NAVAL AIR TRAINING COMMAND

HYDRAULIC SYSTEM

UC 09 03 03 08 ER

CNAT P-1044 (REV. 1-78) PAT

T-28 ENGINEERING PRIMARY

1978

NAVAL AIR STATION · CORPUS CHRISTI, TEXAS

CHIEF OF NAVAL AIR TRAINING
NAVAL AIR STATION
CORPUS CHRISTI, TEXAS 78419

Code 313

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1. CNAT P-1044 (Rev. 1-78) PAT, "Hydraulic System, UC 09 03 03 08 ER, T-28 Engineering, Primary," is promulgated for information, standardization of instruction, and guidance of instructors and students in the Naval Air Training Command.

2. This publication will be used to implement the academic portion of the Primary curriculum.

3. Recommendations for changes shall be submitted to the Commander, Training Air Wing FIVE.

4. CNAT P-1044 (Rev. 1-77) PAT is hereby canceled and superseded.

T. F. KOPFMAN
Assistant Chief of Staff for
Training/Operations

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NAVAL AIR TRAINING COMMAND

PRIMARY PHASE

DISCIPLINE: Engineering

COURSE TITLE: Engineering, T-28 (Primary)

UNIT: Hydraulic System

PREREQUISITES: Units 1-7

FOR INSTRUCTIONAL PURPOSES ONLY

SCOPE: The purpose of this unit is to schematically show operation of the hydraulic system and to acquaint the student with operation of the power/pressure system, hydraulic pump, landing gear, flaps, speed brake, and canopy systems.

SPECIFIC INSTRUCTIONAL OBJECTIVES

Affective Domain

None

Cognitive Domain

Upon completion of this unit, the student will:

1. State the capacity of the reservoir. (Comprehension)

2. Name the hydraulic pumps. (Knowledge)

3. State the electrical source that powers the solenoid-operated bypass valve. (Comprehension)

4. State the purpose of the microswitches in the hydraulic system and how they affect the solenoid-operated bypass valve. (Comprehension)

5. Name the type of hydraulic gauge and the purpose of the snubber. (Knowledge)

6. State the pressure at which the relief valve opens. (Comprehension)

7. State the purpose of the solenoid-operated bypass valve and system pressures, when it is open and closed. (Comprehension)

8. State how a pilot may pressurize the system when the hand pump is used. (Comprehension)

9. State what holds the flaps down. (Comprehension)

10. State what happens to the extended speed brake with an electrical failure. (Comprehension)

11. State the method of lowering the landing gear with a leak in the hydraulic reservoir. (Comprehension)

12. State how to operate the canopy after it has been opened by the emergency air system. (Comprehension)

13. State which components are held up and down by a mechanical lock. (Comprehension)

14. State the function of the external canopy handle. (Comprehension)

15. State how normal braking is provided for with loss of hydraulic fluid from the reservoir. (Comprehension)

16. State the procedure for freeing the gear handle when locked in the UP position. (Comprehension)

Psychomotor Domain

None

INSTRUCTIONAL MATERIALS

The instructor-in-charge must ensure that the following instructional materials are provided:

1. NATOPS Flight Manual
2. T-28 hydraulic system panel.
3. Cutaway hydraulic reservoir.
4. Photograph of T-28 cockpit.

When the materials listed above have been assembled, the student will proceed in accordance with the following directions:

DIRECTIONS TO STUDENT

STEP 1 Read the following pages in the NATOPS Flight Manual:
Pages 1-21, 1-22, 1-23, 1-24, 1-25, 1-26, 1-27, 1-30, 1-31, and 1-32.

STEP 2 Read programed text.

STEP 3 Take the criterion test.

STEP 4 End of this unit. Remedial session prescribed if necessary.

PROGRAM PERFORMANCE VALIDATION RECORD

This instructional sequence was introduced at NAS Whiting Field on 15 May 1971. This unit was validated in August 1977.

Reverse Blank

FRAME 1

Hydraulic power is used to operate the landing gear, wing flaps, canopy, speed brakes, and, in the T-28C aircraft, to retract the arresting hook. A variable displacement, engine-driven hydraulic pump supplies hydraulic pressure to the system. (See figure 1.)

