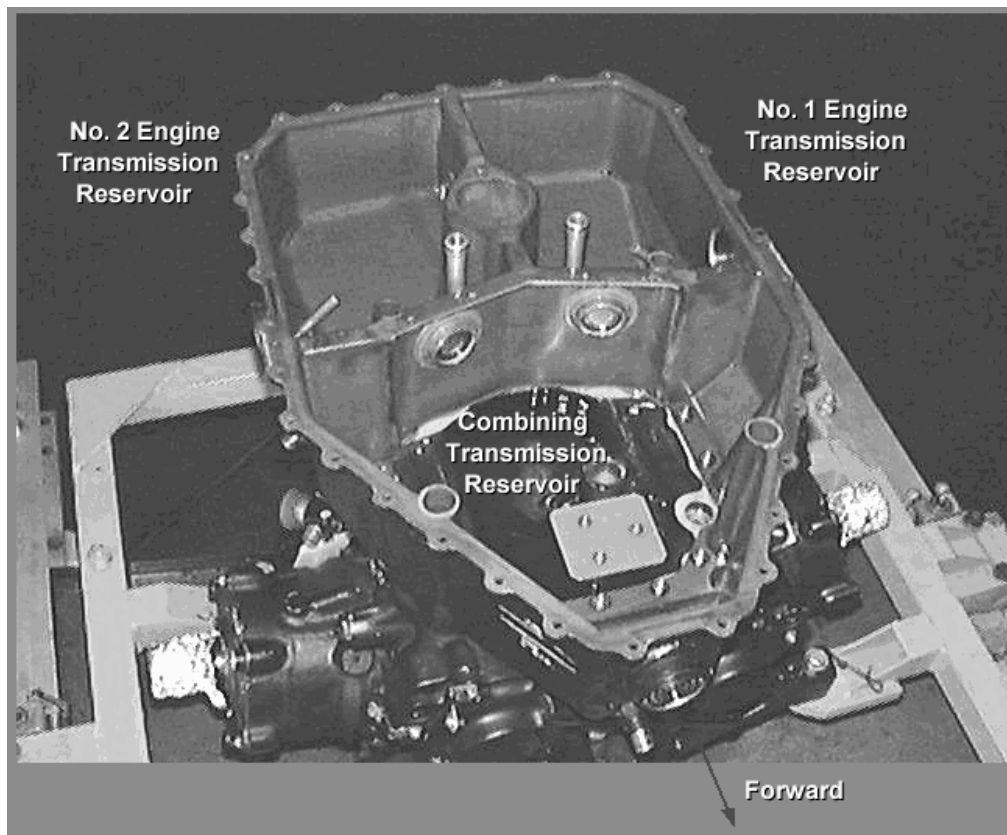
- (1) Located inside the aft pylon on top of the aft transmission.

- (2) Transmits power to the aft rotor system.
 - (a) Splined to the aft transmission.
 - (b) Aft rotor, drive arm, and centrifugal droop stops are attached.
 - (c) Thrust bearing assembly.
 - 1) Bolted to the aircraft structure retaining the shaft to the aft transmission.
 - 2) Lubricated by the aft transmission **main** lubrication system.
 - 3) Chip detector.
 - a) XMSN CHIP DET caution light.
 - b) Magnetic latch indicator on maintenance panel.
 - 4) Pressure switch.
 - a) XMSN OIL PRESS caution light.
 - b) AFT SHAFT OIL PRESS caution light on the maintenance panel.
 - (d) **Exceeding VNE with LCT retracted places excessive stress loads on the thrust bearing.**

3. Learning Step/Activity 3—Describe the Transmission Lubrication System.

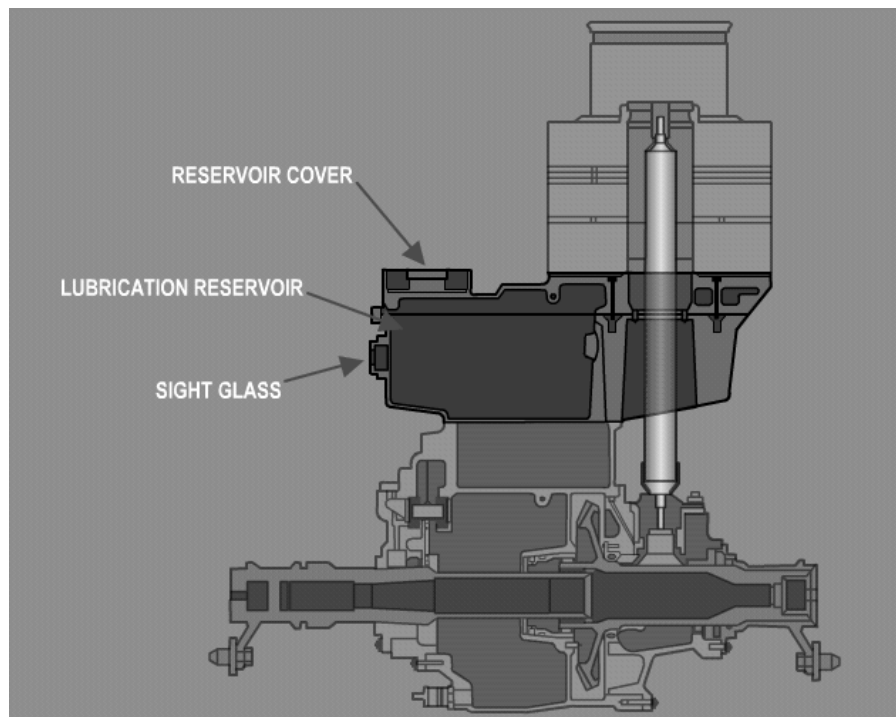


- a. Individual lubrication systems.
- b. Oil sumps/reservoirs.



- (1) Made of Kevlar.
- (2) Engine and combining transmissions.
 - (a) Three section reservoir.
 - (b) Located on top of the combining transmission.
- (3) Forward and aft transmission sumps are located on the bottom of the transmissions.

c. Sight gauges for checking oil levels.



- (1) Check Forward and Aft transmissions after 30 minutes of shutdown.

OPERATOR'S MANUAL NOTE: To prevent overfilling the engine and combining transmissions, check oil level within 30 minutes of shutdown. If the engines have been shut down, for more than 30 minutes, run the helicopter for a minimum of 5 minutes, to verify oil level before servicing.

- (2) Types of oil.
 - (a) MIL-L-23699 for normal conditions.
 - (b) MIL-L-7808 when temperature is below -32° C.
 - (c) The two types may be mixed in an emergency.
 - 1) Make a -13 entry.
 - 2) Oil must be changed and flushed within 6 hours of operation.

NOTE: If the transmission lubrication systems become contaminated by hydraulic fluid, notify maintenance.

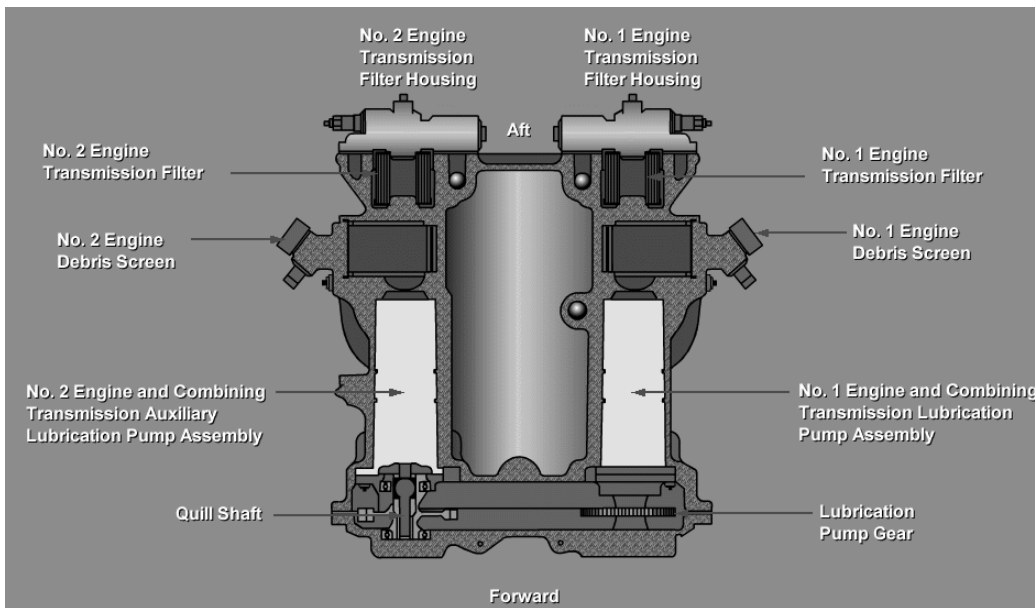
d. Pumps.

