ENGINE

GENERAL

Jet engines produce thrust by accelerating air. It is the product of the mass of the air times the increase in velocity that determines thrust output. To generate a given amount of thrust, a small volume of air can be accelerated to a very high velocity, or a relatively large amount can be accelerated to a lower velocity.

In a turbojet engine, incoming air is compressed, mixed with fuel, combusted and exhausted at a high velocity. In a turbofan engine, only a portion of incoming air is combusted. The hot air then drives the fan which accelerates a large volume of air at a lower velocity. This air is bypassed around the engine and is not mixed with fuel or combusted. The relation of the total mass of bypassed air, to the amount of air going through the combustion section, is known as the bypass ratio. The bypass ratio of the Citation II Bravo engine is approximately 3.2 to 1 at takeoff power.

The twin spool PW530A, developed for the Citation II Bravo by Pratt and Whitney Canada Inc., is a turbofan engine rated at 2750 pounds static thrust. A concentric shaft system supports the fan and turbine rotors. The inner shaft connects the single fan stage integrated bladed rotor (IBR) (N_1), at the front of the engine, to the two rear low pressure turbines. The outer shaft connects the high pressure compressor (N_2) and the forward, two-stage, axial high pressure turbine.

All intake air passes through the fan. Immediately aft of the fan the airflow is divided by a concentric duct. More than two-thirds of the total airflow is bypassed around the engine through the outer duct and is exhausted at the rear. Air entering the inner duct passes through guide vanes to the compressor stage, then through a second set of guide vanes and is compressed by the compressor. The high pressure air then passes through a diffuser assembly and moves aft to the combustion section.

The combustion chamber is of an annular reverse flow design to save space and reduce engine size. A portion of the air entering the chamber is mixed with fuel and ignited. The remainder enters the chamber liner downstream for cooling.

Fuel is introduced by eleven hybrid nozzles supplied by a dual manifold. The mixture is ignited initially by two spark igniters which extend into the combustion chamber at the five and seven o'clock positions. After start, combustion becomes self-sustaining. The hot gases expand, reverse direction and pass through a set of turbine guide vanes to the high pressure turbine. The power generated by this turbine is transmitted by the outer shaft to turn the N_2 compressor.

Only a small part of the energy available in the hot, high pressure air is absorbed by the high pressure turbine. As the expanding gases move rearward, they pass through another set of guide vanes and enter the two-stage, low-pressure turbine. A greater portion of the remaining energy is extracted there and transmitted by the inner shaft to the forward-mounted fan. The hot gases then exhaust into the atmosphere.

The turbofan is in effect two interrelated powerplants. One section is designed to produce energy in the form of high velocity, hot air. The other utilizes some of this air to provide the power to drive the fan. The fan of the PW530A, pumping a high volume of cool low-velocity air, produces over one-half of the total thrust.

The Model 550 Bravo is equipped with a ground idle system which automatically allows the engines to decelerate to an idle speed of 45.5% eight seconds after the landing gear squat switches have sensed a landing. The slower idle speed allows better taxiing control at lighter weights and in very cold temperatures, when the normal flight idle speed of 49.5% (at sea level) would require more use of the brakes, resulting in reduced brake life. The ground idle function is controlled by a GND IDLE switch on the tilt panel, which has HIGH and NORM positions. For normal conditions NORM is selected. HIGH position will disable the ground idle system resulting in an idle speed of not less than 49.5%. A GROUND IDLE annunciator is located on the annunciator panel. The annunciator will illuminate when the airplane is on the ground and the engine has assumed the slower idle speed, or will assume it when the throttle is reduced to idle. If the pilot desires to prevent the engine from assuming the slower idle speed, for reasons of air conditioning, faster engine acceleration time, etc., the HIGH position is selected.

NOTE

When practicing touch and go landings, the GND IDLE switch should be placed to HIGH for maximum engine acceleration capability.

ENGINE SYNCHRONIZER

An engine synchronizer system provides automatic N_1 fan or N_2 turbine RPM matching of the right (slave) engine to the left (master) engine. The synchronizer will continuously monitor the engine speeds and adjust the slave engine speed setting as required. The actuator has a range capability of 2 percent of fan RPM and 2 percent of turbine RPM.

A rotary FAN-OFF-TURB switch on the pedestal actuates the engine synchronizer system. FAN position synchronizes N_1 RPMs and TURB position synchronizes N_2 RPMs. OFF position deactivates the system and drives the actuator to the center of its range before stopping. An indicator light adjacent to the synchronizer switch comes on when the system is turned on.

A turbine out-of-sync condition is generally more noticeable in the cockpit and a fan out-of-sync condition is usually more noticeable in the area of the rear seats.

IGNITION SYSTEM

Each engine incorporates dual exciter units and two igniters. The exciter units convert battery or generator input to high voltage Direct Current (DC), store it momentarily until a given energy level is reached, and allow it to discharge in spark form through the igniters. System wiring is such that malfunction of one igniter or exciter will not affect normal operation of the other.

Cockpit control consists of two-position RH and LH ignition switches. In NORM, function is automatic during start and with engine anti-ice selected. Moving the throttle to IDLE after depressing the start button activates ignition until it is terminated automatically at approximately 39 percent turbine RPM (N_2). Continuous ignition occurs any time the respective engine anti-ice or ignition switch is ON.

A small green light above each ignition switch illuminates when both exciters are receiving electrical power. If one ignitor should fail, ignition will still be available from the remaining ignitor. If the ignition light does not illuminate when ignition is selected, or should be automatically provided, check the applicable ignition system circuit breaker on the left circuit breaker panel, or fuse in the aft power junction box.