The aircraft components requiring hydraulic pressure for operation are _____ _____, _____ _____, _____, _____ _____, and _____.

---

landing gear
wing flaps
canopy
speed brake
tailhook

FRAME 2

When no hydraulic units are being operated in flight, the entire output of the hydraulic pump is automatically diverted to the hydraulic reservoir through an electrically operated solenoid bypass valve powered by the secondary bus. The hydraulic system is depressurized in this state.

While in flight, hydraulic fluid is diverted to the _____ _____ by means of an _____ operated _____ _____ valve.

---

hydraulic reservoir
electrically
solenoid bypass

FRAME 3

When any component control is operated, or the secondary bus is lost, the solenoid bypass valve is electrically de-energized and is spring loaded closed, allowing the hydraulic system to build up pressure for operation of the selected component.

With the loss of d.c. power or by operating any component control, the solenoid bypass valve _____, allowing hydraulic pressure to _____ _____ for operation of the selected component.

---

closes
build up

T-28
HYDRAULIC POWER SYSTEM

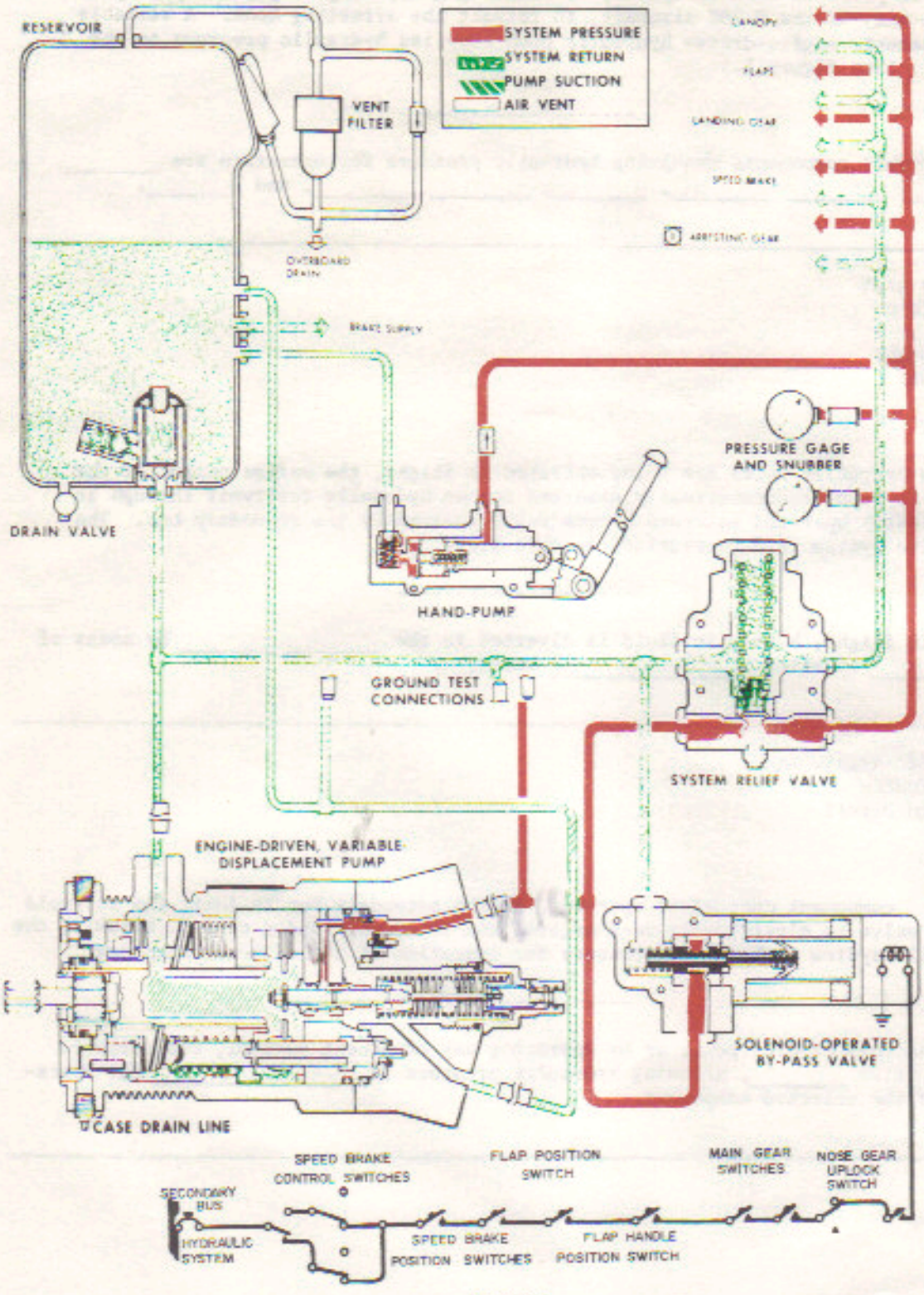


Figure 1

FRAME 4

The solenoid bypass valve is electrically energized to the open position which depressurizes the system only when all units are in the up or off positions. The system is pressurized at all other times, such as when the landing gear is extended or the flaps are down.

In normal cruise, aircraft in clean configuration, the hydraulic system is _____.

---

depressurized

FRAME 5

System pressure is maintained whenever the canopy is actuated, and whenever the speed brake, gear, arresting hook, or flaps are in any position other than UP.

When the flaps are placed down, the hydraulic system maintains _____ _____.

---

system pressure

FRAME 6

A hydraulic hand pump is provided on the left side of the front cockpit. The pump is primarily used for ground check of the hydraulic system, but may be used in flight should the engine-driven pump fail. The hand pump is merely a substitute for the engine-driven pump in the system and does not have separate lines or fluid supply to operate any part of the system. The hand pump may be used to operate any component the normal hydraulic system pressure pump operates. Some hydraulic component must be activated to close the solenoid bypass valve so that pressure may be built up by the hand pump.

With a loss of the engine-driven hydraulic pump, the gear or flaps may be extended by the use of the _____ _____ _____.