(1) Forward transmission.

- (a) Main.
- (b) Auxiliary.

(2) Aft transmission.

- (a) Main.
- (b) Auxiliary.



(3) Combining transmission.

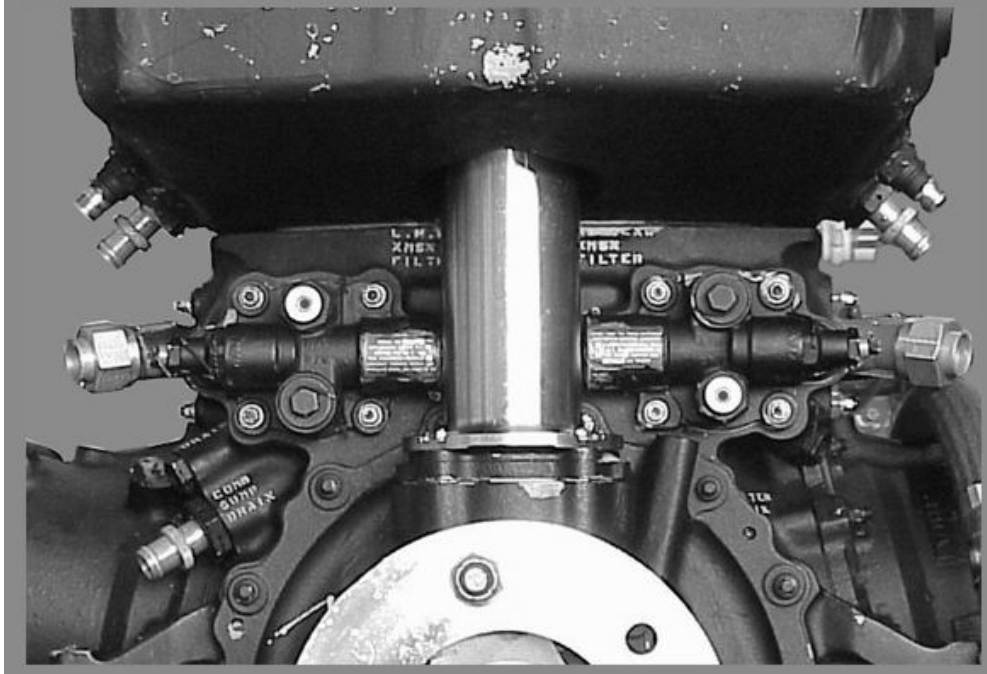
- (a) Pressure - main and auxiliary.
- (b) Scavenge (return) - main and auxiliary.

(4) Engine transmissions.

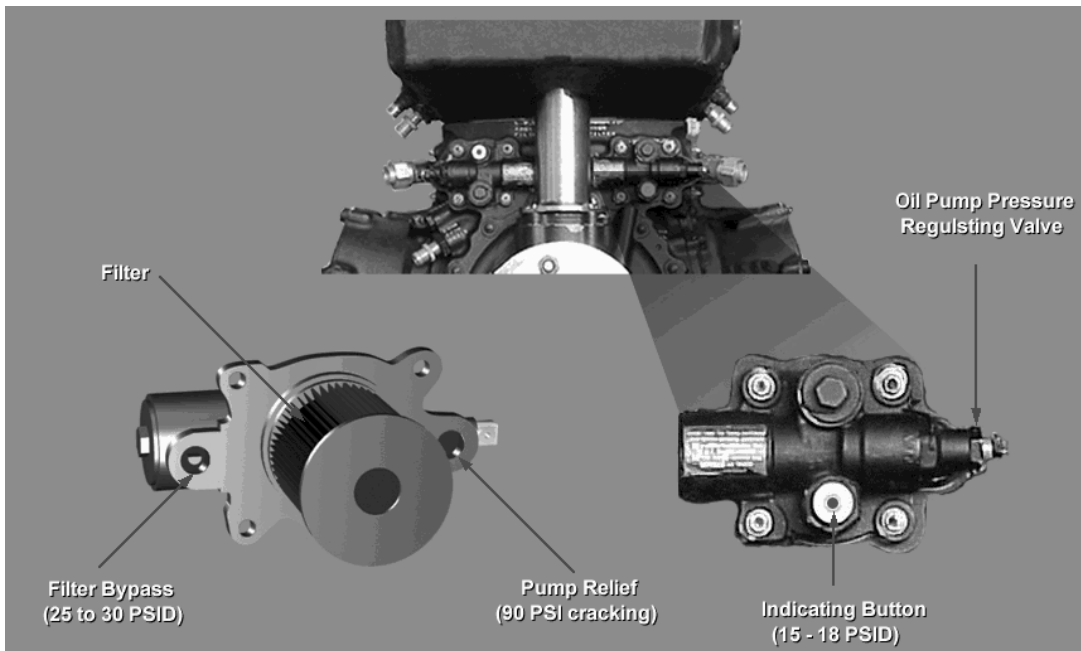
- (a) Pumps are located inside of the combining transmission.
- (b) Pressure.
- (c) Scavenge.

e. Filters.

(1) One for each lubrication system.



(2) Main oil filters.



(a) Impending bypass button.

- 1) Extends with a 15 to 18 PSID pressure differential.
- 2) Cannot be reset while installed.
- 3) Filter element must be replaced if extended.

(b) Bypass capability at 26 to 30 PSID differential.

(3) Auxiliary oil filters do not have indicator buttons.

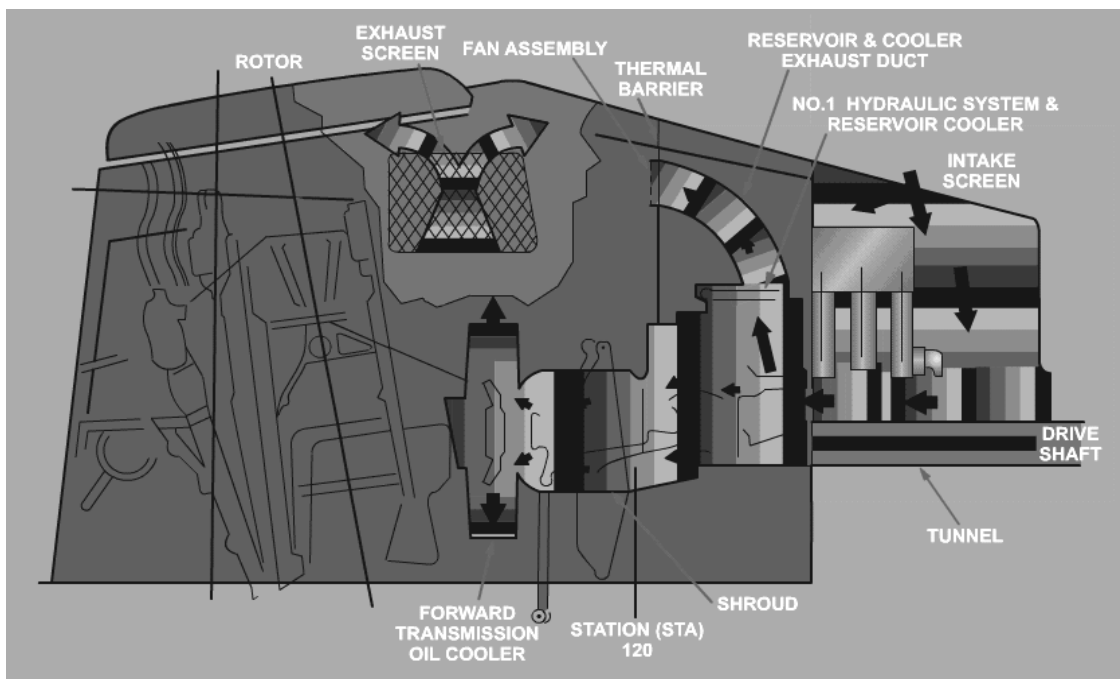
f. Jet protection (inlet) screens.

