CHANGELOG

V1.02

Bug fix:
The magneto switches were reversed.
Carb temperature gauge now show proper value, depending of carb heat setting.
CHT limits now sets to 260°, according to flight manual.
The direct and alternate switches for the carbs were flipped.
The throttle levers now “pushed up” to select Reverse.
ADF now working in V10.
No more control locked for aircraft loaded after the HU-16.
Operating throttle was not possible after copilot shutdown check-list.
Battery amp gauge was showing bus amps and not battery amps.
Battery capacity adjusted (864 watt hours instead of 1000).
The starter amps set to 442 amps instead of 0.

V1.01

New feature:
Added an “Easy taxy” option which remove the freecastoring nosewheel

Bug fix:
Brakes were not functional with freecastoring nosewheel. No more free castor in V10 until it is fixed in X-Plane code (You can select it but you lose brakes...)
Reverse of right prop is fixed
Unfeathering is corrected
Adjustable wings level bar on the Artificial Horizon now move far enough to agree with the gyro.

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Installation
To install this aircraft, you simply need to unzip the archive you downloaded and then copy the whole folder in the X-Plane’s one. You can put this folder in the “Aircraft” folder or copy it wherever you want, as long as it is contained in the X-Plane main folder. It is generally recommended to have a separate folder for add-on aircraft. It may be the good location for your new aircraft.

Hardware requirements
This add-on has been tested on several configuration, on Windows, Mac and Linux OS. It is designed to work at acceptable frame rate on old configuration, but with the best visual experience. If you have an old graphic card with a low amount of video RAM, you can lower texture resolution in the rendering option menu. It will not affect the cockpit texture so instruments remain perfectly readable even at low resolution.

X-Plane settings
For the best in-flight experience, you may set the lateral field of view (FOV) to 60°. That’s a perfect setting for 16/10 screen. You may tune this value a little, depending of you preference and screen configuration. You can set this value in the “Rendering Options” menu.

Manipulators behavior
As all recent aircraft for X-Plane, this add-on intensively use manipulator to enhance flight experience. Use of manipulators allow to smoothly drag levers or click button, depending of the cursor shape. Cursor show cursor while lever need to be dragged and a hand when you need to click (toggle button).

In order to navigate easily in the cockpit, you should map your hat joystick with left/right up/down function. The 3D cockpit mode with mouse in X-Plane is not adapted for instruments tuning. By the way, all efforts has been made so you can use this 3D Cockpit as a 2D one.

Off course, a tracking device like a TrackIr greatly improve the experience.

Frequently asked questions
I got an error message in X-Plane while loading the aircraft ;
This add-on has been developed for X-Plane 9.70 and 10.25+.

My aircraft has a weird behavior, controls doesn’t respond as they would :
It may be caused by plug-in provided with other aircraft. Try to deactivate them in the plug-in menu or move them out of the plug-in folder and then restart X-plane.

My aircraft jerks on the ground, even with engine not running :
Try to adjust the number of flight models per frame in the “Operations & warnings” menu. A good value is within 2 and 3. It has a limited impact on fps and you should always lower rendering setting instead of lower this value to get higher frame-rate.

You can setup some custom functions on keyboard shortcut or joystick buttons. Go to the “Settings => Joystick & Equipment=>Keys or Buttons menu.

Support
3D model, textures, liveries:
http://blog.khamsin.org/contact
Flight model, animation, scripts
contact@hydroz.net

THE AIRCRAFT

Source: NATOPS - Flight Manual - HU-16D Aircraft
Navair 01-85AC-1 - 1 March 1968

The aircraft is an all metal, high wing, twin engine, fixed wing tip float, air-sea rescue amphibian built by the Grumman Aircraft Engineering Corporation. It is powered by two engines driving three-bladed, constant speed, full feathering, reversible pitch propellers. Provisions are made for the installation of JATO units on the hull doors. Oxygen systems are provided for the crew and passengers. The flight deck and cabin are heated and ventilated.

Dimensions
Span: 96 feet 8 inches
Length: 62 feet 10 inches
Height: 25 feet 10 inches
Beam: 7 feet 11 inches
Thread: 17 feet 8 inches

PILOT'S INSTRUMENTS PANEL

1 - Airspeed
2 - Pilot Flight Instrument Warning light
3 - Artificial horizon
4 - Altimeter
5 - Landing Gear Warning Light
6 - Course Indicator Lights
7 - Variometer
8 - Compas
9 - Turn indicator
MAIN INSTRUMENTS PANEL

1 - Clock
2 - Carb temp
3 - Manifold pressure
4 - Tachometer
5 - Wheels and flaps Position indicator
6 - Outside Air Temp
7 - ADF
8 - VOR 1
9 - Oil temp left
10 - Oil pressure left
11 - Fuel press left
14 - Fuel pres right
15 - Elevator trim tab position indicator
16 - empty
17 - Radio altimeter
18 - VOR 2
19 - Cylinder head temperature
20 - Fuel Qty
21 - Rudder and Aileron Trim Tabs Position Indicator
22 - Clock
23 - Fire Warning light - Left engine
24 - Left generator warning light
25 - Right generator warning light
26 - Fire Warning light - Right engine
COPilot’S INSTRUMENTS PANEL

1 - Course Indicator Lights
2 - Airspeed
3 - Propeller Oil Replenish Warning Lights
4 - Auxiliary Fuel Flow Warning Lights
5 - Artificial horizon
6 - Altimeter
7 - Co-pilots Flight Instrument Warning light
8 - Carburetor Air Warning Lights
9 - Variometer
10 - Compas
11- Turn indicator
MAIN CONSOLE LEFT

1 - Inverter Power Off Warning Lights
2 - Inverter Selector Switch
3 - Propeller De-icer Indicator Light
4 - Propeller De-icer Switch
5 - Thermostat Selector Switch
6 - Hydraulic Main System Pressure Gage
7 - Hydraulic Sub-system Pressure Gage
8 - Drop Tank Master Switch
9 - Left Drop Tank Master Switch
10 - Right Drop Tank Master Switch
11 - Drop Tank Jettison Switch
12 - Wing and Tail De-icer Suction Gage
13 - Hydraulic Hand Pump Selector Control
14 - Wing and Tail De-icer Pressure Gage
15 - Ventilating Air Switch
16 - Alternate Static Air Source Control
17 - Heater Control Switch
18 - Pitot Heater Switch
19 - Windshield Anti-icing Control
20 - Windshield Anti-icing and Wash Control
21 - Inverter N°3 Switch
22 - Inverter N°2 Switch
23 - Inverter N°1 Switch
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1 - Starter Switches
2 - Primer Switches
3 - Generator Ammeters
4 - Battery Ammeter
5 - Flight Instrument Power Switch
6 - Voltmeter jack (statique)
7 - External power Switch
8 - Generator Switches
9 - Battery switch
10 - Oil Dilution switches
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12 - Cowl Flap Switches
13 - Oil Cooler Switches
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1. DC Voltmeter
2. Circuit Breaker Panels
3. Safety Belts Sign Switch
4. No Smoking Sign Switch
5. Windshield Wiper Control
6. DC Voltage Selector Switch
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1 - Rudder Trim Tab Switch
2 - Elevator Trim Tab Switch
3 - Aileron Trim Tab Switch
4 - Landing Lights Switch
5 - Navigation Lights Switch
6 - Anti-Collision Light Switch
7 - Strobe Lights Switch
8 - Pilot Lights Switch
9 - Copilot Lights Switch
10 - Cockpit Light Switch
11 - Cabin Lights Switch
12 - Flight Group Inst. Lights
13 - Engine Group Inst. Lights
14 - Garmin 340 Audio Selector
15 - Bendix King KX155 COM1-NAV1
16 - Bendix King KX155 COM2-NAV2
17 - Bendix King KR87 ADF
18 - Bendix King KT776A XPDR
19 - Bendix King KN62A DME
20 - Auto Pilot Power Switch
21 - Auto Pilot Clutch Switch
22 - Auto Pilot Controller
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1 - Emergency Control Panel
2 - Fuel Tank Selector Controls
3 - Fuel Booster Pump Switches
4 - Ignition Switches
5 - Wing Flaps Control
6 - Propeller RPM Switches and Lights
7 - Mixture Controls
8 - Throttles
9 - Gust Lock Control
10 - Supercharger Control Handle

OVERHEAD CONTROL PANEL
1 - Rudder Boost
2 - Emergency Autopilot Disconnect
ENGINE

The aircraft is powered by two nine cylinder Wright R1820-76A/B/C/D engines geared to two propeller revolutions and are equipped with hydraulically operated, single stage, two speed superchargers, and high tension ignition systems. Carburetor air is introduced into each nacelle through two inter-cylinder ducts. Each duct is provided with an alternate air valve to permit mixing of warm air ducted through the accessory compartment baffle from directly behind the engine exhaust stacks.

Throttles

The throttles for the pilot and co-pilot are located on the quadrant section of the overhead control panel. The throttles operate by mechanical linkage to the carburetors on the engines. Aft is CLOSED position; full forward is OPEN. When the throttles are in the CLOSED position, pushing them upward approximately one-half inch trips six limit switches that electrically control the hydraulic action of the propellers and places them in reverse pitch. With the throttles in the reverse pitch position, their action is reversed by means of a mechanical arrangement so that the engine power is increased by further aft movement of the throttles. The propellers are unreversed by moving the throttles forward to CLOSED position and then down. The handle of the gust lock control lever, when in the LOCK position, prevents the throttles from being advanced beyond a partial setting of approximately one-quarter throw and 1500 RPM.

WARNING ! No safety devices are provided to prevent inadvertent propeller reversal in flight. Therefore, care must be exercised to prevent this action if the throttles are closed in flight.

Engine operation

Adjust propeller and throttle controls for desired power settings. Periodically check for desired instrument readings.

Changing power in flight

To increase power, first increase engine RPM, then increase manifold pressure. To decrease power, first reduce manifold pressure, then reduce engine RPM.

High RPM / Low RPM operation

Operation at high RPM and low MAP is one of the major causes of master rod bearing and ring failure and piston loss. Therefore, a minimum of 1 INCH of MAP for EACH 100 RPM shall be maintained during period of rapid and or prolonged descent (normal landing excepted)

Engine overboost limitations

Every effort must be made to reduce the possibility of engine damage resulting from inadvertent operation beyond the established limitations over the usual operation range. Operating beyond the established limitation must be recorded on the Yellow sheet. Note the duration, RPM, cylinder head temperature, and any engine malfunctioning or damage found. Refer to latest revision of GREB N°.197 for specific engine overboost limitations.

Carburetors

The engines are equipped with Bendix Stromberg injection type carburetors. This carburetor employs the method of metering the fuel through fixed orifices according to the venturi suction combined with the function of atomizing the fuel spray under positive pump pressure. As fuel is injected below the throttles venturi, this type of carburetor is relatively ice free. The fuel-to-air mixture metered through the carburetor is controlled by the mixture controls.

Mixture controls

Two mixture control levers, one for each engine, are located to the right of the throttles on the overhead control panel. Three positions are provided : IDLE CUT-OFF, NORMAL, and RICH, with NORMAL and RICH position detended. Movement of the mixture control lever mechanically changes the carburetor mixture. IDLE CUT-OFF, the full aft position, stops fuel flow at the carburetor, thus stopping the engine. NORMAL, the mid position, provides proportioning of the fuel-air mixture in the leanest practicable ratio. RICH, the full forward position, provides the richest possible mixture of fuel and air for short periods when high power is required.

Carburetor Air System

Each engine is provided with a dual air induction system that furnishes either cold or heated air or a mixture of the two to the carburetor. The system consists of two inlet ducts, a duct assembly on each side of the engine, a Siamese duct and the carburetor header. Cold air is inducted through the inlet ducts located between cylinders N° 3 and 4 and N° 7 and 8, passes through the duct assemblies to the Siamese duct thence to the carburetor header. Heated air is taken from around the exhaust stacks through holes in the baffle behind cylinders N° 3 and 8, and passes through flexible ducts attached to the baffle into the ducting that carries the cold air. A carburetor air door in each
duct assembly, whose position is controlled by a DC powered rotary actuator, is located at the junction of the flexible duct and the duct assembly. The two carburetor air doors for each engine operate in unison. When one of the DC energized carburetor switches is positioned, the position of the carburetor air doors determines whether cold or heated air or a mixture of the two is supplied to the carburetor.