ENGINE AIRFLOW

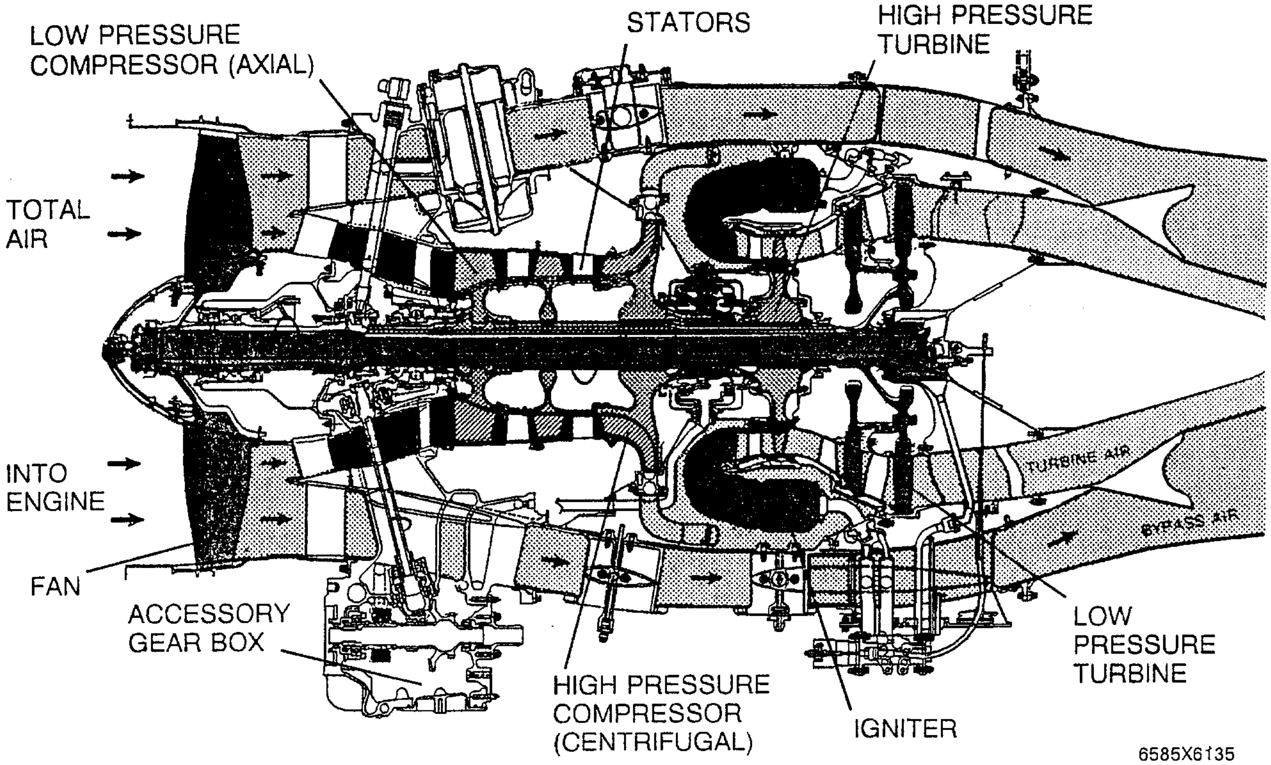


Figure 2-1

ACCESSORY GEARBOX

The starter/generator, fuel pump, fuel control, hydraulic pump, and oil pump are driven by the accessory gearbox mounted below the engine. Power to drive the gearbox is transmitted from the N_2 section through the tower shaft and a series of bevel gears. Lubrication is provided by the engine oil system.

TACHOMETERS

The N_1 and N_2 tachometers are driven by monopole generators on each engine. The N_1 and N_2 circuit breakers (LH TURB SPEED and LH FAN SPEED and RH TURB SPEED and RH FAN SPEED), on the respective left and right circuit breaker panels, provide electrical power for the engine gages. The two fan speed indicators receive DC power from the emergency DC bus when the battery switch is in EMER position.

BLEED VALVE CONTROL (BVC) SYSTEM

The engine is equipped with a bleed valve control system which controls an electro/pneumatic device (a servovalve, or torquemotor) which positions the variable opening or closing of the high pressure bleed-off valve (BOV), located between the high and low pressure compressors, in order to optimize the engine high pressure compressor performance and engine surge margins. The bleed valve system receives inputs from the high pressure compressor (N2) speed sensor, which are corrected by a fan exit temperature sensor (T14). For a given N2 speed (corrected by the temperature input) the BVC requests a given BOV position and outputs a signal to the torquemotor. The torquemotor positions the BOV valve to provide a pneumatic pressure which moves the actual BOV position as commanded. The BOV piston position is fed back through the wiring harness to the BVC system by a linear variable displacement transformer (LVDT) which is fitted to the BOV housing.

OIL SYSTEM

The system provides cooled, pressurized oil for lubrication and cooling of engine bearings and accessory drive gears and bearings. An integral oil tank on each engine has a capacity of 5.03 U.S. quarts, of which 3.17 quarts are unusable.

Oil is drawn from the tank by the two-stage pressure element of the engine oil pump mounted on the accessory gearbox. After leaving the oil tank it passes by a chip collector and through a filtering screen. Should the filter become clogged, a bypass valve opens, allowing lubrication to continue. Before it enters the oil cooler, which is a fuel/oil heat exchanger, it passes a cold start/pressure adjusting valve, which bypasses cold oil back into the tank if the starting oil pressure becomes too high. The cold start/pressure adjusting valve also serves to maintain the desired oil pressure. The oil then passes through individual strainers and to the engine bearings. Pressurized oil from the number five bearing continues to the accessory gear box to lubricate it. Four scavenge pumps return the oil from the main bearings and the accessory gear box, to the oil tank. Oil from the number five bearing scavenge pump is also pumped into the accessory gear box for general lubrication there.