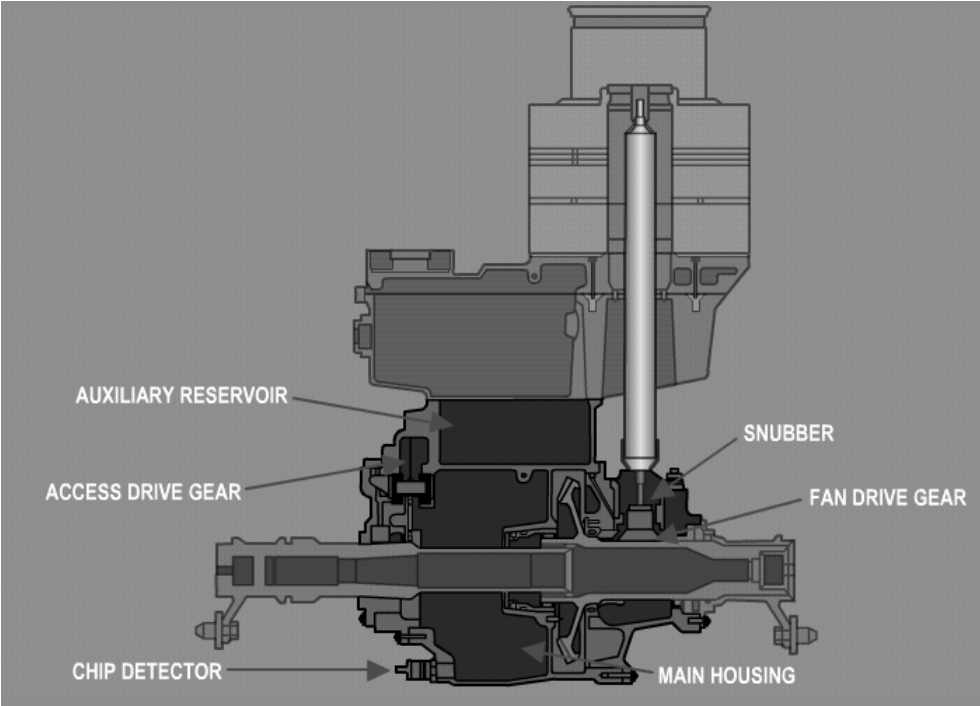
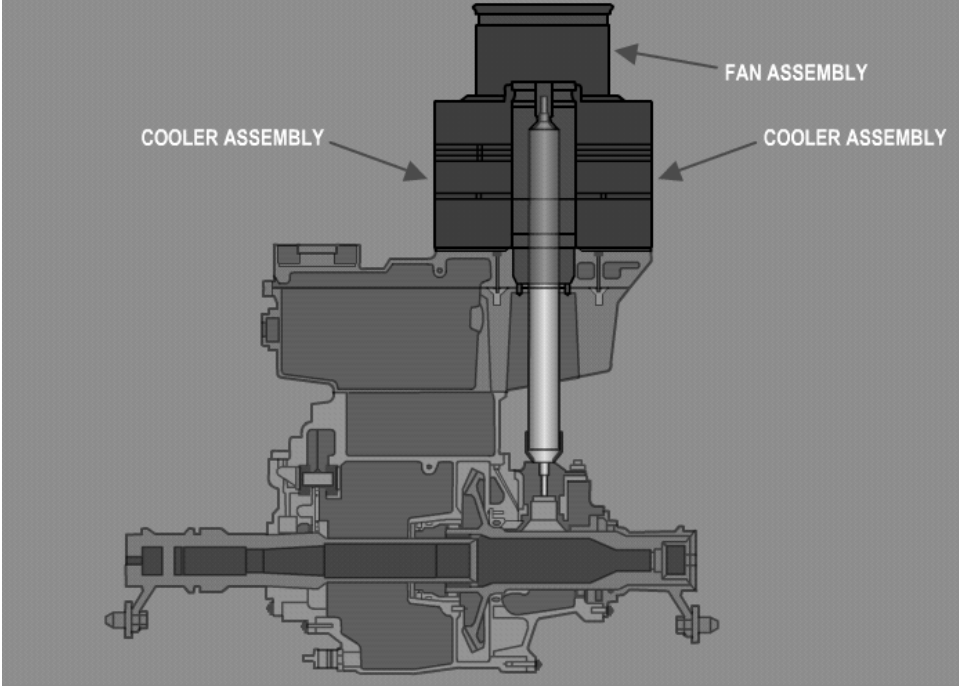
(1) Located in the oil pressure line prior to the lubrication jets.

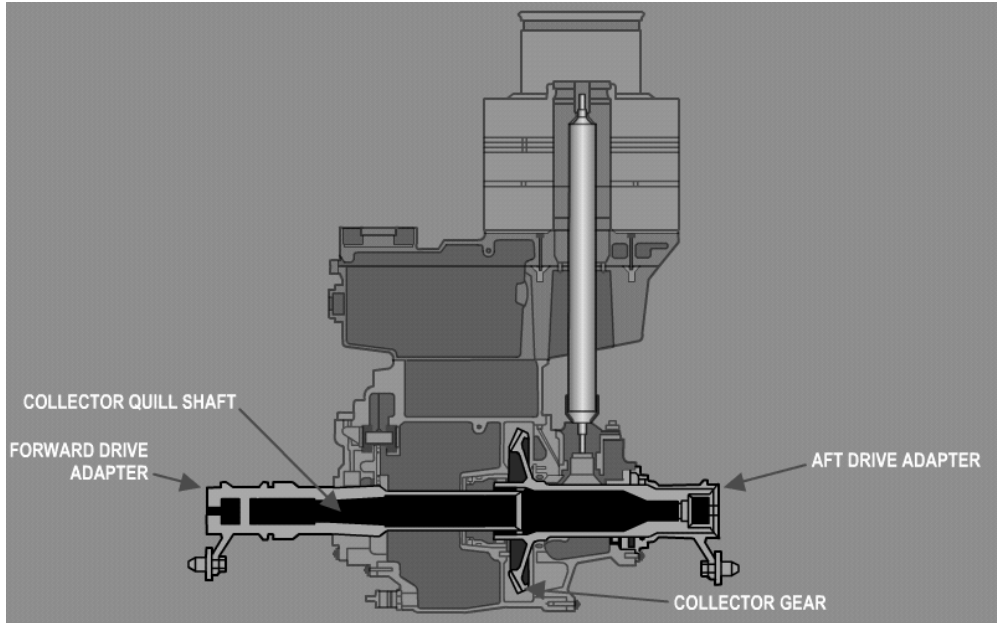
(2) Allows particles less than 50% of the size of the smallest jet to pass.

g. Oil coolers.

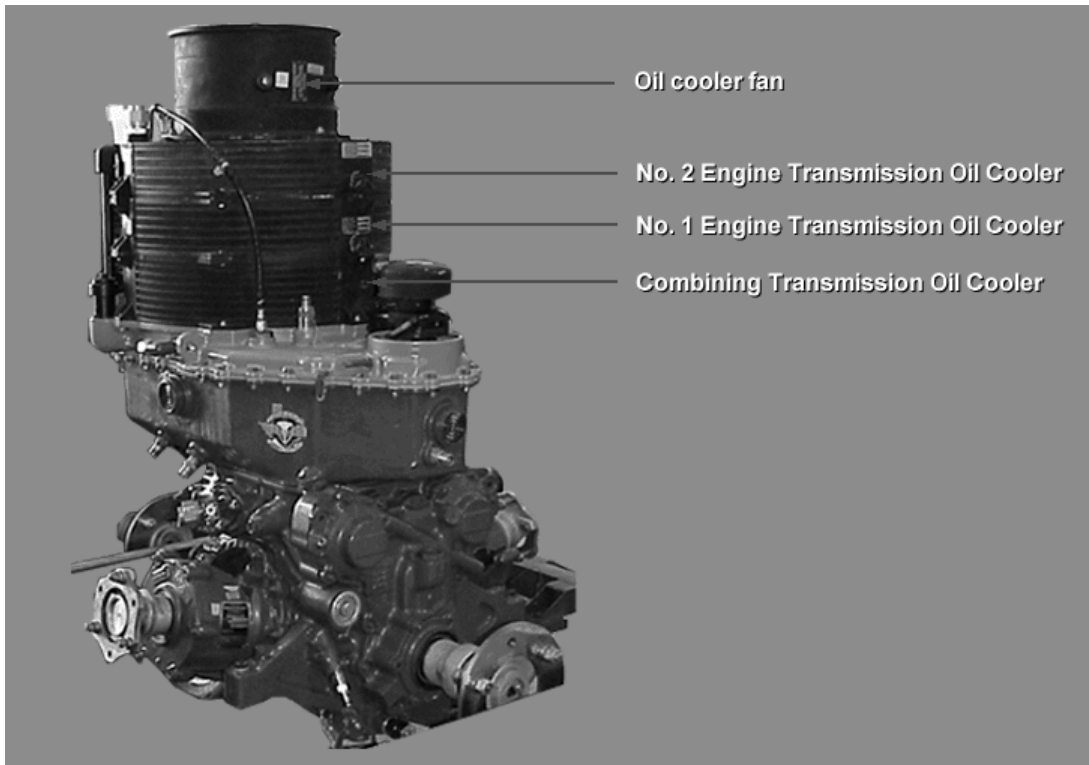
(1) Forward transmission airflow, covers should be installed over the controls closet, heater closet, avionics compartment, and under the forward transmission.