---

hydraulic hand pump

FRAME 7

The engine-driven, variable-displacement pump is a 9-piston, rotary, positive displacement unit. An automatic control device incorporated in the pump permits fluid flow until the system reaches approximately 1300 p.s.i. At this point, the flow from the pump is gradually reduced until it reaches zero at a system pressure

of 1500 p.s.i. The normal operating pressure is between 1250 to 1650 p.s.i. when any one of the subsystems is in use. With a windmilling engine, normal hydraulic pressure may be expected.

Normal operating pressure, when any component is actuated, is _____ to _____ p.s.i.

1250
1650

FRAME 8

A hydraulic reservoir with a capacity of 2.3 U.S. gallons stores and supplies fluid for the hydraulic system as well as the brake system. For a visual check of the fluid level, a sight gauge on the side of the reservoir can be seen through an access door on the left side of the fuselage in front of the canopy.

The hydraulic reservoir has a capacity of ____ ____ _____ and the level of fluid may be checked by means of a _____ _____.

2.3 U.S. gallons
sight gauge

FRAME 9

A hydraulic fluid filter is mounted in the bottom of the reservoir in the return line. A pressure relief valve is installed in this filter. If the filter becomes clogged or restricted, a fluid pressure of 10 p.s.i. opens the relief valve and allows the return fluid to go directly to the reservoir. The hydraulic air vent system allows air to enter the reservoir when fluid is drained off for use. This system consists of a filter, check valve, and relief valve.

The fluid filter relief valve opens at _____ _____ and diverts fluid directly to the _____. The purpose of the _____ _____ _____ system is to permit air to enter the reservoir when the fluid is drained off for use.

---

10 p.s.i.
reservoir
hydraulic air vent

FRAME 10

Control of the pressurization and the depressurization of the hydraulic power system is accomplished through the solenoid bypass valve, which is held open electrically and spring-loaded to the closed position. The component position microswitches are electrically connected in series. These microswitches are closed when their respective subsystems are positioned in the up, or closed, or the canopy control handle button is released. Thus, when all switches are closed, the electrical circuit is complete, the solenoid bypass valve is energized and open, releasing pressure in the hydraulic system. (See figure 1.)