The oil filter is equipped with an impending bypass switch to warn of a pressure buildup in the filter which will soon result in a clogged filter.

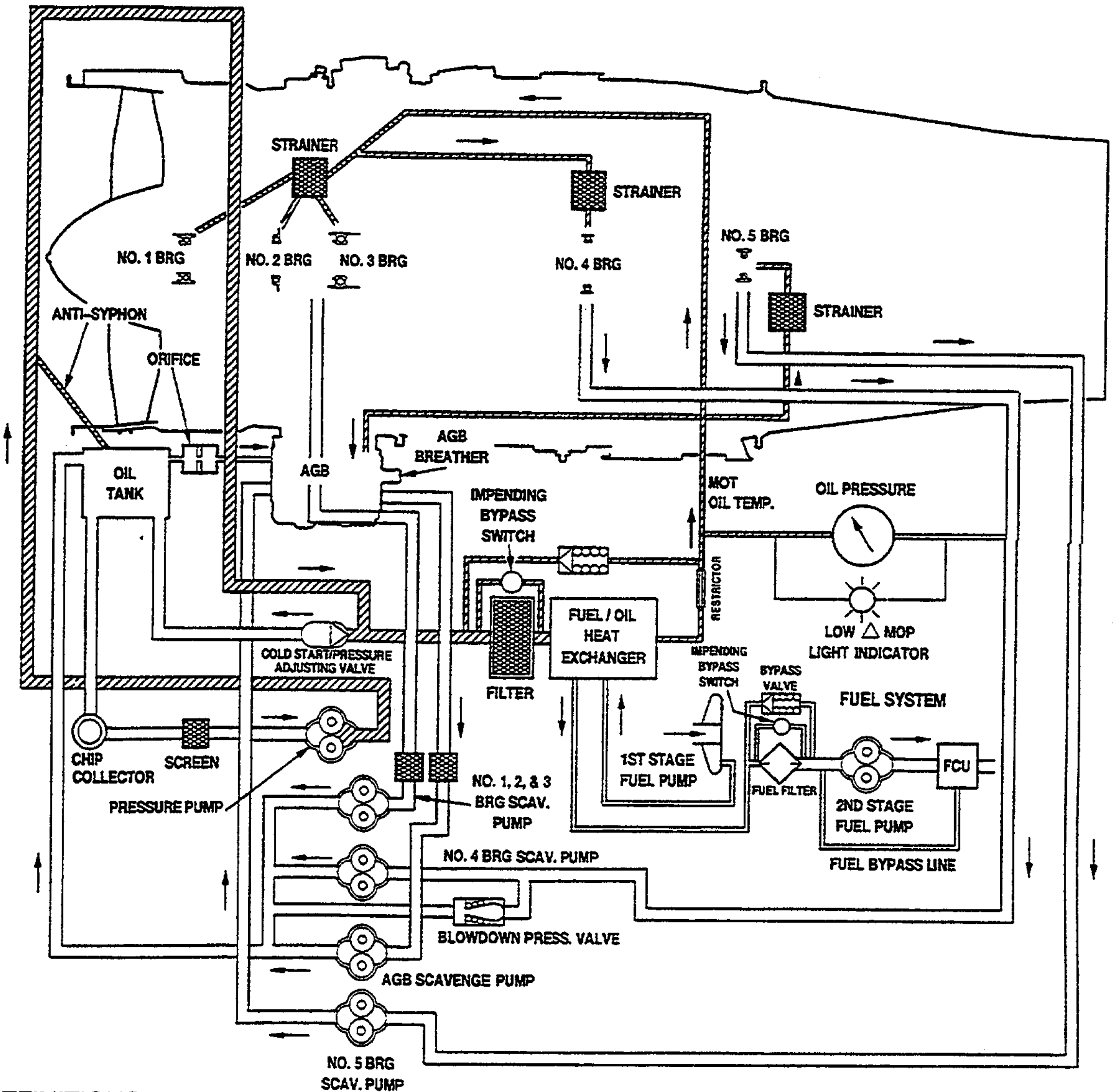
Cockpit indicators receive inputs from the pressure transmitter and the temperature bulb just and downstream of the fuel/oil heat exchanger.

THRUST REVERSER SYSTEM

DESCRIPTION AND OPERATION

The thrust reversers are of the external target type employing two vertically oriented doors or buckets, which, when deployed, direct exhaust gases forward to provide a deceleration force for ground braking. When stowed, the reversers fair into external airplane contours to form the aft portion of the nacelle. The reversers are mounted to the engine fan nozzle through an aluminum support casting and four interconnecting links per door.