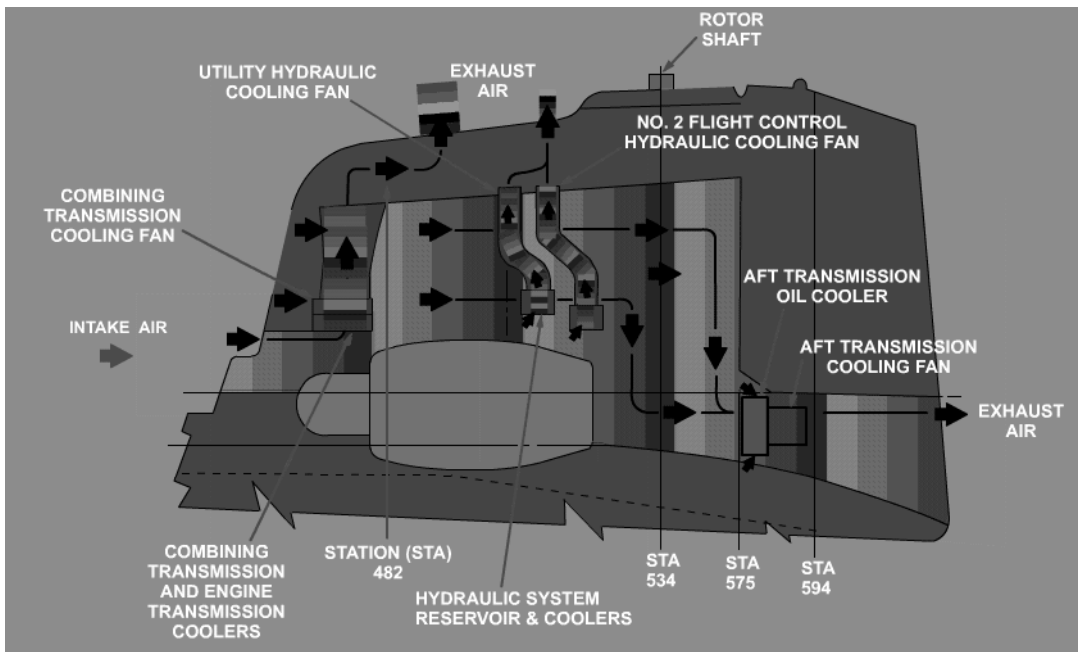
(2) Engine and combining transmissions.



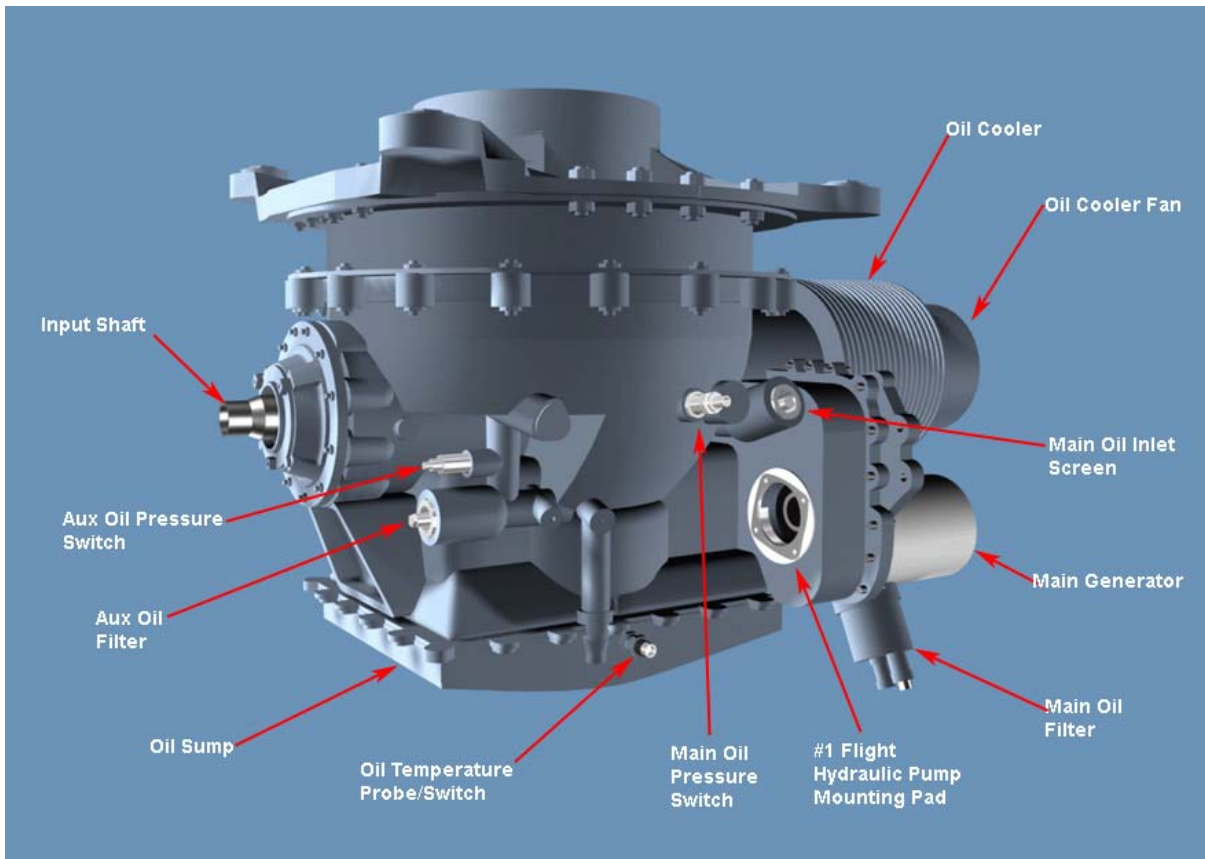
- (a) Separate coolers for each transmission.
- (b) Located above the combining transmission.

(3) Aft transmission.

(a) Cooling airflow.



(b) Doors under the transmission must be closed.



Learning Step/Activity 4–Describe components, functions, limitations, and operational characteristics, of the Transmission Instrumentation.



- a. XMSN OIL PRESS indicator.



- (1) Receives pressure signals from transducers in each system.
- (2) Indicates main oil pressure only.

- (3) Pressures.
 - (a) Ground idle minimum.
 - (b) Normal.
- (4) Oil pressure selector switch.
 - (a) TEST position, pointer will drop to zero.
 - (b) Individual transmission position, the indicator shows the pressure of the selected transmission.
 - (c) SCAN position, indicator shows the lowest pressure of the five transmissions.

b. XMSN OIL TEMP indicator.



- (1) Receives temperature from probes (bulbs) in the sump/reservoirs of each transmission.
- (2) Maximum temperature of 140°C.
- (3) OIL TEMP selector switch.
 - (a) TEST position, pointer will drop to -70°C.
 - (b) Individual transmission position, the indicator shows the temperature of the transmission selected.