With the gear down, the bypass valve is _____ and the hydraulic system is _____.

---

closed
pressurized

FRAME 11

A combination pressure and thermal relief valve is incorporated in the hydraulic power system to protect against excessive pressures in the event of a malfunction in the engine-driven pump. The relief valve will open at 1700 p.s.i. and begin relieving the pressure by routing fluid to the hydraulic reservoir. The relief valve will also relieve pressure in excess of 1700 p.s.i. caused by thermal expansion of the hydraulic fluid.

When the system relief valve opens at _____ p.s.i., the hydraulic fluid is routed to the _____ _____.

1700
hydraulic reservoir

FRAME 12

There is a Bourdon-tube type pressure gauge for the hydraulic system in each cockpit, reading pounds-per-square-inch. Its normal in-flight reading with the airplane "clean" and the canopy button released will be 0 to 100 p.s.i. Normal system pressure with gear, flaps, speed brake, or canopy actuated will be 1250 to 1650 p.s.i. Associated with the pressure gauge, is the snubber, which acts as a hydraulic/air shock absorber within the system. If the snubber becomes dirty or clogged, a very erratic pressure reading will be observed.

With gear down and canopy closed, flaps and speed brake up, the hydraulic pressure would be _____ to _____ p.s.i.

1250
1650

FRAME 13

The landing gear system consists of three retractable landing gear assemblies. Gear limitation airspeed is 140 knots. The landing gear is hydraulically operated by pressure from the hydraulic system. Pressure is directed to the landing gear actuating cylinders by a manually operated selector valve. (See figure 2.)

Placing the gear handle down closes the _____ _____ _____, permitting hydraulic pressure to be routed to the _____ _____ _____ _____ which extends the three landing gear.

---

solenoid bypass valve
landing gear actuating cylinders

FRAME 14

The landing gear selector valve is a two-position poppet-and-spring-type valve assembly located in the left wing center section. Operation is through direct mechanical linkage from the gear handle, which positions the valve for either up or down gear action.

The landing gear selector valve is located in the _____ _____ _____ _____ and is actuated by _____ _____ from the gear handle.