ENGINE OIL SYSTEM SCHEMATIC



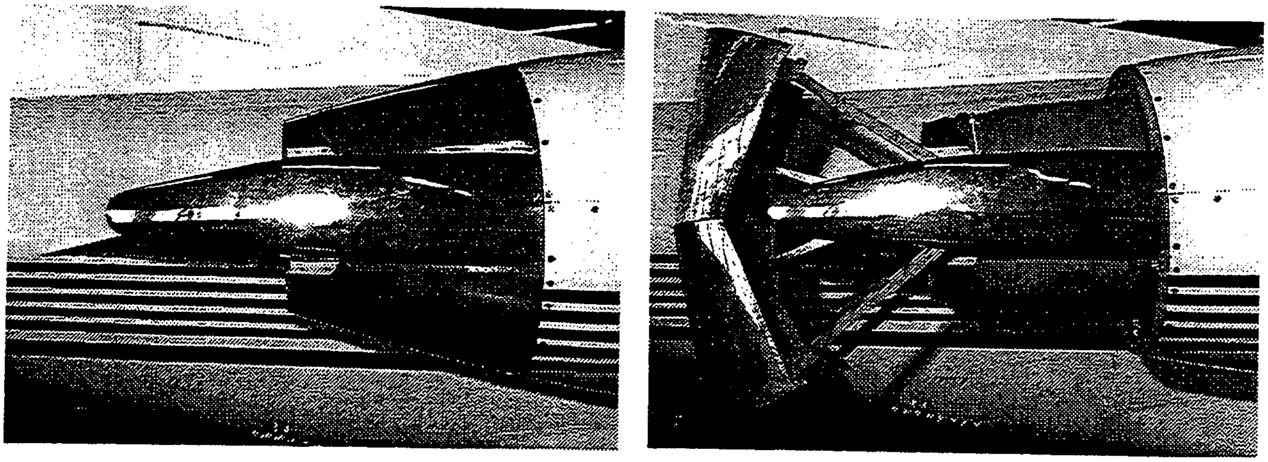
DEFINITIONS:

AGB	-	ACCESSORY GEAR BOX
△ MOP	-	MAIN OIL PESSURE (DIFFERENTIAL)
MOT	-	MAIN OIL TEMPERATURE
BRG	-	BEARING

6585X6133

Figure 2-2

THRUST REVERSER IN STOWED AND DEPLOYED POSITIONS



6585P6122
6585P6123

Figure 2-3

NORMAL OPERATION

The reverser system is designed for two-position operation: stowed during takeoff and flight and deployed during landing ground roll. The reversers are activated by pilot operation of the thrust reverser throttle levers and deployed by hydraulic pressure supplied by an engine-driven pump and directed to the drive actuators. The actuators are connected to a slider mechanism which is in turn connected to the reverser doors by a four-bar linkage system. The system, by design, incorporates an overcenter feature in the linkage which locks the reverser in the stowed position.

Hydraulic actuators are mounted to the support casting on each side of the reverser. The airplane hydraulic system provides pressure to these actuators which in turn operate the linkage system along a sliding track in the support casting to deploy and stow the reversers.

Control of the individual thrust reverser is through the reverse thrust lever mounted on each of the engine throttles. The reversers can only be deployed when the primary throttle levers are in the idle thrust position and the airplane is on the ground as sensed by either of the main gear squat switches. The reverse thrust lever also controls engine thrust during reverse thrust operation.

An automatic system is incorporated in the installation to reduce engine power approximately to idle if an inadvertent deployment, or stowage, of the thrust reverser should occur.