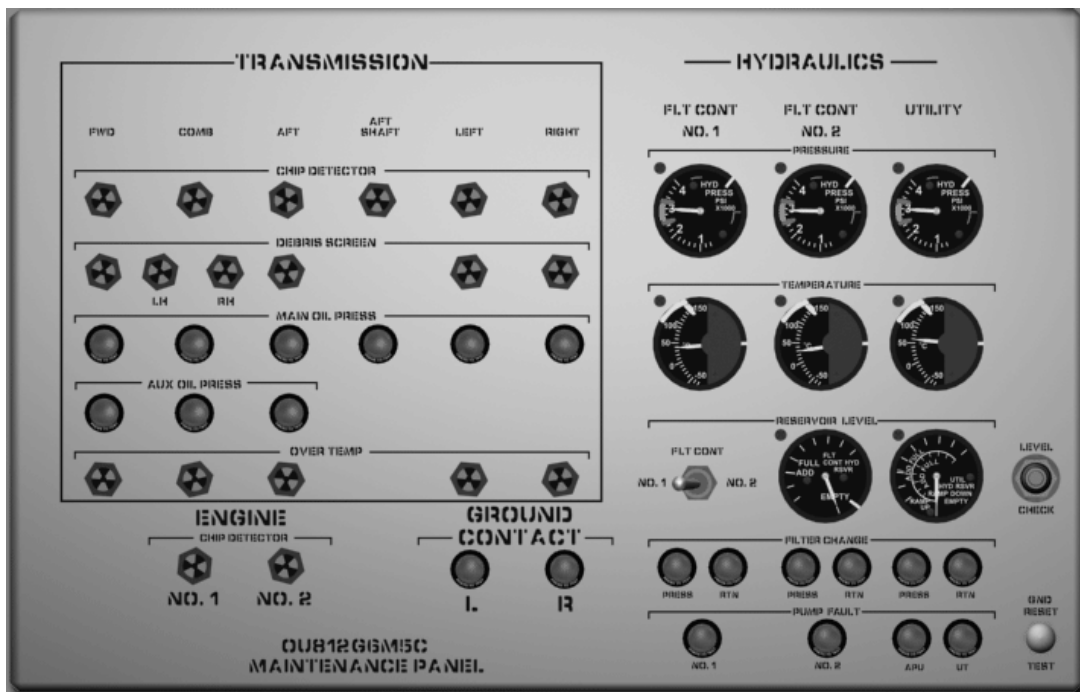
- (c) SCAN position, indicator shows the highest temperature of the five transmissions.
- c. Electrical power.
 - (1) No.1 AC bus through the XMSN OIL PRESS circuit breaker.
 - (2) No.1 AC bus through the XMSN OIL TEMP circuit breaker.
- d. Caution panel lights.



- (1) XMSN OIL HOT.
 - (a) Temperature sensed in the sump/reservoir of the transmissions.
 - (b) Activated by temperature switches at 140°C.
 - (c) May be in the forward, aft, combining, or No.1 or No.2 engine transmission reservoir/sump.
- (2) ENG XMSN HOT (NO.1or NO.2).
 - (a) Temperature sensed in the engine transmission.
 - (b) Activated by a temperature switch in the transmissions at 190°C.
- (3) ENG CHIP DET (NO.1or NO.2).
 - (a) Chips may be in either the engine or engine transmission.
 - (b) Determine location from the maintenance panel (crewmember).
- (4) XMSN CHIP DET. Activated by chip detectors in the forward, aft, combining transmission, or the aft vertical shaft thrust bearing.
- (5) XMSN OIL PRESS.
 - (a) Activated by pressure switches in the main lubrication system.

- (b) Pressure below 20 psi in the forward, aft, combining, No.1 or No.2 engine transmission.
 - (c) Pressure below 10 psi in the aft vertical shaft.
- (6) XMSN AUX OIL PRESS.
- (a) Activated by pressure switches in the auxiliary lubrication systems.
 - (b) Pressures below 20 psi in the forward or aft transmissions.
 - (c) Pressures below 10 psi in the combining transmission.

e. Maintenance panel indications.



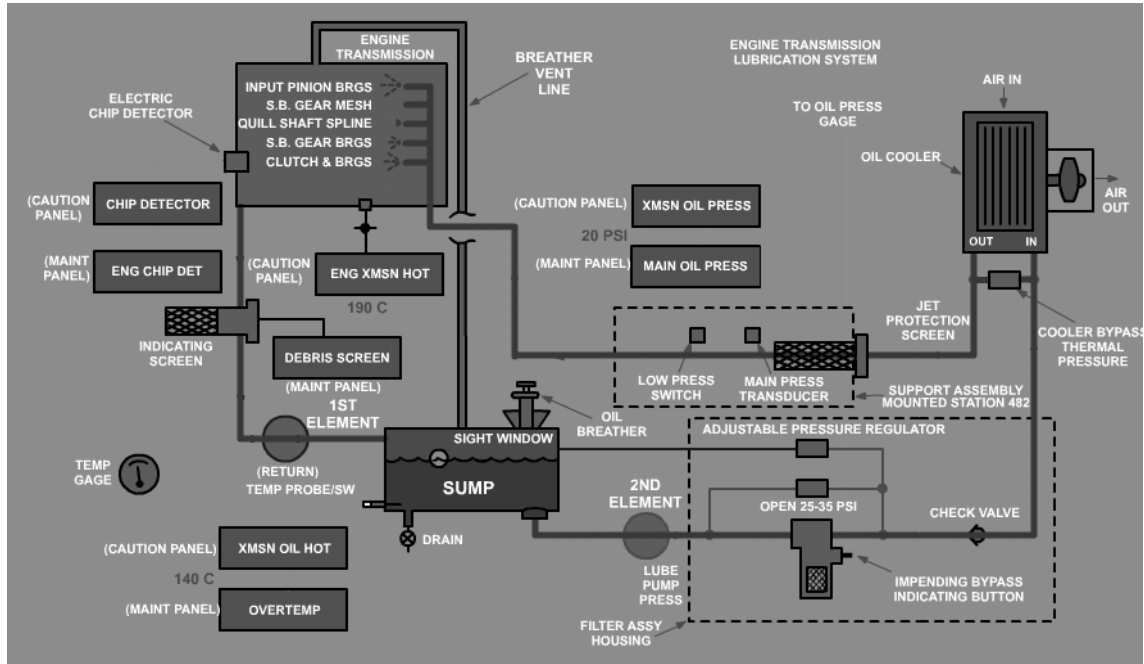
- (1) CHIP DETECTORS.
 - (a) Activated by magnetic chip detectors.
 - (b) Magnetic latch indicators indicate the location of the chips.
- (2) DEBRIS SCREENS (magnetic latch indicators).
 - (a) Activated by debris screens located in:
 - 1) Oil return (scavenge) lines of the combining and engine transmissions.
 - 2) Sumps of the forward and aft transmissions at the auxiliary pump intake.
 - (b) Magnetic latch indicators identify the affected transmissions.

- (c) **There will be no indication in the cockpit.**
- (3) MAIN OIL PRESS lights.
 - (a) Activated by pressure switches when the pressures drop below:
 - 1) 20 psi in the forward, aft, combining, or No.1 or No.2 engine transmission.
 - 2) 10 psi in the aft vertical shaft.
 - (b) Identifies the affected system.
- (4) AUX OIL PRESS lights.
 - (a) Activated by pressure switches when the pressures drop below:
 - 1) 20 psi in the forward or aft transmission.
 - 2) 10 psi in the combining transmission.
 - (b) Identifies the affected system.
- (5) OVERTEMP.
 - (a) Activated by temperature switches at 140°C.
 - (b) Magnetic latch indicator identifies the affected system.
- (6) Electrical power is supplied by the No.1 DC bus.
- (7) Crewmembers should not test in flight without telling the pilots. The XMSN OIL HOT, XMSN CHIP DET, and ENG CHIP DET caution lights will come on.