---

left wing center section
mechanical linkage

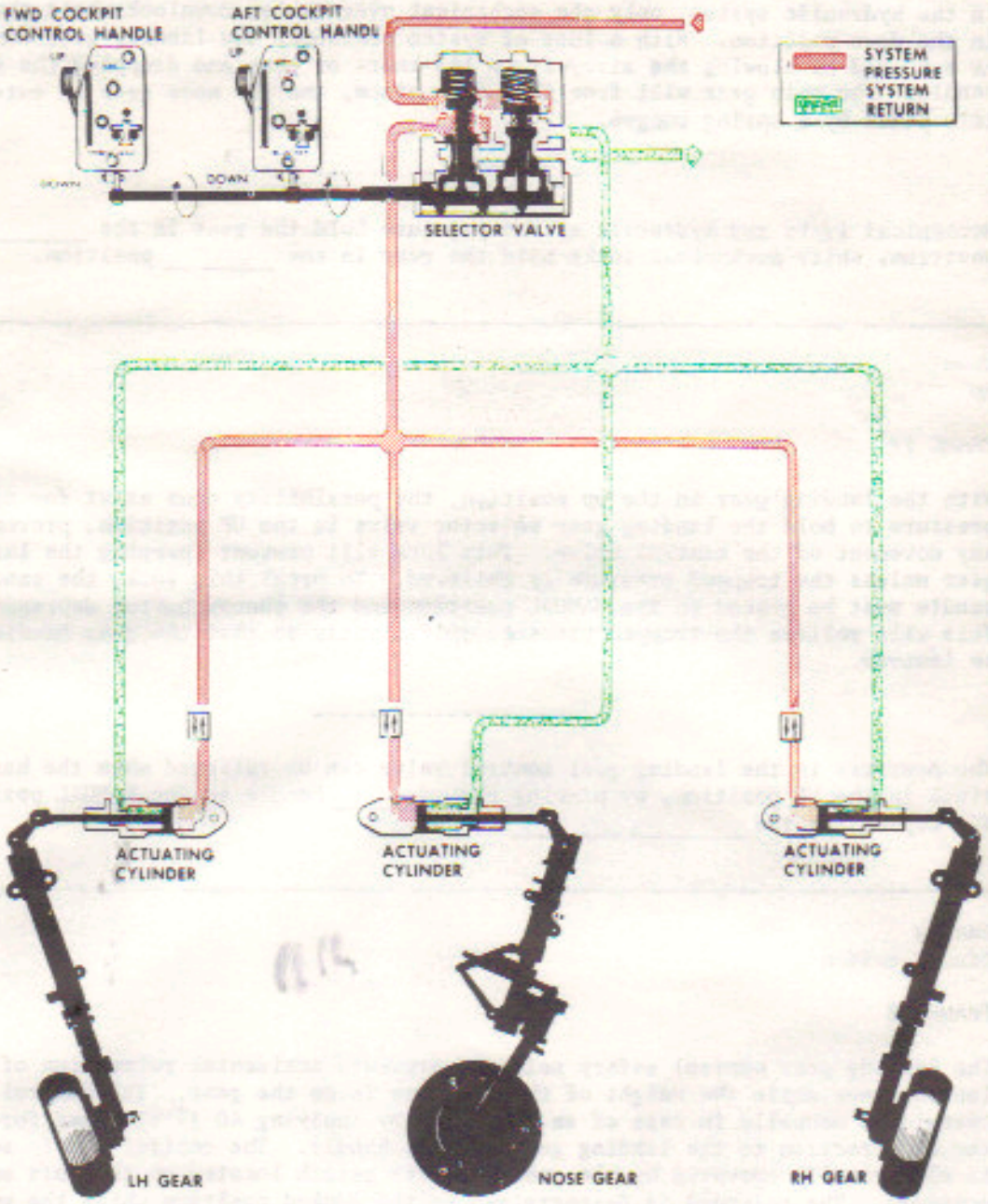
FRAME 15

In addition to positioning the gear selector valve, moving the gear handle unlocks the landing gear uplocks or downlocks. Moving the gear handle in either cockpit will cause this action.

By placing the gear handle down, the _____ _____ is positioned and the _____ are released.

---

selector valve
uplocks



LANDING GEAR SYSTEM

Figure 2

FRAME 16

The landing gear is held up by a set of mechanical uplocks which engage a set of rollers on the respective struts. The gear is held in the down position by mechanical over-center downlocks, and hydraulic system pressure. With a failure in the hydraulic system, only the mechanical over-center downlocks hold the gear in the down position. With a loss of system pressure, the landing gear can still be extended by slowing the aircraft to 115 knots or less and dropping the gear handle. The main gear will free fall into place, and the nose gear is extended into place by a spring bungee.

Mechanical locks and hydraulic system pressure hold the gear in the _____ position, while mechanical locks hold the gear in the _____ position.

---

down
up

FRAME 17

With the landing gear in the up position, the possibility does exist for trapped pressure to hold the landing gear selector valve in the UP position, preventing any movement of the control valve. This lock will prevent lowering the landing gear unless the trapped pressure is relieved. To break this lock, the canopy handle must be placed to the MANUAL position and the canopy button depressed. This will relieve the trapped pressure sufficiently so that the gear handle can be lowered.

The pressure in the landing gear control valve can be relieved when the handle is stuck in the UP position, by placing the _____ handle to the MANUAL position and depressing the _____ _____.

---

canopy
canopy button

FRAME 18

The landing gear control safety solenoid prevents accidental retraction of the landing gear while the weight of the airplane is on the gear. The control can be overridden manually in case of an emergency by applying 40 ($\pm$ 5) pound force in the UP direction to the landing gear control handle. The control safety solenoid is electrically operated by the ground safety switch located on the left main gear scissors. The solenoid is de-energized to the locked position while the weight of the airplane is on the gear.