A carburetor air warning light is installed for each engine. These warning lights are connected electrically only to the left carburetor air door of each engine and will glow only when that door is in the full ALTERNATE position.

**Carburetor Air Control Switches**

The three position, toggle type carburetor air control switches are located on the center main console. The positions are DIRECT, OFF and ALTERNATE. In the DIRECT position (forward), ram air is directed to the carburetors from top-mounted airscoops. In the ALTERNATE position (aft), the carburetor air doors are positioned to permit heated air from behind the engine to enter the carburetor. A mixture of cold and heated air can be obtained by setting the carburetor air switch first to either the DIRECT or ALTERNATE position; then, to OFF when desired carburetor air temperature increase or decrease is observed on the carburetor air temperature gage. In their OFF position, the carburetor air doors are stopped in their travel at intermediate positions, thereby permitting the mixed air to enter the carburetor. The movement of the carburetor air doors can be reversed, regardless of whether they complete the full travel to either the DIRECT or ALTERNATE position.

**NOTE:** After operating the carburetor air switches, allow a 35 second cooling period for the actuating motors before operating the control switches to the opposite position.

**Carburetor Air Warning Lights**

Two carburetors air warning lights, one for each engine, are located to the right on the co-pilot’s flight instrument panel. The DC powered lights glow only when the left carburetor air doors are in the full ALTERNATE (heated air) position. If the left carburetor air door is open to the slightest degree, or if the switches are placed in the OFF position, the light will not glow.

**USE OF CARBURETOR ALTERNATE AIR**

Alternate air must be used whenever conditions are such that carburetor ice can form. The alternate air must be applied before the formation of ice, to prevent its developing, rather than after ice has already formed. It is advisable to use alternate air to improve fuel vaporization and fuel consumption when cruising during cold weather. Because detonation can occur at high power settings when full alternate air is used, the alternate air temperature must be regulated to maintain carburetor air temperature at 20° to 30°. During flight conditions where the carburetor air temperature exceeds 38° in DIRECT position, the allowable manifold pressure for a given RPM shall be reduced by a inch Hg for each 6°C in excess of 38°C.

**CAUTION:** To close the cowl flaps when alternate air is in use, set the carburetor air switch to DIRECT, close the cowl flaps, stabilize the cylinder head temperature, then set the carburetor air switch to ALTERNATE to obtain the desired temperature. Unless this is done, alternate air temperature rise can exceed the required temperature.

**SUPERCHARGERS**

Each engine incorporates an integral single stage, two speed supercharger (blower). One control handle simultaneously operates the superchargers of both engines. In the low speed ratio, the blower speed is 7.21 to 1; in the high speed ratio the blower speed is 10.14 to 1. Movement of the handle positions the supercharger actuator valve which allows engine oil pressure to act on the impeller clutch plates and change the supercharger impeller speed from low to high ratio. The blowers are operated in the low speed ratio for take-off, landing and flight at low altitudes. The high speed ratio is used for flights at higher altitude (12,000 feet minimum density altitude for high blower operation). High speed ratio is not used at lower altitudes because the air at lower altitudes, being more dense, exerts a braking effect on the impeller when compressed by the impeller and imposes a heavy load on the engine, thereby causing a loss of brake horsepower. The lower the altitude, the greater the loss of brake, and the greater the probability of detonation.

**Supercharger Control Handle**

The supercharger control handle is located in the engine controls group on the overhead control panel outboard of the throttles. It has two positions: LOW (forward) and HIGH (aft). This single control handle is connected by mechanical linkage to each supercharger actuator valve located in the supercharger rear housing. Movement of the handle forward or aft positions the supercharger actuator valve (through the mechanical linkage), thereby controlling engine oil pressure, used to actuate blower clutch, to change the speed of the supercharger impeller.

SUPERCHARGER OPERATION

For cruising above 12,00 feet, it may be desirable to use the supercharger. Use the supercharger when unable to maintain allowable climb power in low blower. Use the following procedures when utilizing the supercharger.

1- Reduce manifold pressure to 20 in.Hg MAP and speed engine to 1600 RPM
2- Move blower control rapidly from LOW to HIGH.
3- Adjust power settings as desired
4- Shifting from HIGH to LOW may be accomplished at any power setting
   CAUTION : To avoid excess heating of clutch parts and possible oil starvation of the supercharger, do not shift the blowers through a complete cycle more than once in five minutes.

ENGINE COOLING

Two cowl flaps are provided on each engine nacelle to regulate the flow of air past the engine cylinders, and aid in controlling cylinder head temperature. These electrically actuated cowl flaps are located on the bottom of each nacelle. The cowl flaps are operated by two toggle switches controlling electric actuators and screw jacks. Limit switches, self-contained in the actuator, prevent the actuating motors from burning out by automatically stopping the flaps when they reach the limits of their travel. The travel of the flaps is from 0° in the CLOSE position to 34° in the OPEN position. The time lapse from the full closed to the full open position is 18 to 22 seconds. The position of the cowl flaps can be visually checked from the flight deck windows.

Cowl Flaps Switches

Two three-position toggle switches are located on the main console and control the cowl flaps. These switches, one for each engine, have the following positions : OPEN, OFF and CLOSE. They are normally set on the OFF position. The switches are connected electrically to the flap control actuators and are energized by the DC power supply system. Moving the switch from OFF to either OPEN or CLOSE positions the cowl flaps. Intermediate positions of the cowl flaps can be obtained by moving the switches to OFF after setting the switches to either OPEN or CLOSE.

IGNITION SYSTEM

Each engine is equipped with two complete ignition systems. Each ignition system comprises a high tension magneto, a set of spark plugs and the necessary ignition wiring.

Master and Individual Ignition Switch Unit

The ignition switch unit, located on the overhead control panel, is a two engine type, incorporating a master ignition switch plus an individual ignition switch for each engine. The master switch is marked PULL OFF. The master switch must be in the on (pushed in) position for the individual engine switches to operate. Each engine switch has four positions which control the four circuit conditions available. The positions are : BOTH, L, R and OFF. When the engine switch is in the OFF position, the circuit to both magnetos is grounded, making the magnetos inoperative. In the R position, the right magneto is operative and permits the front spark plugs to fire. In the L position, the left magneto is operative and permits the rear spark plugs to fire. In the BOTH position, both magnetos are operative and permit their respective spark plugs to fire simultaneously.

PRIMING SYSTEM

Fuel under pressure from the fuel booster pump is directed to the electric solenoid operated priming system valve mounted on the carburetor regulator. The opening and closing of the solenoid operated priming valves is controlled by the priming switches, one for each engine. Fuel from priming valve is directed through a “T” fitting on the priming valve to two feeder tubes which carry the fuel to a discharge nozzle installed on each side of the carburetor adapter. The atomized fuel is thus directed into the supercharger housing.

Priming Switches

Two push button type primer switches are located on the main console to the left of center. They are spring loaded to the off position. The primer switches are energized by DC power and are electrically connected to a solenoid operated primer valve. Depressing the switches energizes the primer valve, permitting atomized fuel to enter the supercharger housing.

START SYSTEM

The starter system consists of a direct cranking starter motor, an induction vibrator for supplying continuous high voltage at cranking speeds, a two point priming system, and a starter switch for each engine. The direct cranking starter is a combination unit and provides instantaneous and continuous cranking of the engine. It consists of an electric motor, a gear reduction and an automatic engaging and disengaging mechanism which operates through an adjustable torque-overload release. The torque-overload release mechanism consists of a multiple clutch adjustable to a predetermined value to deliver a
sufficient, yet not excessive, cranking torque to the engine. In case of engine kick-back, the clutch should slip to prevent damage to the engine or starter.

Starter Switches
The two push button type starter switches are enclosed in a guard and are located on the main console, left of center. The switches, when depressed, are energized by DC power from the APU (or an external power source, if used) and are connected to the starter motors through starter relays. These push button switches are spring loaded to the off position.

PROPELLERS
Each engine is equipped with a three blade Hamilton Standard hydromatic propeller. It is a constant speed full feathering, reversible pitch propeller. A propeller governor for each engine automatically adjusts propeller pitch to maintain constant engine speed under varying flight conditions. The control assemblies and the propeller are combined. The oil supply for operating the propeller is independent of the engine oil system and is contained in the integral oil control assembly. An electrically operated emergency propeller oil replenishing system is provided to supply engine oil in the event the oil level in the propeller control assemblies is low. Manual feathering controls are provided. Feathering and unfeathering actions of the propeller are supplemented by an electrically driven auxiliary pump which supplies high pressure oil to the governor.

RPM CONTROLS
Two RPM control switches, for changing engine speeds by altering propeller governor settings, are located on the overhead control panel. These toggle switches (one for each engine) have three positions. The INCREASE and DECREASE positions are momentary, spring loaded in the OFF position. The off position, while not marked on the panel, is the automatic or constant speed setting. Holding a switch in the desired position electrically controls the corresponding propeller governor. Depending on the governor RPM setting, the blade pitch will change to maintain the desired RPM when the throttles are moved.

RPM INDICATOR LIGHTS
Two indicator lights, one for each switch, are located just aft of the RPM control switches on the overhead control panel. When either RPM switch is actuated, the corresponding indicator light will glow when either the maximum (2700 RPM) or the minimum (1200 RPM) propeller governor position is reached.

REVERSE PITCH CONTROL
Propeller reverse pitch operation is controlled by the throttles. With the throttles in the CLOSED position, pushing them upward trips limit switches, automatically setting the propellers to reverse pitch. Further movement of the throttles aft will increase the reverse thrust of the engine.

WARNING: No safety devices are provided to prevent inadvertent propeller pitch reversal in flight. Therefore, care must be exercised to prevent this action if the throttles are closed in flight.

Returning the throttles to the CLOSED forward pitch position will trip the limit switches and automatically return the propellers to a few degrees beyond low pitch. The propeller governor will return the propellers to the RPM setting used immediately before reversing.

NOTE: The RPM control switches have no effect over the reversing circuits. The feathering switch will override the reversing controls.

FEATHERING CONTROLS
Two spring loaded red push-pull type feathering buttons are installed in the emergency control panel of the overhead control panel. These are neutral off type switches with a holding coil acting when the switch is pushed in. The buttons are marked PUSH FEATHER, UNFEATHER PULL. Each button has three positions: full in, full out, and half out (neutral).

A maximum of 5 seconds is required to fully feather a propeller and 12 seconds to pop out the feather button.

The feathering cycle can be stopped by pulling the feathering button to the half (neutral) position. If this is done before the propeller has stopped rotating, the propeller blade will return to the pitch corresponding to the RPM setting of the propeller governor. However, once energized, the auxiliary pump timer will complete its cycle.

Unfeathering is accomplished by pulling the featuring button full out, holding it out for approximately 2 seconds, or until propeller rotation just begins, and then releasing it, allowing it to return to the half (neutral) position.
FUEL SYSTEM

Fuel is supplied to the engines from two tanks contained in the left and right side of the wing center section. Each tank houses three interconnected bladder type cells. In addition, fuel may be carried in auxiliary drop tanks hung under each wing outer panel and in wing tip float fuel tanks. A fuel transfer system is provided to replenish the main tanks with fuel from the corresponding drop tanks or the wing tip float tanks. During normal operation, each main tank supplies the engine on its side, with the transfer system replenishing the fuel in the main tanks. However, in the event of fuel transfer system failure, fuel may be supplied directly to the engine from the respective auxiliary (drop and wing tip float) tanks. A cross-flow feature interconnects the system so that it is possible to operate both engines from a main or auxiliary tank on one side, or, in case of an engine failure, to supply the operative engine with fuel from the opposite main or auxiliary tanks. Fuel management is controlled by tank selector valves actuated mechanically by the tank selectors mounted on the overhead control panel. Fuel transfer system pumps and the auxiliary tanks (drop and wing tip float) electric selector valves are also located on the overhead control panel. Each engine is equipped with a rotary vane type engine driven fuel pump that delivers fuel from the tanks to the carburetor at a pressure necessary for proper engine operation. Two electrically driven booster pumps are installed to augment pressure for engine starting and altitude operation. They also supply the necessary fuel pressure required during emergency operation on the fuel system.