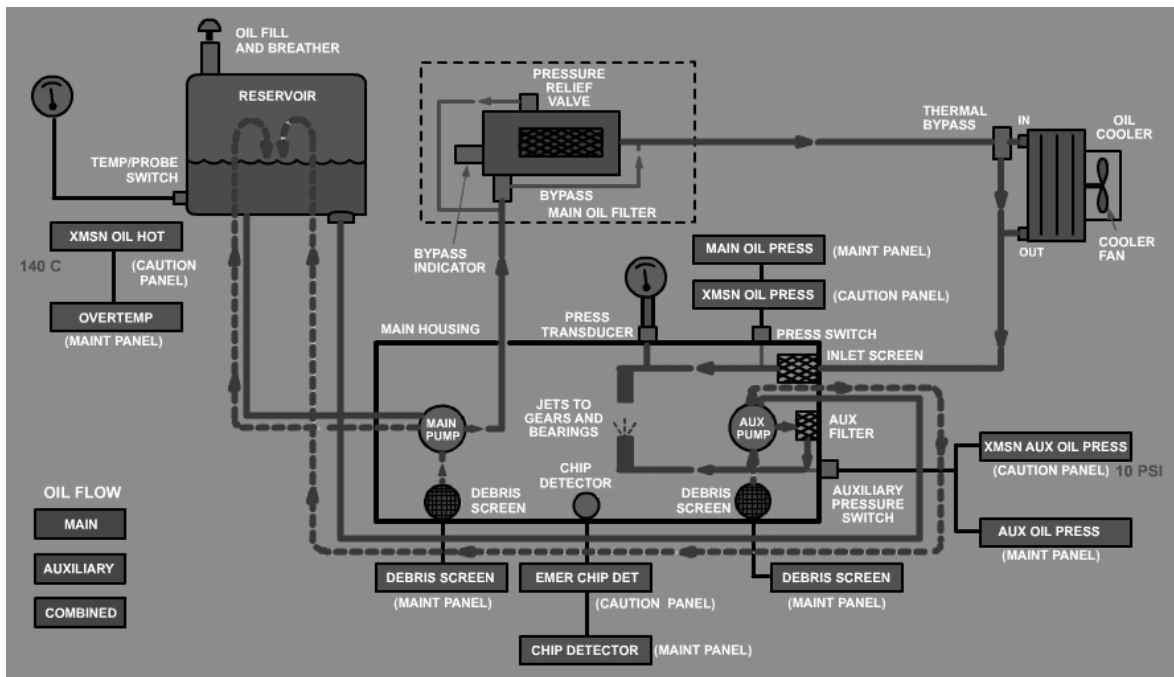
NOTE: Instructor should use the lubrication system schematics to trace the oil flow for each system.

f. Lubrication systems oil flow.

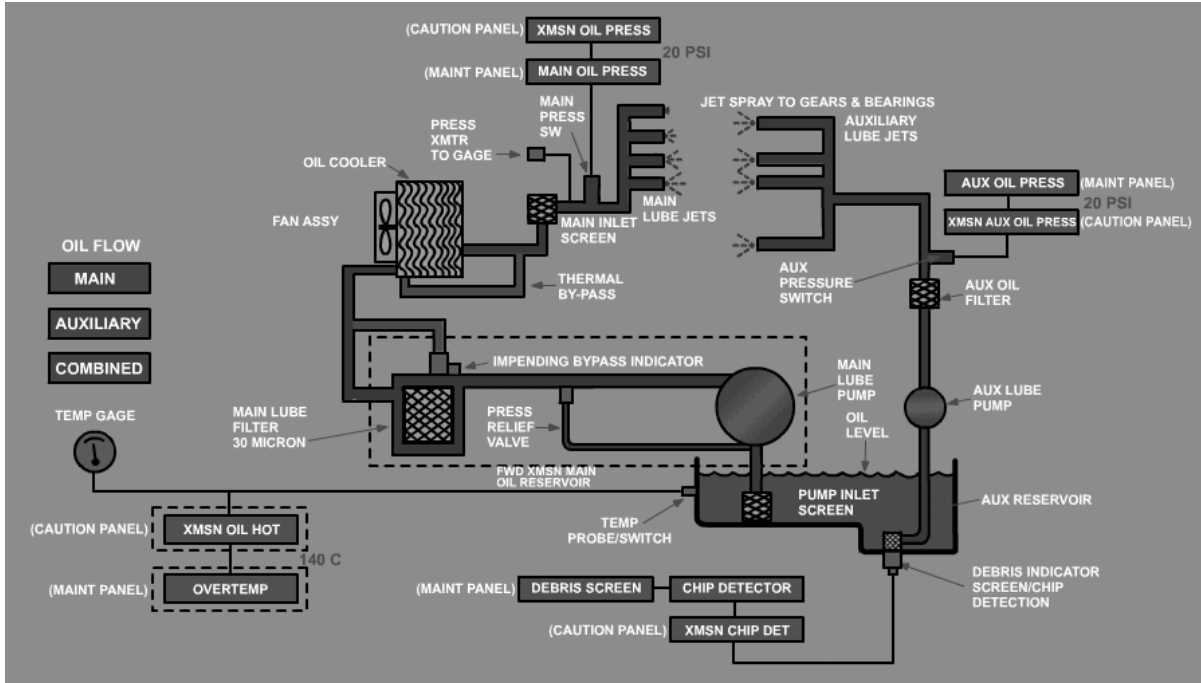
(1) Engine transmissions.



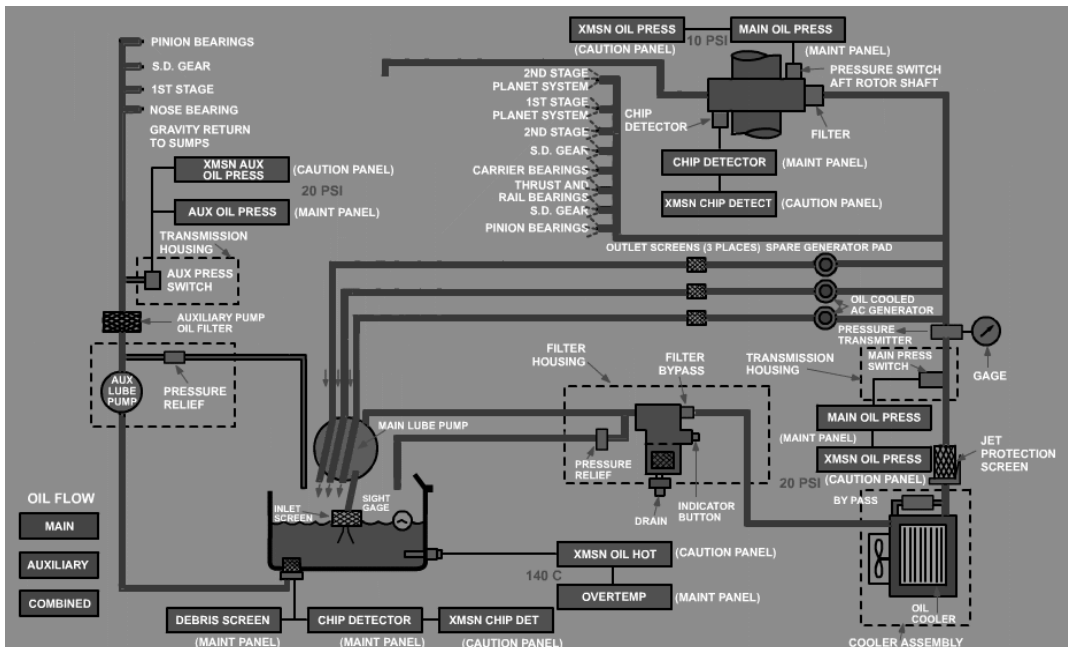
(2) Combining transmission.