THRUST REVERSER HYDRAULIC SYSTEM SCHEMATIC

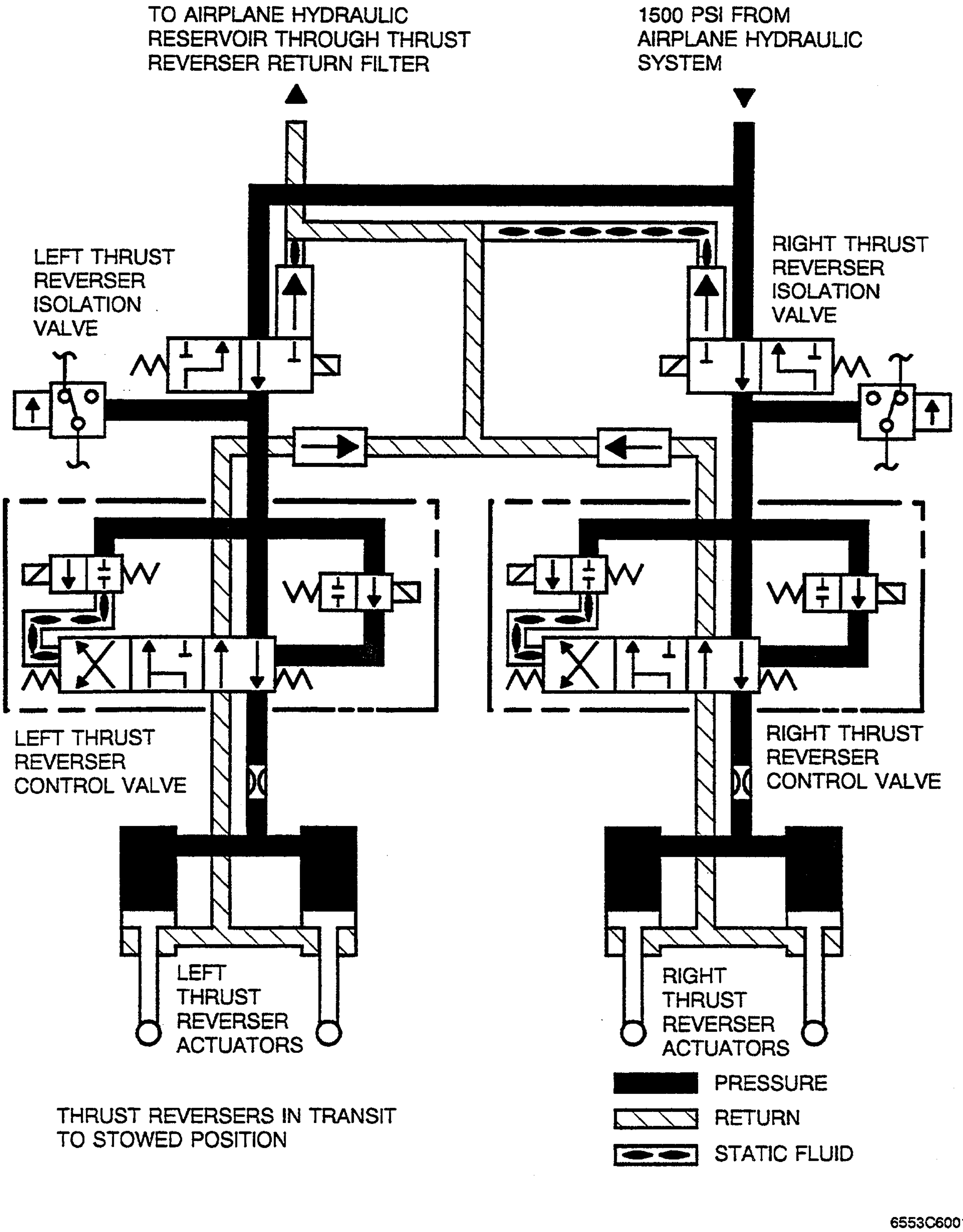


Figure 2-4 (Sheet 1 of 3)

THRUST REVERSER HYDRAULIC SYSTEM SCHEMATIC

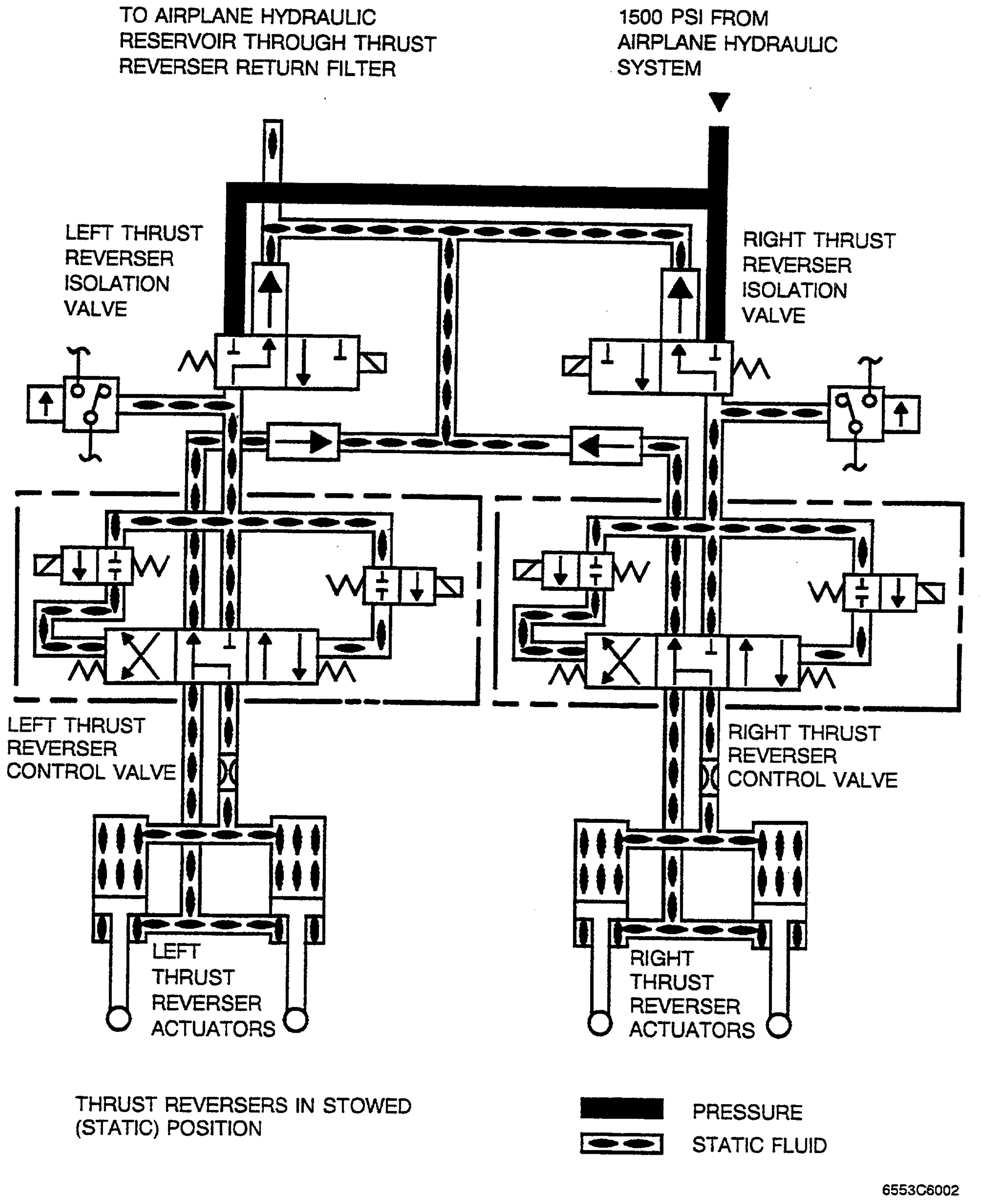
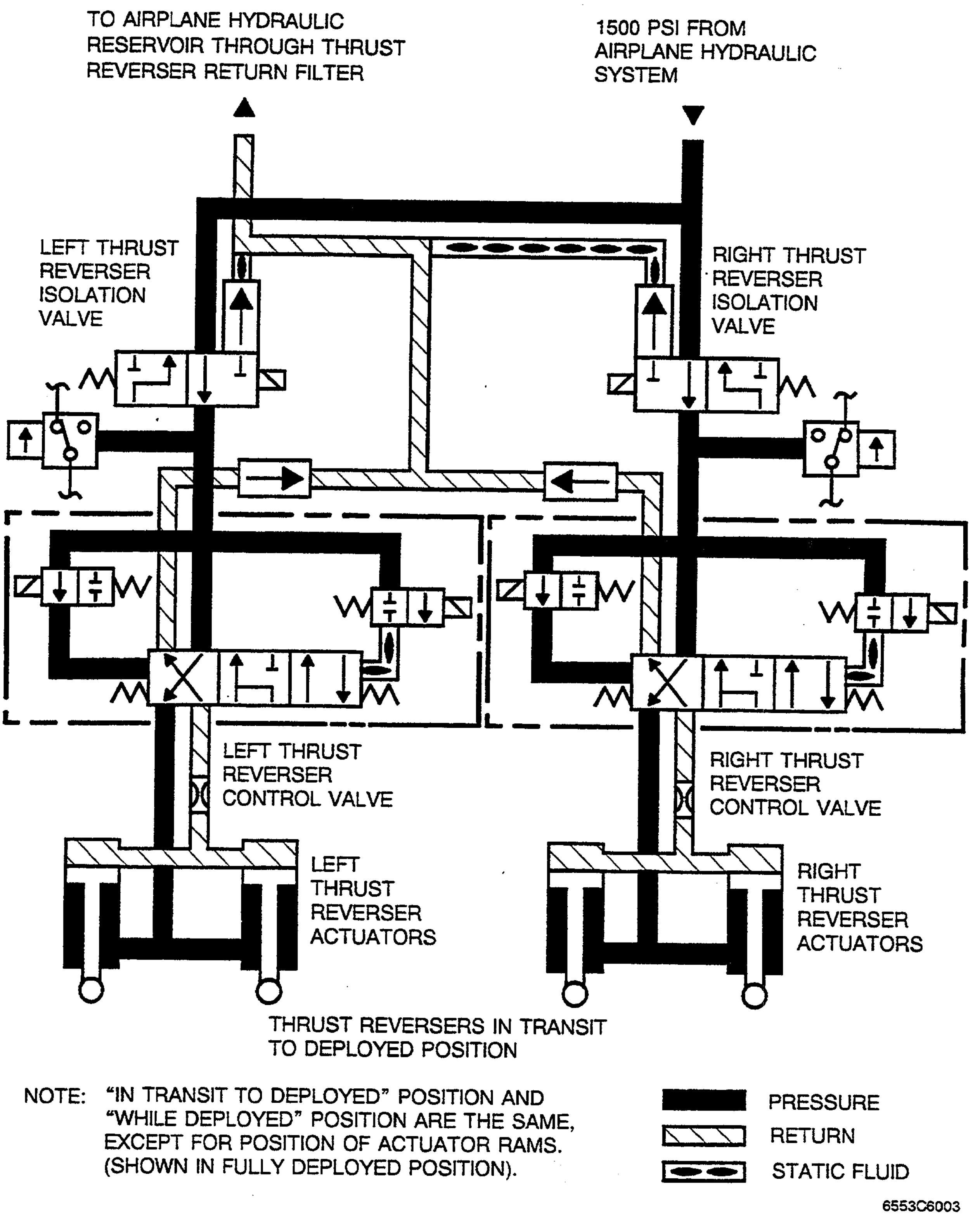