An electrically operated emergency fuel shut-off valve is included for each engine. Should an engine failure occur during flight, as a precaution to prevent any ensuing engine fire, the emergency fuel shut-off switch in the emergency group on the overhead control panel should be set to CLOSE to cut off all fuel to the failed engine.
FUEL TANK SELECTORS

Two fuel tank selector valves are installed in the upper forward portion of both wheel wells. They are not accessible during flight. The tank selector valves are four port, three way valves and are mechanically controlled from the flight deck by the fuel tank selectors. The fuel tank selectors, one for each engine, are installed on the overhead control panel. Each tank selector has four settings:

- on the left selector: OFF, RIGHT TANKS, LEFT MAIN TANK and LEFT AUX TANK;
- on the right selector: OFF, LEFT TANKS, RIGHT MAIN TANK and RIGHT AUX TANK.

In the OFF Position, the tank selector valves are closed. Normal operating positions of the fuel tank selectors are LEFT MAIN TANK and RIGHT MAIN TANK for take-off and for cruise. In these positions, fuel from the selected tanks is fed to their respective engines.

When the left fuel tank selector is set at RIGHT TANKS, fuel is fed from a right tank directly to the right engine and the left engine receives fuel from the right tank via the cross-flow feature of the system. The position of the right fuel selector determines which of the right side fuel tanks feeds fuel to the engines. A similar operation is available when the right fuel tank selector is set at LEFT TANKS. In the case of selecting RIGHT AUX TANK position on the manual right fuel selector, the position of the electric auxiliary tank selector valve determines which fuel tank feeds fuel to the engines. A mechanical interlock prevents both manual fuel tank selectors from being set to draw fuel from the opposite tanks at the same time.

FUEL BOOST PUMP SWITCHES

The right and left fuel booster pump switches are two position ON-OFF toggle switches located on the overhead control panel adjacent to the fuel tank selectors. When the booster pump switches are ON, DC power is supplied through the booster pump relays, operating the booster pumps. Fuel under pressure is thereby supplied to the carburetors when the fuel tank selectors are in any position where fuel is being supplied to the engines and the emergency fuel shut-off valves are in the OPEN position.

FUEL TRANSFER SYSTEM SWITCHES

The two fuel transfer system switches are located on the overhead control panel. These three position toggle switches are marked DROP TANK, OFF, and FLOAT TANK. Setting the switches to either DROP TANK or FLOAT TANK position starts operation of the transfer system by energizing the electrical transfer
pumps, and the auxiliary tank selector valves, arming the auxiliary fuel flow warning lights (amber).

In the DROP TANK position, the auxiliary tank selector valve permits fuel from the drop tank to be transferred to the corresponding main tank. Similarly, fuel is transferred from the wing tip float tanks to the main tank when the switch is set to FLOAT TANK. With fuel available in the selected auxiliary tanks, the transfer pumps will replenish the main tanks until they become full. When a main tank is full, a float valve in the tank will close, preventing fuel from being forced out the vent. The transfer system will remain pressurized, and the main tank will be kept filled, until the fuel is completely transferred from the auxiliary tank. At this time, the auxiliary fuel flow warning light will come on to indicate that there is no pressure in the line and that the fuel transfer sequence has ceased. The fuel transfer system switch should be switched either to the remaining auxiliary tank or to OFF.

Note: Carefully monitor fuel quantity when transferring fuel, to make sure the high level float switch automatically closes when the main tanks are full. If the float switch does not operate properly, fuel may be pumped overboard.

CAUTION: Since the transfer pump gets its lubrication from the fuel and will be running dry, which might cause pump damage, the switch should be set to OFF.

ln the OFF position, the transfer system is deenergized; however, the auxiliary fuel tank selector valve will remain in the last position selected by the fuel transfer system switch.

Auxiliary Fuel Flow Warning lights

The auxiliary fuel flow warning lights are mounted above the copilot’s instrument panel. When the fuel transfer system is energized, these lights will glow momentarily until at least 2 PSI pressure is established in the system. If the warning lights glow during the transfer operation before the normal time required to empty the selected tank, it is indicative of a failure in the transfer system. When the fuel transfer pressure drops below at least 2 PSI the corresponding light will glow to indicate an empty auxiliary tank or a loss of transfer fuel pressure.

DROP TANK RELEASE SYSTEM

Drop Tank Jettison Control

The drop tank jettison controls are located on the drop tank panel on the left main console. The controls consist of a master switch, two selector switches and a release switch. An auxiliary release receptacle is also included in this group.

Drop Tank Master Switch

The master switch is a two position toggle switch marked ON and OFF. Placing the switch in the ON position supplies DC electrical power to complete the circuit to the release switch, hence to the selector switches.

Drop Tank Selector Switches

The selector switches, one for each drop tank, are two position toggle switches. They are marked SELECT and SAFE. Placing the switches in the SAFE position breaks the circuit to the drop tank release solenoid in the rack. In the SELECT position, with the master switch ON, the circuitry is completed, permitting the drop tanks to be jettisoned when the release switch is actuated.

Drop Tank Jettison Switch

The jettison switch is a guarded switch marked SAFE and RELEASE. It is guarded in the SAFE position. When the guard is lifted and the switch is placed in the RELEASE position, the circuits are completed causing the drop tanks to be jettisoned, provided the master switch and the selector switches are in the appropriate positions.

Auxiliary Release Firing Key

An auxiliary release firing key is provided to permit a crewmember other than the pilot or co-pilot to jettison the drop tanks. The auxiliary release consists of a pistol grip type firing key with a 3-foot extension cable and plug. This key is plugged into the auxiliary firing key receptacle on the drop tank panel. When installed, and with the master switch ON and the selector switches in the SELECT position (release switch in SAFE position), pressing the key by-passes the release switch and jettisons the drop tanks. This auxiliary release firing key is stowed at the pilot’s left foot near the pyrotechnic signal (Very) pistol and cartridges.

EMERGENCY DROP TANK RELEASE SYSTEM

The emergency drop tank release system (sometimes referred to as the emergency bomb release system) is provided in case of failure of the electrical release system. It is an independent hydraulic system operating through the action of the plunger in the master cylinder. A lever type handle, located at the leit knee of the pilot, when pulled aft releases the plunger of the master
cylinder, thereby transferring pressure through a residual pressure valve to the slave cylinder on top of each bomb rack. The residual pressure valve is installed to maintain hydraulic pressure and reduce the possibility of air seepage into the system. A release cable running from each slave cylinder to a release mechanism in the rack, releases the drop tank. If the system is air-tree, the action of the plunger in the master cylinder is sufficient to actuate this emergency system.

**EMERGENCY FUEL SHUT-OFF VALVE SWITCHES**

An emergency fuel shut-off valve switch for each engine is installed on the emergency control panel of the overhead control panel. The switches have two positions: OPEN and CLOSE. In the CLOSE position, DC electrical power energizes the electrically operated shut-off valve. When closed, the valve cuts off the supply of fuel to the engine.

Note: These switches are one of the emergency gang switches marked FUEL, HYD OIL, GEN and FIRE EXT. Care must be exercised not to actuate the gang switches inadvertently.

**FUEL QUANTITY INDICATOR**

A dual, capacitance type fuel quantity indicator is installed on the main instrument panel. The dial is divided into two scales. Each scale is marked in increments of 1 pound (x100) from 0 to 20. A small square marked FULL 25°C with two arrows pointing to a spot midway between the 19 and 20 increments indicates that when fueling, the pointers will go as far as this position, thereby indicating that at this temperature (25°C) the tanks are full. Since normal fuel temperature is usually less than 25°C, the average full tanks indication will run closer to the 20 increment. The fuel quantity indicator measures the amount of fuel in the main tanks only.

Note: The pilot should anticipate variations in tanks full instrument indications, since the weight per gallon of fuel varies with the specific gravity and temperature of the fuel.

**FUEL SYSTEM MANAGEMENT**

Take-off and climb to a safe altitude should always be made on the main tanks, with the fuel transfer system off. On long range flights requiring the use of fuel from the drop and float tanks, immediately upon reaching a safe altitude after take-off, the fuel transfer system should be placed in normal operation to replenish the main tanks from the float tanks. Fuel should always be transferred from the fuel tanks first and as soon as possible. The fuel system transfer switches should not be set to DROP TANK until float tank fuel is exhausted. When float fuel is exhausted (indicated by the fuel flow warning lights coming on, and/or the main tank fuel quantity gage indicating that replenishing has stopped), the fuel transfer system selector switches should be set to DROP TANK to replenish the main tanks from the drop tanks. After drop tank fuel is exhausted, the fuel transfer system selector switches should be set to OFF and the flight continued on the main tanks.

Note: It is best to withhold replenishing operations until after take-off, as acceleration forces during take-off may cause loss of fuel through the main tank vents if replenishing is commenced earlier.

The fuel system management outlined above will eliminate any danger of fuel exhaustion in the event of fuel transfer system selector valve malfunction.

Note: The preflight check of the auxiliary fuel tank selector valve will not necessarily indicate the correct position of the selector valve, only the proper operation of the actuating motor.

The float tanks fuel replaces fuel used from the main tanks during takeoff and climb; consequently, any subsequent malfunction of the fuel transfer system selector valves will be an obvious “400 gallons” from the point of departure, leaving a positive 675 gallons of main tank fuel available for return if an abort is necessary. In the event of engine failure during the early portion of flight at high gross weights, the drop tanks may be jettisoned, thus immediately relieving the aircraft of 3890 pounds of unnecessary weight.

In the event of flight operations with external drop tanks fuel only, the preflight check assures that the fuel transfer system selector valves are last positioned in the DROP TANK positions, and fuel from the drop tanks may be used to replenish the main tanks or to operate the engines directly from the drop tanks, whichever is desired. In order that the expendable load will remain as great as possible, do not start replenishing at the beginning of the flight. The drop tank fuel can still be used directly in the event of transfer pump failure. Burn the main tank fuel down to the point where you can still reach a suitable landing area on one engine, and then replenish intermittently after this point. Should you want the main tanks full when the drop tanks go dry, compute the rate of transfer (200 gallons per hour, 8-1/3 gallons per minute) minus fuel flow to the engines and plan to fill the main tanks before the drop tanks are empty. At this time you will have burned up enough weight in fuel to maintain flight on one engine. If operation directly from the drop tanks is desired, switch fuel
tank selector to AUX TANKS 15 minutes apart to avoid running both tanks dry at same time.

**ELECTRICAL SYSTEM**

The aircraft components requiring electrical power are supplied by two engine driven DC generators, an APU DC generator, a battery, and three AC inverters. The engine driven generators form the principal direct current source during normal operation of the aircraft. The auxiliary power plant generator can be utilized as a supplementary power source in flight, on the ground, or on water. A standby or emergency source! direct current power is incorpo rated in a 24 volt, 36 ampere hour shielded battery which powers the DC systems essential to flight should the generators malfunction or fail entirely. An auxiliary battery can be used, if available, by plugging it into the auxiliary battery receptacle located on the left mid cabin connector box. Fixed frequency alternating current is supplied by inverters which furnish 115 volt, three phase, 400 cycle power.

An external DC power receptacle is provided for connection to an external DC power supply for ground operation of all electrical and electronic equipment and for engine starting. The electrical system is a composite of main power distribution circuits with individual system circuits branching from the power busses. The individual circuits are protected by circuit breakers or fuses. See figure 1-36 for the DC power supply and branching circuits and the total ampere load drawn by each circuit.

**DIRECT-CURRENT SYSTEM**

The DC system is energized by two parallel connected, 400 ampere, engine driven generators (one for each engine) which are regulated to a nominal 27.7 volts. The APU generator, rated at a maximum of 165 amperes can be used, if desired, to supplement the engine driven generator output. The generators can be manually monitored to power the DC distribution circuits by means of individual generator control switches. ‘The switches, when set to ON, energize the reverse current cutouts to route generator output to the DC distribution system through the reverse current cutouts. Should the DC output of any generator diminish or fail, its associated reverse current automatically disconnects the faulty generator from the system. If the essential bus is energized, a warning light for each engine driven generator glows when the respective generator is not delivering DC power to the supply system.