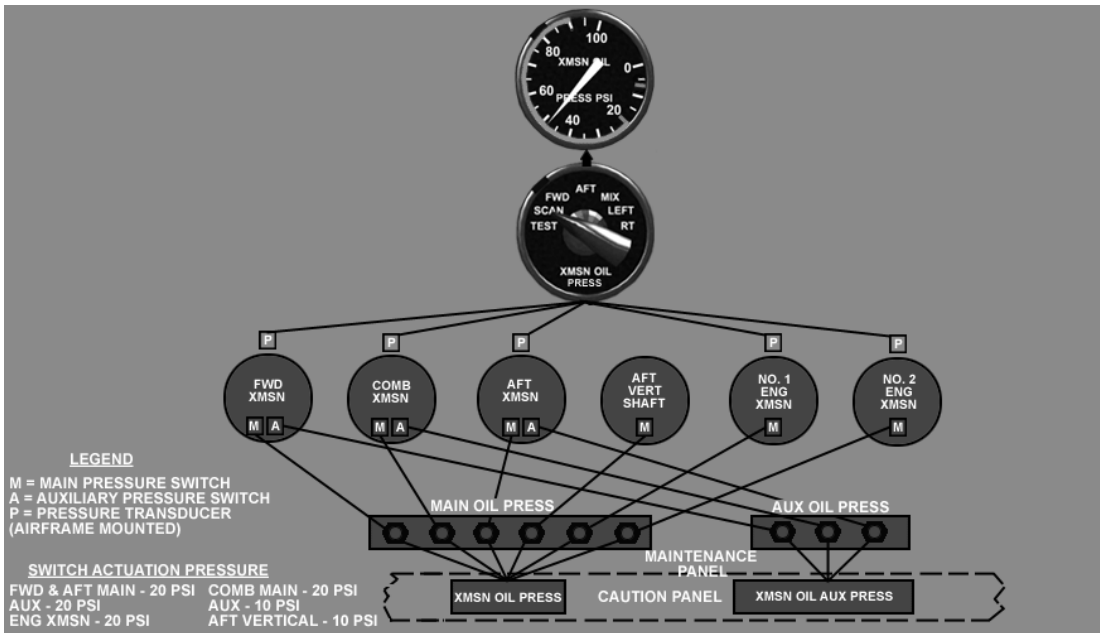
- (a) Main.
 - (b) Auxiliary.
- (3) Forward transmission.



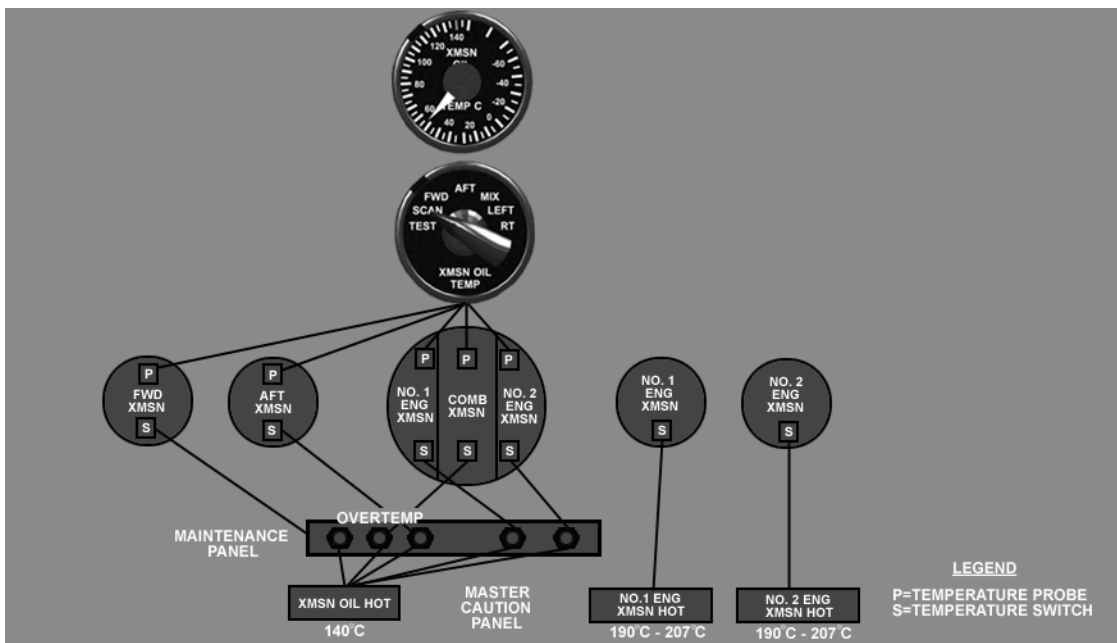
- (a) Main.
 - (b) Auxiliary.
- (4) Aft transmission.



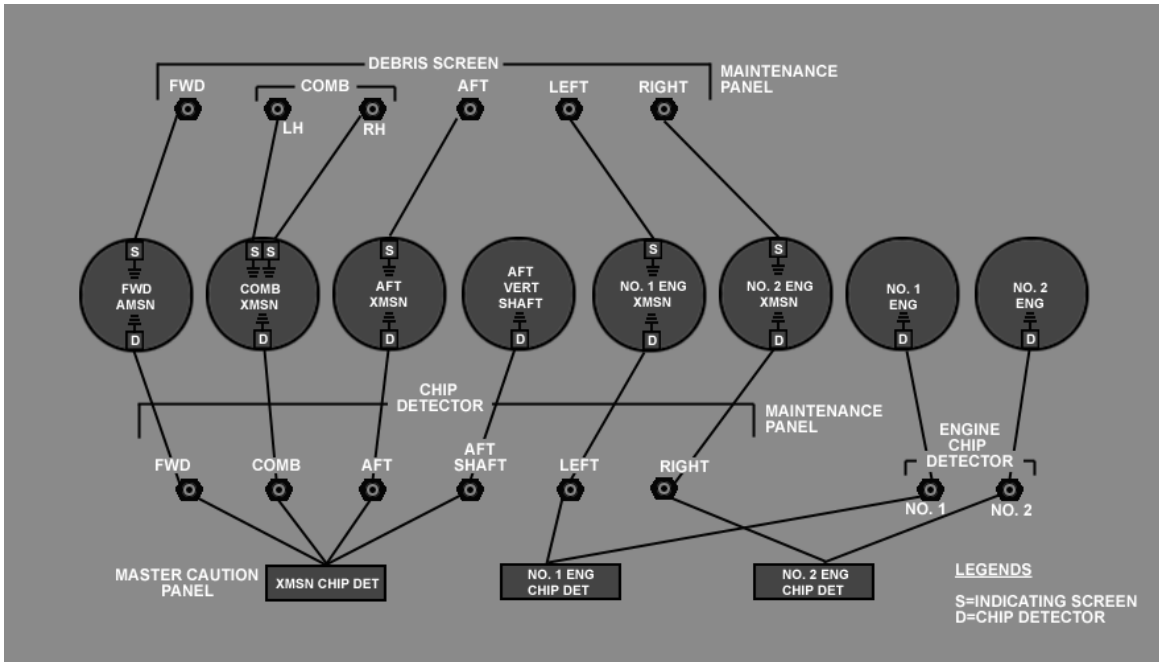
- (a) Main.
 - 1) Aft vertical shaft.
 - 2) Generators.
 - (b) Auxiliary.
- (5) Transmission oil pressure system.



- (6) Transmission oil temperature system.



(7) Oil debris and chip detection.



5. Learning Step/Activity 5—Describe Transmission Emergency Procedures.

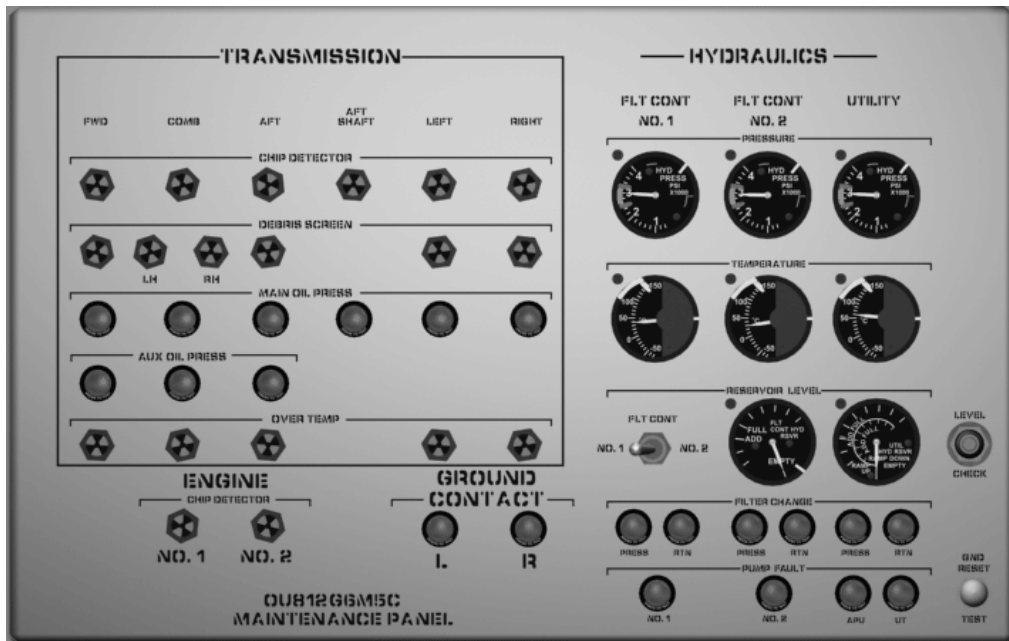
NOTE: The instructor will explain the current –10 procedures.