Figure 2-4 (Sheet 2)

THRUST REVERSER HYDRAULIC SYSTEM SCHEMATIC



NOTE: "IN TRANSIT TO DEPLOYED" POSITION AND "WHILE DEPLOYED" POSITION ARE THE SAME, EXCEPT FOR POSITION OF ACTUATOR RAMS. (SHOWN IN FULLY DEPLOYED POSITION).

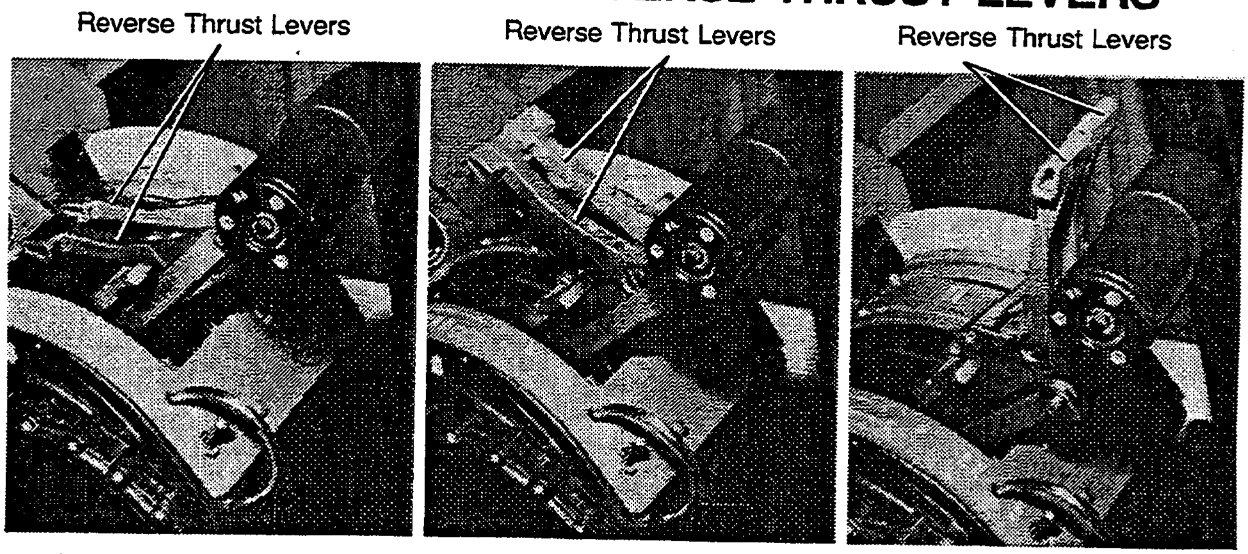
Figure 2-4 (Sheet 3)

In the event of an inadvertent thrust reverser deployment, an automatic throttle retarding device will bring the throttle to approximately idle thrust depending on the amount of throttle friction that has been applied. after this device has activated, the throttle lever can be advanced resulting in corresponding reverse thrust. It is possible for a pilot, with hand on the throttle levers, to override the retraction mechanism resulting in corresponding reverse thrust should inadvertent deployment occur. Subsequent reduction of the throttle lever to idle will not result in engine flameout unless mechanical damage has resulted from the deployment.