Conventional controls and protective devices to ensure efficient system performance under all operating conditions are incorporated in each engine driven generating system and in the auxiliary power plant generating system. Voltage regulators control generator voltage and also function to maintain proper load distribution between the two engine driven generators and the auxiliary power plant generator. The reverse current cutouts remove their respective generators from the system in the event of reversed generator polarity or reverse current flow. In addition, each engine driven generator system includes a generator control switch, a generator emergency field switch, a generator warning light, and an ammeter. The auxiliary power plant generating system contains the same components as the engine driven generating system, with the exceptions of the generator emergency field switch and the generator warning light. Power distribution is accomplished through a multiple bus network, i.e., battery bus, essential bus, and the nonessential bus. The battery bus is energized directly from the positive terminal of the battery. It is energized at all times (provided the battery quick disconnect plug is connected) to supply battery power to the anchor lights circuit, to the tire extinguishe circuit, and to the voltmeter voltage selector switch, regardless of battery control switch setting. The essential bus is energised, when either or both engine driven generators are operating, by the auxiliary power plant generator, by the battery, by the auxiliary battery, and by external power. The essential bus controls the nonessential bus, if both engine generators are functioning normally.

The nonessential bus is energized automatically through the normal nonessential power relay when both engine driven generators are operating. Should an engine driven generator fail, the nonessential bus is automatically disconnected from the essential bus. If any of the equipment connected to the nonessential buses required, a manual emergency override switch type circuit breaker located on the radio operator’s table can be used to reconnect the nonessential bus to the essential bus through the emergency override nonessential power relay. Before reconnecting the nonessential bus the load on the essential bus, as indicated on the ammeter, must be reduced by an amount equal to the load remaining on the nonessential bus. This reduction of the load is required so that the power demand does not exceed the full ampere capacity of the remaining generator. The APU can be started and its generator output can be used to supplement the operating generator. The electrical system is designed to provide automatic monitoring of power to nonessential equipment during in-flight emergencies when both engine driven generators are inoperative. This conserves battery power to give added safety of flight. Although the system is largely automatic in operation, individual circuits must be manually monitored when one generator fails, either by turning off the
equipment or by pulling out the appropriate circuit breaker.

A DC voltmeter is incorporated in the system. It is used, in conjunction with the voltage selector switch, to indicate the essential bus voltage or the voltage output of the left or right generators, the battery, or the APU generator. Separate ammeters are provided to indicate the amperage (current flow) of the battery, the left or right generators, and the APU generator. During normal system operation, the voltage selector switch should be set to BUS to inform the pilot of distribution system voltage values from all sources. During normal operating conditions, the battery is connected to the supply circuits through the battery switch and relay when the battery switch is set to ON. The battery is thus maintained in a fully charged state by the generators so that battery power is always available in an emergency. An external power switch is provided which must be set to ON to connect it external power supply or the auxiliary battery to the system circuits.

Battery Switch

The toggle-type ON-OFF battery switch is located on the center portion of the main console. When this switch is set to ON, the battery connected to the essential bus through the battery relay contacts. Because battery power is required to energize the battery relay, approximately 18 volts and 0.6 ampere are sufficient for this purpose. In addition when the battery switch is set to ON and the engine driven generator (or generators) are operating, it battery is maintained in a fully charged condition. When the battery switch is set to OFF, the battery relay is deenergized and battery power is remove from the essential bus.

Note: Battery power is always available to the anchor lights circuit, to the fire extinguisher, and to the voltmeter voltage selector switch, regardless of the battery control switch setting.

Generator Switches

Three generator control switches are provided: one for each engine driven generator and one for the APU. The engine driven generator control switches are located on the center portion of the main console. The APU generator control switch is located on the APU electrical connector box in the APU compartment. All switches have ON and OFF positions. The switches provide manual control of their respective generators and, when set to ON, energize the associated reverse current cutout to route generator control power to the essential bus. The switches also complete a portion of the bus equalizing (parallel operation) circuit. Setting a generator control switch to OFF deenergizes its respective reverse current cutout and removes the generator from the system.

Note: The bus equalizing circuit becomes operative only if more than one generator is operating.

CAUTION: When external electrical power is supplied to the aircraft, the generator control switches and the battery switch must be set to OFF to prevent possible damage to the system wiring.

Generator Emergency Field Switches

The engine emergency switches, one of which is the generator emergency field switch, are arranged in two groups (one group for each engine) and are located on the overhead emergency control panel. During normal system operation, the generator emergency field switches are maintained at ON. Each group of switches is actuated by a gang bar which should be operated only in case of fire. When the switch is set to OFF by operating the gang bar, the generator field circuit is deenergized and the generator is removed from the system. No generator emergency field switch is provided for the APU generator.

Emergency Override Switch

The emergency override ON-OFF switch-type circuit breaker is located on the radio operator’s table. During normal system operation, the switch is set to OFF. If an engine driven generator fails and power to the nonessential bus is desired, the switch can be set to ON to reconnect the nonessential bus to the essential bus.

CAUTION: To prevent overloading of the operative generator, decrease the electrical load or run the APU before setting the emergency override switch to ON.

External Power Switch

The external power ON-OFF toggle switch is located on the center portion of the main console. When the switch is set to ON, external power or auxiliary battery power is routed to the essential bus through the external power relay contacts. When the external power switch is set to OFF, the external power relay is deenergized and external power or auxiliary battery power is removed from the system.

Circuit Breakers

The circuit breakers are grouped in three panels: one panel is on the main
console right side, another panel is outboard and below the main console right side, and the third panel is on the flight deck left side.

Note: To prevent unnecessary wear, the push-pull type circuit breakers should not be used as switches, except as an emergency measure. Circuit breakers tripped by it circuit malfunction should not be reset more than once until the cause of the malfunction is corrected.

WARNING: Never hold a circuit breaker in the reset position because this action by-passes the safety feature and can result in a fire or in complete loss of electrical power.

**Generator Warning Lights**

A press-to-test generator warning light for each of the two engine driven generators is located below the center instrument panel. During normal system operation both generator warning lights are off to indicate that their respective generators are functioning normally. If an engine driven generator fails, its respective generator warning light glows to indicate the abnormal condition. Both generator warning lights glow when external power is connected to the aircraft.

Note: No generator warning light is provided for the APU generator.

**Nonessential bus Warning Lights**

The nonessential bus warning lights (press-to-test type) are located on the radio operator’s table. The NOR POWER OFF light glows to indicate loss of power to the nonessential bus which is automatically disconnected when either or both engine driven generators fail. The EMER POWER ON light glows to indicate that the emergency override switch is set to ON and that the nonessential bus has been reconnected to the essential bus.

Note: The NOR POWER OFF light continues to glow, regardless of the emergency override switch setting, if one or both engine driven generators are inoperative.

**Ammeters**

Three ammeters are mounted on the center console. One ammeter is for the left generator, another one is for the right generator, and the third is for the battery. An ammeter for the APU generator is located on the APU connector box. The ammeters indicate the output (current flow) of their respective generators and the battery.

**Voltmeter and Voltmeter Voltage Selector Switch**

A voltmeter and a six position rotary selector switch are located on the main console to the left of the circuit breaker panel. The switch positions permit selection of the output voltage of the left and right generators, the battery, the essential bus, and the APU generator. The selected output voltage is read on the voltmeter. Except for the battery voltage which should be 24 volts, all voltages should be approximately 27.7 volts during normal system operation. During normal aircraft operation, the voltage selector switch should be set to BUS to inform the pilot of distribution system voltage values from all sources.

To prevent battery discharge through the voltmeter, never leave the voltmeter voltage selector switch set to BAT when the aircraft is secured.

**External DC Power Receptacle**

The external DC power receptacle is located on the left side of the fuselage, beneath the wing. DC electrical power (24-28 volts) can be connected to the receptacle for ground operation and test purposes.

**AC POWER SUPPLY SYSTEM**

Fixed frequency alternating current is furnished by three 115 volt, three phase 400 cycle inverters, designated as No. 1 inverter, No. 2 inverter, and No. 3 inverter.

During normal system operation, the No. 1 and No. 2 inverters receive DC control power from the essential bus; the No. 3 inverter receives its DC control power from the nonessential bus. In the event that either the No. 1 or No. 2 inverter fails, the No. 3 inverter can be used as a replacement to supply the essential loads of the inoperative inverter. When the No. 3 inverter is used as a replacement, the nonessential loads which are normally connected to it have no source of AC power. The nonessential bus (which supplies DC control power to the No. 3 inverter) is normally energized only when both engine driven generators are operating. Failure of either engine driven generator causes the nonessential bus to be automatically disconnected from the essential bus, resulting in failure of the No. 3 inverter. If it is desired to reenergize the nonessential bus, the emergency override switch located on the radio operator’s table must be set to ON. An individual inverter power switch-type circuit breaker and an inverter power failure warning light are provided for each of the three inverters. The switches provide on-off control of, and overload protection for, their respective inverters, and the warning lights glow...
to indicate inverter failure or that the applicable inverter power switch is set to OFF.

Flight instruments warning lights are provided to the pilot and co-pilot to indicate failure in the auto pilot power junction box. If such failures occur, the essential flight instruments, the remote compass system, and the autopilot lose their source of AC power. In such an emergency, the flight instruments power selector switch must be set to EMER to transfer the remote compass and other essential flight instrument loads to the standby instrument power and compass transformers; the auto pilot remains inoperative.

**Inverter Selector Switch**

The inverter selector switch is located on the left side of the main console, adjacent to the three inverter power switches. Indicated positions of this switch are #1 OUT, NOR, and #2 OUT. The switch is used to monitor the output of the No. 3 inverter if either the No. 1 or the No. 2 inverter fails. During normal system operation, the switch is set to NOR and all inverters supply their respective loads. If the No. 1 inverter fails, the switch can be set to #1 OUT. When this is done, the No. 3 inverter supplies those loads normally supplied by the No. 1 inverter. If the No. 2 inverter fails, the switch can be set to #2 OUT. When this is done, the No. 3 inverter supplies those loads normally supplied by the No. 2 inverter. If the No. 3 inverter is used as a replacement, the loads that are normally connected to it have no source of AC power.

**Inverter Power Control Switches**

Three inverter power control switch-type circuit breakers, one each for the No. 1, the No. 2 and the No. 3 inverters, are located on the left side of the main console. These switches, identified as INV #1, INV #2, and INV #3, provide individual on-off control of their respective inverters. During normal system operation, all three inverter power switches should be set to ON, and the inverter selector switch should be set to NOR. If any of the three inverters fail, the associated inverter power switch must be set to OFF.

**Inverter Warning lights**

Three press-to-test inverter power off warning lights, one each for the No. 1, the No. 2, and the No. 3 inverters, are located on the left side of the main console. A light glows when its respective inverter fails, when there is low voltage output, during phase failure, or when the inverter power switch is set to OFF.

If a warning light glows, the associated inverter power control switch must be set to OFF. The light continues to glow when an inverter power switch is set to OFF, to provide constant reminder of the abnormal condition.

**Flight Instruments AC Power Off Warning lights**

Two press-to-test flight instruments AC power warning lights are provided, one for the pilot and one for the co-pilot. The lights are located above their respective instrument panels. When the pilot’s (light instruments warning light) glows, it indicates failure in the auto pilot power junction box, which results in loss of AC power to the pilot’s flight instruments and to the remote compass system. When this condition exists, the flight instruments AC power selector switch must be set to EMER so that standby power from the instrument power transformer is supplied to the pilot’s flight instruments, and to the remote compass system through the stand-by power compass transformer. The pilot’s flight instruments warning light goes out when the switch is set to EMER. When the co-pilot’s flight instruments warning light glows, it indicates a loss of AC power to the co-pilot’s attitude indicator only. It both pilot’s and copilot’s flight instruments warning lights glow, it indicates loss of the normal source of AC power on the pilot’s and copilot’s flight instruments, to the remote compass system, and to the autopilot. When this condition exists, the flight instruments AC power selector switch must be set to EMER so that AC power is supplied to the remote compass system only.