- a. NO.1 or NO.2 ENG XMSN HOT caution. Pg: 9–21.



1. EMERG ENG SHUTDOWN.
2. Affected engine transmission — Check.
3. Land as soon as possible.

- b. Transmission DEBRIS SCREEN Latches. Pg: 9–21.



OPERATORS MANUAL: Trouble developing any of the five transmissions may be indicated by a tripped latch indicator. This information will be presented on the flight engineer’s MAINTENANCE PANEL but will not be shown in the cockpit. If a latch indicator trips, it may be reset once during the flight. If an indicator trips:

- (1) **FWD, COMB, or AFT DEBRIS SCREEN** indicator:

RESET/GND/TEST switch — RESET.

*If indicator **does not** reset or trips again:*

Land as soon as possible.

- (2) **LEFT or RIGHT DEBRIS SCREEN** indicator:

RESET/GND/TEST switch — RESET.

*If indicator **does not** reset and engine power is required then:*

Land as soon as possible.

*If indicator **does not** reset or trips again and engine power is NOT required then:*

EMERG ENG SHUTDOWN (affected Engine).

Refer to single engine failure emergency procedures.

- c. XMSN OIL PRESS caution.

Pg: 9-21.



OPERATORS MANUAL: Transmission Low Oil Pressure or High Temperature Indications.

Developing trouble in the transmissions can be identified by high oil temperature or low oil pressure, as indicated by transmission temperature and pressure indicators and cautions. If an abnormal temperature or pressure indication develops, closely monitor the caution capsules. The XMSN OIL PRESS (main or aux) and XMSN OIL HOT caution capsules operate independently of the pressure and temperature indicating system and come on when a low pressure or high temperature condition occurs. Additional information may be obtained by the flight engineer checking the MAINTENANCE PANEL. The transmission temperature and pressure selector switches shall be used to assist in determining the defective transmission.

- (1) **FWD or COMB.**

Altitude — Descend to minimum safe altitude.

Airspeed — 100 KIAS or Vne, whichever is slower.

Land as soon as practicable.

(2) AFT or AFT SHAFT (confirm AFT SHAFT with flight engineer):

Land as soon as possible.

(3) LEFT or RIGHT.

*Engine power **is** required:*

Land as soon as possible.

*Engine power **is not** required:*

EMERG ENG SHUTDOWN(affected engine)

Land as soon as practicable.

d. XMSN OIL PRESS and XMSN AUX OIL PRESS or XMSN CHIP DET. caution.
Pg: 9-22.



Land as soon as possible.

e. XMSN AUX OIL PRESS caution.

Pg: 9-22.



MAIN XMSN, (FWD, COMB (MIX) or AFT)

Main transmission oil pressure and temperature are abnormal:

Land as soon as possible.

Main transmission oil pressure and temperature are normal:

Land as soon as practicable.

f. XMSN OIL HOT caution.

Pg: 9-22.



(1) FWD or COMB.

Land as soon as possible.

(2) AFT transmission is indicated.

Land as soon as possible.

Electrical load— Reduce as much as possible

(3) LEFT or RIGHT.

Engine power is required:

Land as soon as possible.

Engine power is not required:

EMER ENG SHUTDOWN.

Refer to single-engine failure emergency procedures.

g. Engine Transmission Clutch Failure to Engage. Page 9-19

NOTE: An engine transmission clutch failing to engage is most likely to occur when the engine condition lever is advanced from GND to FLT or during engine start. The indications of an engine transmission clutch failing to engage are: a loss of torque indication for an engine or erratic torque indications for an engine or failure of the N1 of an engine to accelerate past 70 percent N1 when advancing the ENG COND lever to FLT. A sudden high torque clutch engagement may cause severe engine and/ or drive train damage. A sudden engagement is indicated by a loud noise and/or a sudden large increase in engine torque. Should the engine transmission fail to engage, perform the following:

WARNING: Do not shutdown both engines simultaneously. Maintain RRPM with the engaged engine until affected engine N1 reaches zero (0).

1. **EMER ENG Shutdown — (Affected engine).**

When N1 reaches (0):

2. **EMER ENG Shutdown — (engaged engine).**

Appendix C - Practical Exercises and Solutions

CH-47D POWER TRAIN SYSTEM

PRACTICAL EXERCISE

NOTE: This practical exercise covers the instruction you received in this handout. Completion is optional, but strongly encouraged!

1. Which transmissions do not have an auxiliary lubrication system?
2. How can you identify low oil pressure in the aft vertical shaft?
3. What indication will the crew have when a debris screen is bridged with conductive particles?
4. The _____ lubrication system lubricates the main generators?
5. What should you do if you find an engine or combining transmission oil quantity indication low and the aircraft has been shutdown for more than 30 minutes?
6. What is the purpose of the 9 and 4 degree tilt in the aft and forward transmissions?
7. What is the location of the temperature switch that turns on the ENG XMSN HOT caution light?
8. The fluid levels in the combining and engine transmission should be checked within _____ minutes after engine shutdown?
9. Why must you reduce the electrical load if the XMSN OIL HOT caution light is on and the aft transmission temperature is high?
10. What will happen if the maintenance panel is tested in-flight?
11. What is the emergency procedure for the ENG XMSN HOT caution light ON?
12. How many synchronizing drive shafts are installed on the CH-47D?
13. What is the emergency procedure for XMSN OIL HOT caution light ON for the AFT transmission?
14. What is the emergency procedure for XMSN OIL PRESS caution light ON with power required (Left or Right)?

15. Exceeding VNE with the LCT retracted places excessive stress on what component?
16. What is the emergency procedure for AUX OIL PRESS caution light ON?
17. What is the emergency procedure for XMSN OIL PRESS and XMSN AUX OIL PRESS caution light ON?
18. What items in the drive-train system allows the shaft assemblies to flex?
19. What is the emergency procedure for XMSN CHIP DET caution light ON?
20. What action should you take if a debris screen latch indicator trips for the forward, aft, or combining transmission and cannot be reset?
21. What prevents vibration between shaft and aircraft and give longitudinal movement to the synchronizing shafts?
22. What is the emergency procedure the pilots must accomplish if a LEFT or RIGHT DEBRIS SCREEN latch indicator is latched and **will not reset** and power **is not** required?

CH-47D POWER TRAIN SYSTEM
PRACTICAL EXERCISE SOLUTIONS

1. Engine transmissions.
2. XMSN OIL PRESS caution light ON with the gauge showing normal system pressure; verify aft shaft by maintenance panel.
3. The maintenance panel will have an associated debris screen latch
4. Aft Transmission Main Lubrication system.
5. Run up for 5 minutes, shutdown, recheck.
6. To aid in ground taxiing.
7. In the engine transmission.
8. 30 Minutes
9. The generators are oil cooled, reducing the electrical load will extend their operational time.
10. The XMSN OIL HOT, XMSN CHIP DET, and the NO.1 and NO.2 ENG CHIP DET caution lights will come on.
11. **EMER. ENG. SHUTDOWN.**
FE (Affected Engine transmission –Check)
Land as soon as possible.
12. 9 Sync Shafts.
13. **Land as soon as possible**
Electrical load—Reduce (as much as possible)
14. **Land as soon as possible.**
15. The aft vertical shaft thrust bearing.
16. **Land as soon as possible.**
17. **Land as soon as possible.**
18. The adapter and plate assembly
19. **Land as soon as possible.**
20. **Land as soon as possible**
21. Shock Mounts (Lord Mounts)
22. EMER ENG SHUTDOWN.
Land as soon as practicable