WARNING

DO NOT USE THROTTLE FRICTION OR MANUALLY RESTRAIN THE THROTTLE LEVERS DURING TAKEOFF. SHOULD AN INADVERTENT THRUST REVERSER DEPLOYMENT OCCUR, THIS COULD RESULT IN A DANGEROUS ASYMMETRICAL THRUST CONDITION.

THROTTLES WITH REVERSE THRUST LEVERS



Thrust Reversers Stowed
Idle Thrust

Thrust Reversers Deployed
Idle Thrust

Thrust Reversers Deployed
Max Reverse Thrust

6585P6020
6585P6021
6585P6022

Figure 2-5 (Sheet 1)

WARNING

SHOULD AN INADVERTENT THRUST REVERSER DEPLOYMENT OCCUR, THE PILOT MUST ENSURE THAT THE THROTTLE LEVER IS IN THE IDLE POSITION.

Moving the reverse thrust lever from the STOWED to the IDLE REVERSE position actuates the deploy cycle. This electrically opens the isolation valve, moves the reverser control to deploy and pressurizes the airplane hydraulic system. The isolation valve allows the airplane hydraulic system to pressurize the thrust reverser system. The amber ARM light indicates hydraulic pressure to the reverser control valve as sensed by a pressure switch.

During thrust reverser deployment, the initial movement of the actuators activates the unlocked switches. Either switch will cause the amber UNLOCK light to illuminate. Further movement of the actuator unlocks the reverser through the overcenter linkage. The remaining travel of the actuators deploys the reverser doors.

At full deployment of the reverser, the deploy switch is activated which in turn illuminates the white DEPLOY light and unlocks the pedestal-mounted throttle lock-out cam. The purpose of the lock-out cam is to prevent increasing engine thrust, once reverser deployment has been selected, until the reversers have fully deployed.

THRUST REVERSER EMERGENCY STOW SWITCHES AND INDICATOR LIGHTS

A2198

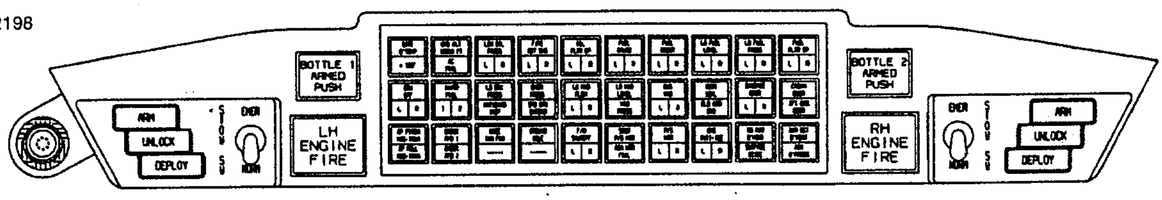


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Figure 2-6

Three reverser indicator lights for each reverser are mounted on the cockpit glareshield for monitoring reverse functions: ARM, UNLOCK and DEPLOY.

NOTE

The DEPLOY light shall illuminate in less than 1.5 seconds after the hydraulic UNLOCK light illuminates. An erroneous sequencing or a delay in the illumination of the thrust reverser lights indicates a failure in the thrust reverser system. Either or both conditions requires a maintenance check.

WARNING

DO NOT ATTEMPT TO FLY THE AIRPLANE IF THE THRUST REVERSER PREFLIGHT CHECK IS UNSUCCESSFUL.

As previously mentioned, either of the landing gear squat switches must be activated to complete the electrical circuit necessary to initiate deployment of the thrust reversers.

The thrust reverser lever(s) should not be placed in the idle reverse detent position in flight since a single failure of either squat switch could permit deployment of the thrust reverser(s). If the thrust reverser lever is placed in the idle reverse detent position while airborne, the airplane MASTER WARNING light will flash along with illumination of the ARM and HYD PRESS ON annunciator lights. A MASTER WARNING light, when thrust reversers are moved to deploy on the ground, means that neither landing gear squat switch has activated. To ensure actuation of the squat switches and to eliminate any delay in the deployment of the thrust reversers, it is recommended that the speed brakes be extended immediately following touchdown.

After deployment, power may be increased by moving the thrust reverser throttle levers aft for maximum reverse thrust. Thrust reverser throttle stops are set for approximately 80% N_2 (turbine) RPM. These stops will allow the pilot to keep his/her attention on the landing rollout instead of diverting attention to the reverse power settings.

For increased aerodynamic drag on landing roll, it is suggested that the thrust reversers remain in the deployed idle reverse power position after reverse thrust power has been terminated at 60 KIAS unless loose pavement, dirt or gravel is present on the runway. Idle reverse thrust is capable of causing ingestion of small grit at very low ground speed.

To stow the thrust reversers, move the reverse thrust lever through the idle reverse detent to the stow position. This actuates a switch in the pedestal which moves the thrust reverser control valve to the stow position. Hydraulic pressure is directed by the valve to the two actuators in the reverser which move the thrust reverser doors to the stowed position. Initial movement of the linkage toward the stowed position deactivates the deploy switch extinguishing the DEPLOY light. As each actuator moves to the fully stowed and locked position, they deactivate a thrust reverser unlocked switch. When both switches in a reverser have been deactivated, the UNLOCKED light is extinguished, the airplane hydraulic system is depressurized and the affected thrust reverser isolation valve closes. This puts the ARM light out as the pressure in the line downstream of the isolation valve drops.