**Note**: Do not attempt to set the flight instruments AC power selector switch to EMER when only the co-pilot’s flight instruments warning light glows.

**Circuit Breakers**

Overload protection for the inverter control systems is provided by the trip-free inverter power control switch-type circuit breakers. In addition, three push-type circuit breakers to protect the inverter DC power input circuits are mounted on the DC essential bus connector box on the right side of the flight deck, below, the radio operator’s station.

**Note**: Circuit breakers tripped by a circuit malfunction should not be reset more than once until the cause of the malfunction is corrected. Never hold a circuit breaker in the reset position because this action by-passes the safety feature and can result in a tire or in complete loss of electrical power.
HYDRAULIC SYSTEM

The hydraulic system incorporates a 0-3000 PSI open center system for operation of the landing gear and the wing flaps, and closed type subsystem which maintains 1250-1500 PSI pressure for operation of the brakes, windshield wipers, and rudder boost. Pressure to the sub-system is continuous and is supplied through an unloader valve (pressure regulator) during normal flight (landing gear and wing flaps not helm operated) and through a pressure reducer valve during the periods when the landing gear and/or wing flaps are in operation. With the engines operating and all hydraulic system units inactive, hydraulic fluid is drawn from the reservoir by the engine driven pumps, circulated through the electrically actuated by-pass valve and the unloader valve and returned to the reservoir, with 1250-1500 PSI being maintained in the sub-system by the unloader valve.

The engine driven pumps are axial type, nine piston pumps with constant displacement per revolution which furnish a non-pulsing flow of hydraulic fluid and supply pressure for all the units of the hydraulic system. The by-pass valve is composed of an actuator, a by-pass valve manual override and a selector valve. The actuator has a 90° reversible type actuator mechanism. Operation of the landing gear or wing flaps controls positions limit switches on the selector valve to complete a circuit causing the actuator to select 3000 PSI pressure. At the end of hydraulic operation, the completed travel of the hydraulic units operates limit switches, causing the actuator to select 1500 PSI pressure. If a selected movement is stopped somewhere in its cycle by the manual controls, the manual override must be operated to cycle and synchronize the actuator with the controls. The selector valve portion of the by-pass valve operates in two positions, 90° apart. In one position, it directs hydraulic fluid pressure to the main system and the sub-system via the pressure reducer valve; in the other position, hydraulic fluid pressure is directed to the sub-system only via the unloader valve. The unloader valve acts as a pressure regulator to divert sub-system pressure in excess of 500 PSI back to the reservoir. Two relief valves, one for the main system, the other for the sub-system, operate when these pressures are exceeded, and direct the excess hydraulic fluid back to the reservoir. The welded aluminum reservoir has a live gallon capacity and is located in the upper portion of the left engine nacelle. Two pressure gages, one for each system, are located on the left side of the main console. There is no accumulator for the main system. However, there are two accumulators in the sub-system. One is for the entire system and the other is for the rudder boost system.

An emergency system is also provided. It is operated by a hand pump located on the floor beneath the pilot's seat, right side. A hand pump selector valve controls the flow of hydraulic fluid to the landing gear, wing flaps, and the emergency and parking brakes.

This valve is positioned by the hand pump selector control located on the vertical face of the left main console, adjacent to the landing gear selector handle.

CAUTION : After the emergency hydraulic system has been utilized, the hand pump selector control should be set to ENGINE PUMP position to prevent the possibility of hydraulic fluid leaking past the hand pump selector internal ball valves, thereby pressurizing the parking and/or emergency brakes.
Normal operation of the main hydraulic system depends upon the 3000 PSI pressure build-up by the constant displacement piston type engine driven pumps and DC power to actuate the electrically controlled by-pass valve. The by-pass valve is energized to activate the 3000 PSI system only during landing gear and wing flaps operation. Limit switches actuated by the landing gear and wing flaps control selector valves, the landing gear up and down locks, and the wing flaps gear box mechanism electrically control the action of the by-pass valve. Operation of either the landing gear or wing flaps controls electrically positions the actuator of the by-pass valve to permit 3000 PSI pressure to be directed to the respective cylinders. Upon arrival at the selected position, limit switches are contacted, electrically operating the by-pass valve actuator which diverts the hydraulic fluid back to the reservoir via the unloader valve (the unloader valve being a combination unload of valve and pressure regulator). If neither the landing gear nor the wing flaps system is in operation, the 3000 PSI system is inactive and fluid under pressure from the engine driven pumps is routed through the by-pass valve to the unloader valve, which maintains the 1250-1500 PSI pressure in the sub-system and routes excess fluid back to the reservoir. With the 3000 PSI system inactive, pressure will bleed oil from the main system gage. Check valves in the supply lines prevent actuating systems from bleeding off in this manner.

Note: While the system is pressurized at 3000 PSI, a constant 1400 PSI is maintained in the sub-system by the pressure reducer valve.

Sub-system (Closed Center, 1500 PSI)

Hydraulic pressure is continuously supplied to the sub-system when the engines are in operation. If all the hydraulic systems are inactive, hydraulic fluid is drawn from the reservoir by the engine driven pumps, routed through the DC actuated by-pass valve to the unloader valve and returned to the reservoir. The necessary constant pressure required for operation of the sub-system during times when the 3000 PSI main system is inactive is maintained by pressure directed through the unloader valve. This valve “cuts in” to supply pressure when a minimum pressure is reached and “cuts out” to divert fluid back to the reservoir when maximum pressure is obtained. A relief valve exists to protect the system against a failure of the unloader-regulator valve. It opens to return at 1725 PSI. Initial movement of the landing gear or wing flaps selector valves closes an electrical circuit to position the actuator of the by-pass valve which directs engine pump pressure through the by-pass valve to the actuating cylinders and through a pressure reducer valve to the sub-
system. When sufficient pressure has been delivered to move the cylinder pistons, and the last stage of the mechanical action is completed, a limit switch is contacted, causing the actuator of the by-pass valve to reposition the by-pass valve and direct the pressure through the by-pass valve of the unloader valve and back to the reservoir. An accumulator in the 1500 PSI system stores a reserve of built-up pressure to dampen pressure surges in the system. The second accumulator in the 1500 PSI systems is in the rudder boost system, downstream of the check valve, and provides additional protection for the rudder boost system. It performs the same function as the 1500 PSI accumulator.

Pressure Gages

Two hydraulic pressure gages, one for each system, are located on the left side of the main console. The main system gage registers hydraulic pressure in pounds per square inch. During normal aircraft operation, this gage reads 0 PSI until either of the systems operated by the 3000 PSI system is activated. The sub-system gage registers hydraulic pressure in pounds per square inch and shows the actual pressure in the system at all times during aircraft operation.

EMERGENCY HYDRAULIC SYSTEM

The emergency hydraulic system incorporated in the aircraft functions by the use of the hand pump. The hand pump is used to build up pressure for emergency operation of the landing gear, wing flaps, and emergency and parking brakes. The system to be operated is selected by turning the hand pump selector control to the appropriate position. The emergency hydraulic system uses the regular system reservoir and lines with the exception of the landing gear up and down lines. The reservoir has a standpipe as part of its internal structure. This standpipe is on the engine suction line with the hand pump suction outlet at a lower point. When fluid level is below the engine suction (standpipe) level, there are approximately 2 gallons of hydraulic fluid available for hand pump operation. Using the hand pump, this amount of hydraulic fluid is sufficient to lower the landing gear, raise and lower the flaps, and apply the emergency and parking brakes.

Hand Pump

The hydraulic hand pump is installed on the cabin floor to the right of the pilot’s seat. The pump, equipped with a telescopic handle, is used to supply pressure to the landing gear, wing flaps, and emergency and parking brakes when the engine driven pumps are inoperative. With the hand pump selector control placed at the desired position, the hand pump will deliver approximately 3/4 cubic inch of fluid per operating cycle. The operation at the pump is similar to that of any double-acting piston type pump.

Note: A periodic lack of pressure may be felt when lowering the landing gear by use of the hand pump. This condition is evident when the landing gear is lowering by its own weight.

Hand Pump Selector Control

The head pump selector control is mounted on the hand pump selector panel on the vertical face of the left main console. The valve it controls is located behind the instrument panel. This valve directs hand pump hydraulic pressure to the wing flaps selector valve, the brake cylinders, and the up and down sides of the landing gear cylinders as selected by the hand pump selector control. It also dumps the back pressure on the landing gear shuttle valves during hand pump and system operation. The control may be set to any one of the five position marked on the panel. These positions are: EMERG. AND PARKING BRAKES, FLAPS, LANDING GEAR DOWN, ENGINE PUMP, and LANDING GEAR UP. There are two stops on the hand pump selector panel. One of the stops is a fixed stop which prevents the hand pump selector control from being moved from the LANDING GEAR UP to the EMERG. AND PARKING BRAKES position and vice versa. The other stop is a spring loaded stop installed between the ENGINE PUMP and LANDING GEAR UP positions to prevent the hand pump selector control from being turned to LANDING GEAR UP position inadvertently and retracting the landing gear by means of the hand pump hydraulic pressure while the aircraft is on the ground. This stop must be depressed with a finger prior to moving the hand pump selector control between these two positions. With the exception of the landing gear selector handle, setting the normal control to the desired position and the hand pump selector control to the corresponding position, operation of the hand pump control need be positioned. Shuttle valves in the main system lines prevent normal landing gear operation when the hand pump is being used.

- When the emergency system is not in use, the hand pump selector control must be set to ENGINE PUMP. This insures that the landing gear shuttle valves are vented and will not move.
- After the emergency hydraulic system has been utilized, the hand pump selector control should be set to ENGINE PUMP position to prevent the possibility of hydraulic fluid leaking past the hand pump selector internal ball valves, thereby pressurizing the parking and/ or emergency brakes.
Emergency Hydraulic By-pass Control

The emergency hydraulic by-pass control is designed for use in pressurizing the 3000 PSI system in the event of an electrical failure which would render the electrically actuated by-pass valve inoperative. It is a manually operated mechanical system which permits overriding or duplicating the normal action of the electrically actuated by-pass valve. The control lever is located on the left vertical face of the overhead control panel. Pulling the lever down actuates the by-pass valve to pressurize the 3000 PSI system, while pushing the lever up actuates the by-pass valve to relieve the pressure in the 3000 PSI system. Cycling the lever will also relieve any pressure shown on the main system pressure gage when the 3000 PSI system is not in operation.

Emergency Hydraulic Oil Shut-Off Switch

The emergency hydraulic oil shut-off switches are mounted on the emergency panel of the overhead control panel. These toggle switches are marked OPEN and CLOSE and are normally left in the OPEN position. They control the DC motor driven hydraulic shut-off valve installed in the hydraulic supply line to each engine driven hydraulic pump. The flow of hydraulic fluid to the hand pump is not affected by the closing of these shut-off valves; therefore, the hand pump is available for emergency hydraulic operations.

FLIGHT CONTROLS SYSTEM

The primary flight control surfaces, consisting of ailerons, elevators, and a rudder, are operated conventionally from either the pilot’s or co-pilot’s position. The control wheels and the adjustable rudder and brake pedals are mechanically connected to the control surfaces. All surface controls are conventional except that a hydraulic boost system is available to assist rudder movement for take-off, landing and single engine operation. Aileron, elevator and rudder trim tabs are operated electrically. An automatic pilot is provided.

CONTROL WHEELS

A pair of conventional offset control wheel and column assemblies are installed. The pilot’s control wheel incorporates a microphone button; attached to the upper left spoke is a push button for JATO firing. The copilot’s control wheel is identical to the pilot’s control wheel except that it does not have the JATO firing button. The control wheels and columns are connected through mechanical linkage to the ailerons and elevators.

RUDDER PEDALS

Two combination rudder and brake pedals are installed for each pilot. These pedals are mechanically linked to the rudder and are adjustable. An adjustment lever is located on each pedal and is marked with an arrow to indicate the direction to move the lever for adjusting the pedals. There are four adjustment positions available, as indicated by the stenciled numbers, 1, 2, 3, and 4 on the floor. After pushing the adjustment lever outward (direction indicated by arrow) and pushing the pedals full forward, the pedals are then pulled aft, by the toes, one notch at a time until they reach the desired position.

RUDDER BOOST SYSTEM

The rudder boost system consists of an on-off valve, booster valve, hydraulic cylinder, and an accumulator, operating on the 1500 PSI hydraulic sub-system. The actuating units are located in the tail of the aircraft with the rudder boost control lever mounted on the aft portion of the overhead control panel and connected to the on-oti valve by cables. Moving the control lever to ON actuates the on-oil valve to the open position, which allows hydraulic pressure to enter the rudder booster system. When the rudder pedals are moved, pistons in the booster valve are actuated to direct hydraulic fluid to and from the hydraulic cylinder, which is connected to the rudder. As the rudder reaches the desired position the booster valve pistons return to neutral. The accumulator absorbs pulsations in the system which might otherwise be transferred to the actuating units. The approximate ratio force applied with the rudder boost on is four to one. When the rudder boost system is set to NORMAL OFF, it not only shuts off the system pressure hut allows fluid to by-pass from one side of the cylinder to the other, permitting mechanical operation of the rudder.

CAUTION: Excessive rudder loads can be inadvertently imposed on the aircraft with the rudder boost operating. It is mandatory that the rudder boost be OFF at all times except during take-off, landing or single engine operation.

Rudder Boost Control

The rudder boost control (figure I-45) is located on the aft portion of the overhead control panel. It is a knobbed lever having two operating positions: NORMAL-OFF and ON-TAKE-OFF, LANDING, BINGLE ENGINE. Pulling this knobbed lever forward activates the rudder boost system.

GUST LOCK SYSTEM

A gust lock system has been provided to lock all the primary control surfaces in their neutral position when the aircraft is not in use. It is mechanically operated, through a series of cables and push rods, by the movement of the gust lock.
lever on the overhead control quadrant in the flight deck compartment. With the gust lock control lever in the LOCK position, the handle on the control lever mechanically blocks the throttles from advancing beyond the partial open setting of approximately one-quarter throw and 1500 RPM.

**Gust Lock Control Lever**

The gust lock control lever, is located on the left side of the overhead control quadrant, outboard of the throttles and supercharger and mixture controls. The control lever consists of a handle, a spring loaded latch, and the control lever. Two positions are provided: full forward is UNLOCK; full aft is LOCK. The spring loaded latch engages to retain the control lever in either the UNLOCK or LOCK position. To engage the gust lock, the spring latch knob, located on the outboard side of the control lever, is pulled downward toward the handle. The control lever is pulled down and aft, releasing the spring latch and lever from the UNLOCK position. Continued aft pull is maintained until the spring latch engages in the LOCK position, locking the control lever in the LOCK position. To release the gust lock control lever from the LOCK position, an aft pull exerted on the control lever permits the spring latch to be released from the LOCK position. Pushing the control lever full forward and upward positions it and permits the spring latch to engage in the UNLOCK position.

**Trim Tabs**

Fixed tabs, adjustable only while the aircrafts are on the ground, are installed on both ailerons. Electrically operated DC powered trim tabs, controllable from the flight deck, are installed on the left aileron, both elevators and the rudder. The tabs control switches are mounted on the forward left corner of the pedestal console. The rudder tab is controlled by a momentary switch marked NOSE LEFT and NOSE RIGHT; the aileron tab is controlled by a momentary switch marked LEFT WING DOWN and RIGHT WING DOWN; and the elevator tabs are controlled by a left and right momentary switch, each of which is marked NOSE DOWN and NOSE UP. The left elevator tab switch actuates the left tab for normal operation. If the left tab is inoperative, the right tab may be used to trim the aircraft. Both tabs may be used in unison if a faster nose-up or nose-down trim is required.

**Trim Tab Position Indicators**

An electrically operated combination rudder and aileron tabs position indicator and an electrically operated elevator tabs position indicator are installed on the main instrument panel. The aileron and rudder trim tab indicator is a dual indicator. The upper half of the dial registers aileron trim tab deflections from 20° left wing down to 20° right wing down. The lower half of the dial registers rudder trim tab deflection from 15° nose left to 25° nose right. The elevator trim tab indicator registers the deflection of the left and right elevator trim tabs with the dial divided to show both tab deflections from 5° nose down to 10° nose up.

**Wing Flaps**

The hydraulically operated split type wing flaps are designed to assume any one of four predetermined positions as marked on the flaps control lever. The control lever is on the overhead control panel. A thermal expansion relief valve allows the flaps to blow up before any structural damage due to excessive air loads occurs. The flaps automatically reset themselves to the selected position as the air loads decrease.

Note: The wing flap is a “servo controlled,” multi positioned flap. The controlling flap (the one with the servo follow-up linkage) is the right flap. There is no positional control on the left flap. Therefore, positioned synchronization between the two flaps is by virtue of a balance of flap force transmitted through the hydraulic actuating cylinder on each flap and the hydraulic lines between them. When a 15° or 30° flap setting is selected, it is possible for the left flap to be at an angle different from the right flap during static run-up or taxiing operations. To check system integrity when an asymmetrical condition occurs, increasing engine RPM (100 RPM differential) on the side that has the greatest flap deflection should result in “up” motion of that particular flap. It must be remembered, however, that flap deflection will quickly become symmetrical during the takeoff run as soon as air loads are imposed on the flaps.

**Flaps Control Lever**

The flaps control lever is located on the copilot’s side of the overhead control panel and has a flap shaped knob. Four positions, UP, APPROACH 15°, 30° and LAND 40° are engraved on both sides of the lever proper, with a line over each engraved position. When the lever is moved to index one of the four positions with the face of the overhead control panel, the flaps selector valve is positioned through a mechanical linkage to cause the flaps to assume the same relative position.

**Hand Pump**

A hydraulic hand pump is installed on the cabin floor under and to the right of the pilot’s seat. In the event of a hydraulic system pressure failure, operation of this hand pump in conjunction with the appropriate positioning of the hand
pump selector control and the normal control lever will supply hydraulic pressure to raise or lower the flaps to the desired angle.

**HAND PUMP SELECTOR CONTROL**

The hand pump selector control is located on the hand pump selector panel on the vertical face of the left main console. The panel is placarded with five positions, one of which is FLAPS. When the selector control is set to FLAPS, the hand pump selector valve is positioned to permit hydraulic fluid to be pumped to the flap cylinders by the hand pump. With the normal control lever set to the desired degree of flaps, operation of the hydraulic hand pump will raise or lower the flaps to the preset position.

**WING FLAPS POSITION INDICATOR**

A flaps position indicator combined with the landing gear position indicator is located on the main instrument panel. It is DC powered, and gives the pilots a visual indication of the flap setting.

Note: Before reading the wing flaps position indicator, check that the three INSTRUMENT circuit breakers are in. The indicator will give a false reading if the corresponding circuit breaker is out.

**LANDING GEAR**

The nose landing gear and the main landing gear are hydraulically extended and retracted by the aircraft’s main hydraulic system (3000 PSI). The landing gear may also be raised or lowered by the emergency hydraulic hand pump system. The nose wheel is non-steerable, but swivels 70° to the right and left of the center. Landing gear doors and fairings are operated mechanically by the action of the landing gear they enclose. The wheel wells are sealed to prevent water from entering the hull and the wheel well doors are provided with drains to permit water trapped in the wheel well to flow out when the aircraft becomes airborne. A safety switch controls a solenoid that locks the landing gear selector handle when the solenoid is deenergized. The safety switch prevents inadvertent landing gear retraction when the aircraft is on the ground. When the aircraft is airborne, movement of the left drag strut contacts the switch to energize the solenoid lock, permitting the selector handle to be moved to retract the landing gear. Under normal hydraulic pressure, 15 seconds are required for landing gear retraction. In the event of electrical failure, or of an emergency during takeoff, the lock pin located under the main console may be depressed to unlock the landing gear selector handle.

**LANDING GEAR CONTROL HANDLE**

A landing gear control handle is located at the left side of the pedestal console. When this control handle is set to either UP or DOWN it trips a limit switch which closes an electric circuit to the electrically operated by-pass valve, making 3000 PSI hydraulic pressure available at the actuating and locking cylinders. It also permits selector valve fluid to go to the actuating pistons. At the end of the extending or retracting cycle, the actuating cylinder trips a limit switch which repositions the by-pass valve to return hydraulic fluid to the reservoir.

**HAND PUMP**

A hydraulic hand pump is installed on the cabin floor under and to the right of the pilot’s seat. In the event of a hydraulic system pressure failure, operation of this hand pump, in conjunction with the appropriate positioning of the hand pump selector control, will supply hydraulic pressure to raise or lower the landing gear.

**HAND PUMP SELECTOR CONTROL**

The hand pump selector control is located on the hand pump selector panel on the vertical face of the left main console. The panel is placarded with five positions, two of which are LANDING GEAR UP and LANDING GEAR DOWN. In the event of hydraulic pressure failure (main system) placing the selector control on the appropriate setting properly positions the hand pump selector valve to permit hydraulic fluid to be pumped to the landing gear cylinders by the hand pump. The normal landing gear control does not have to be set to move the gear up or down; however, it must be in the proper position for the landing gear indicator and warning light to give a correct indication. Approximately 250 hand pump strokes are required to raise the landing gear and 360 strokes are required to lower and lock it.

Note: A periodic lack of pressure may be felt when lowering the landing gear by use of the hand pump. This condition is evident when the landing gear is lowering by its own weight.

**LANDING GEAR POSITION INDICATOR**

A landing gear position indicator, in combination with the flaps position indicator, is located on the main instrument panel. With the landing gear up and locked, the word UP appears in the three windows representing the main gears and nose gear. With the landing gear down and locked, representations...
of wheels are displayed in the windows. A barber pole indication in the windows indicates that the landing gear is either not down and locked or not up and locked, is in transit, or that there is no electrical power to the instrument. The indicator is electrically operated by DC power. The indicator will not function until the limit switches are tripped at the up locks or down locks on each gear. Before reading the landing gear positions indicator and checking the landing gear warning light, make sure that the three INSTRUMENT circuit breakers are in. These indicators will give a false reading if the corresponding circuit breaker is out.

**Landing Gear Warning Light**

The landing gear warning light is located on the instrument bulkhead between the top corners of the pilot’s and main instrument panels. The light glows during landing gear extension and retraction to warn the pilots that all wheels are not locked up or down. When the landing gear is being extended or retracted by the emergency system, the landing gear selector handle must be in the corresponding position in order for the light to operate correctly.

**Nose Wheel Down Lock Indicator**

The nose wheel down lock indicator is a mechanically actuated metal flag inscribed NOSE WHEEL LOCKED DOWN. It is located just outboard of the aisle floor between the pilot’s seats, on the copilot’s side. When the nose gear is down and locked, the flag becomes visible.

**Aisle Floor Window**

A window is provided on the aisle floor for visually checking that the nose gear is down and locked.

**Brake System**

The brake system consists of a self-adjusting, segmented dual rotor, disc type brake mounted on each main landing gear axle and operated by power boost master cylinders located just forward of both the pilot’s and co-pilot’s rudder pedals. The power boost master cylinders receive pressure from the 1500 PSI hydraulic sub-system. The boost brake system differs from the usual power brake system in that the hydraulic system pressure does not enter the brake but is used to assist the pedals.

Note: The combined efforts of both pilots on the brake pedals will not result in an increased brake force, but will result only in the pressure exerted by the pilot or co-pilot, which ever is greater.

Any pressure appearing on the sub-system pressure gage after the hydraulic system fails represents accumulator pressure but is no indication of volume. Due to internal leakages, the accumulator pressure will be slowly lost. Normally, immediately after system failure, with the pressure gage reading 1500 PSI, there remain approximately 10 full applications of the brakes, provided the windshield wipers and rudder.

**Emergency and Parking Brakes**

In the event of a hydraulic system failure, or for parking, the brakes may be set by hand pump pressure. The hand pump selector must be placed in the EMERG AND PARKING BRAKES position. The hand pump will lock both wheels evenly and directional control cannot be maintained by the emergency system. Approximately five strokes of the hand pump are required to lock the brakes.

**Emergency Equipment**

**Fire Extinguishing System**

The fire extinguishing system consists of a right and left engine fire extinguishing switch, the extinguishing agent, bromotrifluoromethane, tubing and discharge nozzles. The agent in a metal sphere located in each engine nacelle with tubing routed from it through the firewall to a discharge ring in the accessory section and to a discharge nozzle in each oil cooler duct and carburetor header. The presence of fire is detected by any one of the fire detectors which will illuminate one of the fire warning indicator lights. Each guarded fire extinguisher switch in the emergency control panel on the overhead control panel is operated by a gang bar and cannot be moved independently. Moving this gang bar forward sets the fire extinguisher switch to ON (and also sets the emergency fuel shut-off and emergency hydraulic switches to CLOSE and sets the emergency generator switch to OFF). This actuates an electrically controlled valve in the sphere which releases the extinguishing agent. Repeated or prolonged exposure to high concentrations of bromotrifluoromethane or its decomposition products should be avoided.

**Fire Warning Light Indicator**

The red right and left engine press-to-test fire warning lights are located on the vertical instrument panel and the main console. The lights are energized
by the fire warning detectors located at various points around the engine to warn on engine compartment fire. Operation of any one of the detectors will close the normally open warning circuit and cause a light to glow.

**DE-ICING AND ANTI-ICING SYSTEMS**

**WING AND TAIL DE-ICING SYSTEM**

The wing and tail de-icing system uses pulsating rubber boots installed on the leading edges of the wing, fin, and stabilizer to eliminate ice formations. Air pressure, and suction, supplied by the two engine driven air pumps, alternately inflate and deflate the de-icer boots through electronically regulated cycles. On the HU-16D the inflation tubes of the wing boots run chordwise while the inflation tubes at the fin and stabilizer boots run spanwise. The electronic timer, in conjunction with solenoid operated control valves, regulates the proper sequencing of the de-leer boot pulsation cycle. DC power is used to operate the electronic timer and the various solenoid controlling valves.

**WINDSHIELD DEFROSTING SYSTEM**

Windshield defrosting and defogging is accomplished by directing hot air (or ventilating air) over the interior surface of the windshield. This is performed by defroster ducts located behind the instrument panel and adjacent to the bottom of the windshield. One defroster duct is located in front of the pilot's station and one in front of the co-pilot's station. Defrosting is controlled by dampers inside the ducts. Levers attached to the dampers are operated manually to obtain full open or full closed positions. Heated air for the windshield defroster system is supplied through the flight deck heating system distribution duct; therefore, the heating system must be in operation for windshield defrosting. For maximum defrosting after heater is in operation, turn cabin airflow damper control to OFF, shut oil (light deck outlets, and move windshield defroster duct levers to their open positions.

**Electronic timer**

The electronic timer, is located on the left side of the flight deck between the pilot's seat and the fuselage. It is mounted about a foot of the floor within easy reach of the pilot. All the de-icer control switches are mounted on the timer. An operating light, with dimmer control, is mounted on the upper left corner. When lighted, it indicates that power is available for operation of the de-icer system. The light contains a press-to-test feature enabling the bulb to be tested without the system operating. A push button located at the top center of the timer panel is used for single cycle operation. The primary de-icer control is a five position rotary switch marked OFF, 1, 2, 3, and 4 and is located in the upper right corner of the timer. Five auxiliary, hand operated, two position selector switches are provided for emergency operation and localized icing. These switches are marked with the sequence letter of the boot controlled as indicated on the outlined aircraft on the panel. They are operated in conjunction with the No. 1 position of the primary (rotary) switch and automatically return to the center (off) position when the operation is completed. Ten fuse receptacles are installed at the bottom of the timer panel to protect the system from current overloads.

**DE-ICER SYSTEM GAGES**

An air pressure gage and a suction gage are installed on the main console, left side (figure 1-9), in front of the pilot. When the de-icing system is operating, the pressure should indicate a system pressure of 17 to 19 PSI and the suction gage should register 3.5 to 5 in. Hg.

**AUTOMATIC OPERATION**

Turn rotary switch in upper right corner of timer to any of the following positions, selected according to icing conditions: (allow 20 seconds warm up)

1. Position 1: Single cycle operation for low-rate (light) icing conditions. Depress button marked SINGLE CYCLE to operate system through one pulsation cycle, which is completed in approximately 60 seconds. Repeat as necessary by depressing button.

2. Position 2: Automatic operation of de-icing system for medium-rate icing conditions, with a 60 second “dwell” between the approximately 60 second pulsation cycles.

3. Position 3: Automatic operation of system for severe icing conditions without a “dwell” between the approximately 60 second pulsation cycles.

4. Position 4: Automatic operation of system without “dwell” period and with a 50 per cent increase in inflation periods. This position is used only when boots do not fully inflate due to a low airflow.

Note: Position 4 - EXTENDED CYCLE operation produces only an increase in duration of the inflation period. The boots do not expand any further, since the air pressure remains the same for all operating conditions. During certain severe icing conditions, position 4 could be harmful, since the longer boot inflation might allow ice to form around a fully inflated boot which subsequent boot pulsations would fail to remove.
5. OFF: De-icer system inoperative.

**MANUAL AND EMERGENCY OPERATION**

A row of two position, auxiliary, hand operated switches is located on the timer panel. These switches are used in the electronic timer tails and for localized icing conditions. Each switch controls the pulsation of a set of boot cells and is marked with the corresponding sequence letter. To operate:

1. Set primary (rotary) switch to position 1.
2. Set one auxiliary switch on at a time, starting with AB and following the de-icing sequence, as marked, through JK. Each switch is spring loaded to the OFF position and initiation of the boots continues only as long as the switch is depressed.
3. Press push button to start inflation cycle.

**PROPELLER DE-ICING SYSTEM**

This system removes ice formations on the propellers by means of DC heating pads cemented to the leading edge of the blades. To protect against excessive overloads in the high amperage circuit employed in this system, two 200 ampere fuses are installed in the electrical distribution box on the right side of the flight deck.

WARNING: Before replacing the fuses in flight or on the ground, shut off the generator and battery switches as a precaution against coming into contact with high amperage current.

**Propeller De-Icing Switch**

The propeller de-icing switch, mounted on the left side of the main console has three position: BLOW, FAST and OFF. In the FAST position, the heater pads are energised for shorter periods of time and the heating cycle is completed more quickly. In the SLOW position, the pads are kept energized longer and the heating cycle is completed more slowly. The FAST position is used for severe icing and the SLOW position is used for light icing conditions.

**Propeller De-Icing Indicator Light**

An indicator light, located above the propeller de-icing switch on the instrument bulkhead, glows when this system is operating.

**Propeller De-icing Operation**

Set propeller de-icing control switch to either SLOW or FAST, depending upon severity of icing conditions.

The timer energizes the left and right propeller blade heaters alternately as follows:

**Fast Cycle**

1. Left propeller heaters on and right propeller heaters off for 20 seconds.
2. Left and right propeller heaters off for 20 seconds.
3. Right propeller heaters on and left propeller heaters off for 20 seconds.
4. Left and right propeller heaters off for 20 seconds. Cycle is then repeated.

**Slow Cycles**

The slow cycle is the same as the fast cycle described above except that the time interval is 80 seconds instead of 20 seconds for each step.

CAUTION: When the engines are not running, do not operate the propeller de-icing system for longer than eight minutes at any one time without a suitable cooling period.

When the RPM of each engine is increased sufficiently to bring each generator output into the circuit and the de-icing switch is set to SLOW or FAST, an increase of the amperage reading indicates that the de-icing system is functioning. The amperage gain will be approximately 102 amperes, evenly distributed between the two ammeters, provided all propeller heating elements are functioning. A drop-off in increments of approximately 84 amperes, also distributed between the two ammeters, would indicate that the heating elements of one or more blades are not functioning. No increase in amperage denotes that the propeller de-icing system is completely dead.

**PITOT HEATER**

Setting the pitot heater switch, located on the main console, left side to ON electrically heats the pitot tube to prevent and/or dissipate icing.

**WINDSHIELD ANTI-ICING SYSTEM**

The windshield anti-icing system consists of a six quart anti-icing fluid tank, a DC powered electric motor driven pump, a selector valve, a flow control rheostat and a windshield spray tube assembly. All components
of the windshield anti-icing system, except the fluid tank, also are utilized by the windshield wash system and the selection of either anti-icing or wash functions are controlled by the selector valve. The anti-icing system should be operated in conjunction with the windshield wipers, since the area of the windshield covered by the spray is limited and the wipers will spread the anti-icing fluid over a greater area. If and when the fluid has been depleted, the system should be turned off. See figure 1-76 for servicing data.

Selector Valve
The two position selector valve controls which of the fluids, anti-icing or wash water, will be sprayed on the windshield. It is located on the left side of the vertical face of the left console. Setting the valve to ANTI-ICER causes anti-icing fluid to be directed to the windshield spray tubes. For wash purposes, the valve is set to WASHER.

Rheostat Control
The rheostat control is located adjacent to the selector valve on the vertical face of the left console. It is marked OFF, ON, and DECREASE FLOW. Turning the control clockwise from OFF to ON starts the electrically driven pump operating at maximum speed. Continuing to turn the control clockwise decreases the speed of the pump and, consequently, the amount of liquid sprayed onto the windshield.

AUTOMATIC PILOT SYSTEM
The aircraft is equipped with a P-1(F-1) electronic automatic pilot that provide a means of automatically holding the aircraft on any desired magnetic heading while simultaneously keeping it stabilised in pitch and bank. The autopilot operates on AC which is normally supplied by the No. 1 inverter and on the DC. If the inverter 1 is inoperative, the No. 3 inverter can be utilized to supply power for the autopilot.

Electrical servos actuate the primary flight control surfaces. Normal control of the system is exercised from the automatic pilot control panel located on the aft face of the pedestal console where it is convenient to pilot and co-pilot. An emergency mechanical disconnect is also included in the system.

Autopilot Power Switch
The autopilot power switch is located on the pedestal console aft face right side. When this switch is set to ON (and the inverter is operating and the flight instruments power switch is set to ON), electrical power is supplied to the autopilot control circuits and units.

Clutch Switch
This push-pull button switch is located below the autopilot power switch on the aft face of the pedestal console. Pushing this switch into its ON position engages the autopilot for normal operation. The autopilot is normally disengaged by pulling the clutch switch out (off position).

Controller
The autopilot controller is located on the left side of the aft face of the pedestal console. By manipulating this control, with the autopilot engaged, the aircraft can be made to turn left or right by changing the heading selected course.

Autopilot Emergency Disconnect
This “T” control handle is located on the right aft end of the overhead control panel and is for use in the event that a normal electrical disengagement fails. When the handle is pulled, the autopilot servo clutches are disengaged.
AIRCRAFT OPERATING LIMITATIONS

ENGINE LIMITATIONS

RPM
Continuous Operation: 1400 to 2500 RPM
Max: 2700 RPM (Take-off 5 min max - Military 30 min max)

Manifold Pressure:
Continuous Operation: 21 to 46.5 In.Hg
Max: 51.5 In.Hg (Take-off 5 min max - Military 30 min max)

Cylinder Head Temperature:
Continuous Operation: 100 to 245°C
Max: 260°C (Take-off 5 min max - Military 30 min max)

Oil Pressure:
Minimum: 55 PSI
Continuous Operation: 65 to 75 PSI
Maximum: 90 PSI

Oil Temperature:
Minimum: 40°C
Continuous Operation: 75 to 90°C
Maximum: 95°C

Fuel Pressure:
Minimum: 21 PSI
Continuous Operation: 21 to 23 PSI
Maximum: 25 PSI

Carburetor Air Temperature:
Minimum: -10 to 5°C (Danger of icing)
Continuous Operation: 5 to 38°C
Maximum: 38°C (Danger of detonation)
CAUTION: Reduce max allowable manifold pressure 1 In.Hg for each 6°C that exceeds 38°C

HYDRAULIC LIMITATIONS
Main Hydraulic Pressure:
Normal Operation: 0 to 3000 PSI
Max: 3250 PSI

Sub Hydraulic Pressure:
Normal Operation: 1250 to 1500 PSI
Max: 1550 PSI

VARIOUS SYSTEMS LIMITATIONS
De-Icer Pressure:
Normal Operation: 17 to 19 PSI

De-Icer Suction:
Normal Operation: 3.5 to 5 In.Hg

AIRSPEED LIMITATIONS
In smooth or moderate turbulent air: 254 kts
In severe turbulent air: 125 kts
Full aileron deflection: 208 kts
Full rudder deflection: 150 kts
With landing gear extended: 150 kts
With landing lights extended: 120 kts
Flaps down (design limit): 141 kts

MANEUVERS
The following maneuvers are prohibited:
Intentional spins
Aerobatics

The following maneuvers are permitted:
Bank angles up to but not in excess of 60 degrees
Slipping or skidding, as required for asymmetrical power conditions or for landing approaches at indicated airspeeds up to but not in excess of 150 kts.
Maximum permissible acceleration: at 29500 lb gross weight: +3G - 0G
Avoid acceleration superior to 1.8G to avoid excessive stress on the aircraft

CENTER OF GRAVITY LIMITATIONS
CG Range from 20.5 to 28% of the MAC.
CHECKLIST

PRESTART

Chocks/Parking Brake .......................................... In place/Set
Gear Handle .......................................................... Down
Gust Lock .............................................................. Off
Radio ................................................................. Off
Fuel transfert ......................................................... Off
Boost Pumps ......................................................... Off
Ignition ................................................................. Off
Fuel Selectors ....................................................... Mains
Mixture ................................................................. Idle Cut-off
Throttle friction ....................................................... Set
Super Charger ....................................................... Low / Locked
Hydraulic Bypass .................................................. On
Prop replenish / Unfeather and Unrev ...................... Off
Wing De-icer ......................................................... Off
Gyros ...................................................................... Caged
Inverters ............................................................... Off
Inverter selector ..................................................... Normal
Heater / De-icer ..................................................... Off
Alternate Static ..................................................... Off
Drop Tank Jettison .................................................. Off
Oil Coolers / Cowl flaps ......................................... Open
Carb Air ................................................................. Direct
Oil Dilution ............................................................ Off
External Power ....................................................... Off
Generators ............................................................. On
Battery ................................................................. On / Volt checked
#1 and #2 Inverters ............................................... On / Checked
Circuit Breakers .................................................... Normal
Seat Belt / No Smoking Sign .................................. On
Props ................................................................. High RPM, Lights On

Flaps ......................................................................... Up
Warning Lights ..................................................... Checked
Radios ..................................................................... On
Aircraft Clear ........................................................ Checked
Manifold Pressure .................................................. Noted

START

RIGHT ENGINE START

Boost Pump .......................................................... On
Fuel pressure ......................................................... On
Engage Starter for six blades
Magnetos ............................................................... Both
Prime ........................................................................ if necessary
Mixture ................................................................. Rich
Throttle ............................................................... Set to 1000 RPM
Oil Pressure ........................................................... 40 PSI
Hydraulic System .................................................. Checked

REPEAT FOR LEFT ENGINE

PRE-TAXI

Hydraulic Pressures ................................................ Checked
Vacuum Pressures .................................................. Checked
De-icer Gauges ..................................................... Checked
Aux Fuel Tanks ..................................................... Checked
Engine Instruments ............................................... Normal
Gyros ................................................................. Uncaged
Altimeter / Clock .................................................. Set
Hatches / Doors ..................................................... Secured

RUN-UP

Parking Brakes ........................................................ Set
APU ........................................................................ As Required
Engine Instruments ............................................... Normal

Engine Run-Up :
Mixture .................................................................... Set to Rich
Throttle full back .................................................. 650 RPM

Master ignition switch to OFF Engine quit momentarily
Each Magnetos switch to OFF Engine quit momentarily
Propeller Reverse Checked
Propeller feathering Checked (1500 RPM)
Generators Checked
Blower (2100 RPM) Checked (Manifold pressure drop)

**PRE-TAKE-OFF**

APU As Required
Rudder boost On
Fuel Transfer Switches Off
Boost Pumps On
Fuel Transfer Selectors Main Tanks
Superchargers Low/Locked Mixtures Rich
Propeller switches Increase RPM / Lights On
Carburetor Ar Switches Direct
Cowl Flaps and Oil Coolers As Required
Drop Tank Jettison Switches As Required
De-Icer/Anti-Icer As Required
Inverter #3 On
Lights As Required
Trim Tabs Set
Controls Free
Flight Instruments Checked
Engine Instruments Checked
Crew Briefing Completed
Throttle Friction Set
Flaps Set/Checked
Hatches and harness Locked
Anti Collision Light On
Radios Set

**NORMAL TAKE-OFF**

Add power to 30 inches MAP Check engines instruments
Advance throttles to MAX power
Rise nose at about 60-65 kts
Take off at 80-95 kts
Momentarily toe brakes and retract landing gear when a safe landing cannot be made

Upon reaching 105 kts and landing gear is retracted, reduce power to the normal rated power
Accelerate to 115 kts for clim and reduce to climb power
At 1000ft AGL go through post Take-off Checklist

**POST TAKE-OFF**

Landing Gear and Flaps Up/Checked
Climb Power Set
Hydraulic Pressure Checked
Mixture Normal
Booster Pumps Off (Pressure checked)
Rudder Boost Off
No Smoking, Seat Belt Sign As Required
Cowl Flaps and Oil Coolers As Required
Drop Tank Jettison Switches Off

**CRUISE**

Cruise Power Set
Cowl Flaps and Oil Coolers Set
Carb Air Set

**APPROACH**

Crew Alerted
No Smoking, Seat Belt Sign On
APU On
Auto Pilot Off
Altimeters Set
Heaters and De-Icers As Required
Fuel Transfer Switches Off
Fuel Selectors Mains
Superchargers Low/Locked Mixtures Rich
Boost pumps On
Props 2300 RPM
**LANDING**

Wing De-Icers.................................................................Off
Rudder Boost .................................................................On
Landing Gear .................................................................Down (Land) - Up (Water)
Brakes.................................................................Checked / Pressure up
Flaps ........................................................................As Required
Harness ...........................................................................Locked
Landing Lights .............................................................As Required
Props ................................................................................Full Increase

**POST LANDING**

Flaps ................................................................................Up
Boost pumps .................................................................Off
Rudder Boost .................................................................Off
Carburetor Heat ...............................................................Direct
Cowl Flaps and Oil Cooler ................................................Open
De-icing/Anti-icer .............................................................Off
Anti Collision Light ........................................................Off
Pitot Heater .................................................................Off
APU ................................................................................On

**GROUND SECURE**

Parking Brake ...............................................................Set
Scavenge engine .........................................................1200 RPM (30sec minimum)
Idle Mixture .................................................................Check
Right Mixture .................................................................Idle Cut-off
De-Icer Pressure and Suction .........................................Checked
Main Hydraulic System ...............................................Check Operation with flaps
Left Mixture .................................................................Idle Cut-off
Ignition Switches ........................................................Off
Gyros ...............................................................................Caged
Inverters .........................................................................Off
Heating and Ventilating Switches ....................................Off
Cowl Flaps and Oil Coolers Switches ...............................Off
Light Switches ...............................................................Off
Landing Lights ...............................................................Retracted
Radios ..............................................................................Off
Chocks ............................................................................In Place

Parking Brake ...............................................................As Required
Battery Switch and DC voltmeter .....................................Off
Controls ...........................................................................Locked
NORTH AMERICAN B-25 Mitchell by Khamsin

Accurate 3D visual model with normal maps - HD 4K textures
Fully detailed and animated 3D cockpit with 3D gauges
Polygon optimized model, manipulators technology
Night lights effects — Strafer version added (solid nose)

Included in the package
6 liveries (Bomber version) + 3 liveries (Strafer version)
Requirements
Windows Vista or Seven (32 or 64 bits) / MAC OS X / Linux
XPlane 10.20 (or higher - 64 bit compatible)
Pentium 2 GHz - 4GB RAM/1GB VRAM
70MB available hard disk space

http://store01.prostores.com/servlet/x-planestore/Detail?no=508

DE HAVILLAND DHC-1 Chipmunk by Khamsin

Accurate 3D visual model with normal maps
Fully detailed and animated 3D cockpit with 3D gauges
Polygon optimized model, manipulators technology
Night lights effects
3 liveries (RAF, RCAF, civil)
Requirements
Windows Vista or Seven (32 or 64 bits) / MAC OS 10.3.9 (or higher) / Linux
XPlane 10.20 (or higher - 64 bit compatible)
Pentium 2 GHz - 4GB RAM/1GB VRAM
70MB available hard disk space

http://store01.prostores.com/servlet/x-planestore/Detail?no=456
NORTH AMERICAN T-28 Trojan by khamsin

- Highly detailed and fully animated exterior model
- Fully detailed and animated 3D cockpit with 3D gauges
- Polygon optimized model, manipulators technology
- Night lights effects
- 3 liveries

Requirements
- Windows Vista or Seven (32 or 64 bits) / MAC OS 10.3.9 (or higher) / Linux
- XPlane 10.22
- Pentium 2 GHz - 4GB RAM/1GB VRAM
- 88MB available hard disk space

http://store01.prostores.com/servlet/x-planestore/Detail?no=351

PACIFIC ISLANDS WW2 by Khamsin

- Munda, Gizo, Barakoma airfields (Salomon Islands)
- Espiritu Santo Palikulo (Vanuatu Islands)
- Original objects: Vought F4U Corsair, Lockheed P-38 Lightning, Douglas C47 Dakota, Consolidated B-24 Liberator, Consolidated PBY Catalina, Liberty Ship, Patrol boat, Jeep Willis, GMC Truck, tents, towers, barraks, Quonset hut...
- X-Plane 10 lights, HDR rendering

Requirements
- Windows Vista or Seven (32 or 64 bits) / MAC OS 10.3.9 (or higher) / Linux
- XPlane 10 (or higher - 64 bit compatible)
- Pentium 2 GHz - 4GB RAM/1GB VRAM
- 180MB available hard disk space

http://store01.prostores.com/servlet/x-planestore/Detail?no=373
The Consolidated PBY Catalina is one of the most significant aircraft of the golden years of aviation. This American flying boat produced by Consolidated Aircraft was widely used as a versatile aircraft during World War II. Awesome 3D Model throughout
Fully animated with Virtual (3D) Cockpit - Fps friendly
Intensive use of manipulators technology - realistic movements of parts, levers, knobs, etc.

7 different versions of the PBY-5A
Military, 2 Civilian, 2 Water Bomber, Modern, and actual ‘9767’

http://store01.prostores.com/servlet/x-planestore/Detail?no=238

Consolidated PBY-5A Catalina 9767 by Hydroz

BOEING B-17 Flying Fortress V1.3 by Khamsin

Freeware
High definition 4K (diffuse, normal ans specular)
Fully animated exterior model
Fully animated 3D cockpit with 3D gauges
Manipulators technology
Night lights effects, high frame rate

Requirements
Windows Vista or Seven (32 or 64 bits) / MAC OS 10.3.9 (or higher) / Linux
XPlane 9.55 -> Xplane 10.22+
Pentium 2 GHz - 4GB RAM/1GB VRAM
55MB available hard disk space


Boeing B-17 Flying Fortress V1. by Khamsin

Freeware
High definition 4K (diffuse, normal ans specular)
Fully animated exterior model
Fully animated 3D cockpit with 3D gauges
Manipulators technology
Night lights effects, high frame rate

Requirements
Windows Vista or Seven (32 or 64 bits) / MAC OS 10.3.9 (or higher) / Linux
XPlane 9.55 -> Xplane 10.22+
Pentium 2 GHz - 4GB RAM/1GB VRAM
55MB available hard disk space

Pottier 130UL by Hydroz

The Pottier 130UL is a modern ultra light aircraft (610lbs) with a wooden frame. It is powered by a Jabiru 2200 engine making 80hp.

The X-Plane model was designed using the real aircraft blueprints and with the assistance of a real P130UL pilot. The goal was to make the flight model as accurate as possible for all ultra-light lovers.

http://store01.prostores.com/servlet/x-planestore/Detail?no=490

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