The thrust reversers are not to be used during touch and go landings. A full stop landing must be made once reverse thrust has been selected. Less distance is required to stop, even on a slick runway, once the reversers have been deployed, than is required to restow the reversers and takeoff.

Landings with a crosswind component of 20 knots at 30 feet above runway were demonstrated. Adequate control of the airplane was maintained during and after thrust reverser deployment. Single-engine reversing has been demonstrated during normal landings and is easily controllable.

EMERGENCY STOW OPERATION

An emergency stow switch for each thrust reverser is located on the cockpit glare shield and will provide the same stow sequence (using the alternate 28 Volt thrust reverser power source) as the thrust reverser throttle levers, in the event of a failure of the pedestal-mounted deploy and stow switch, or of the respective 28 volt direct current (VDC) bus.

Each emergency stow switch receives its electrical power through the opposite thrust reverser circuit breaker. The emergency stow function can be checked on the ground by deploying the reversers normally and then actuating each emergency stow switch. The DEPLOY and UNLOCK lights shall extinguish. The ARM and HYD PRESS ON lights remain illuminated. Return the thrust reverser lever to stowed position, then turn each emergency stow switch off. All lights shall be extinguished.

FIRE PROTECTION

Engine fire detection consists of a closed-loop sensing system and detector control unit which illuminates the respective red ENG FIRE warning light on the cockpit glare shield if a fire or overheat condition is present. The warning light, under a transparent, spring-loaded guard, also serves as a firewall shutoff switch.

FIRE DETECTION INDICATING LIGHTS

A2199

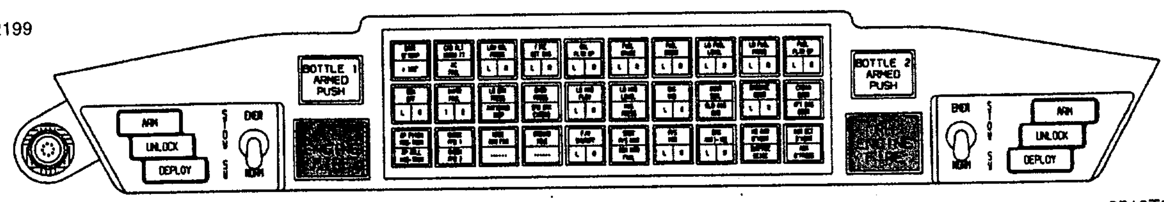

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Figure 2-7

Lifting the guard and depressing the warning light simultaneously closes the respective firewall fuel and hydraulic valves, deenergizes the starter/generator and arms the two freon extinguishing bottles. Firewall shutoff and extinguisher arming are indicated by illumination of the respective LO FUEL PRESS, HYD PRESS, F/W SHUT OFF and GEN OFF annunciator panel lights and both white BOTTLE ARMED lights.

ENGINE FIRE EXTINGUISHING SYSTEM

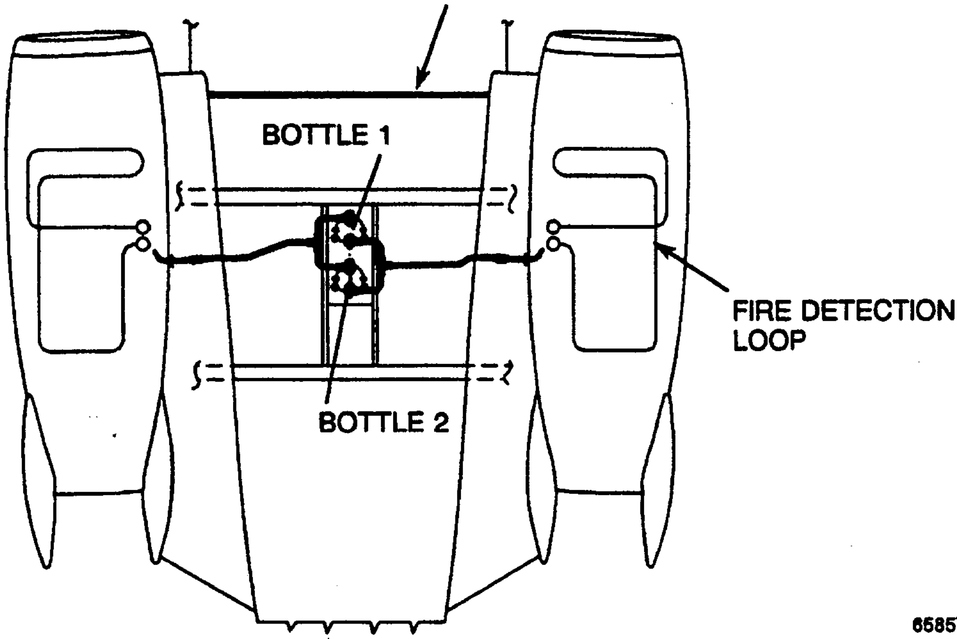

Figure 2-8

Once armed, either bottle may be discharged to the selected engine by pushing the BOTTLE ARMED light. The light will go out as the light is pushed. System plumbing is such that both bottles can be directed to the same engine if necessary.

Function of the lights and continuity of the sensor and detector control units is checked by placing the rotary TEST selector in the FIRE WARN position and observing illumination of both red lights. Depressing either fire light will then illuminate both BOTTLE ARMED lights. Since the BOTTLE ARMED lights will come on each time the system is tested or initially activated regardless of freon quantity, it is necessary to check proper bottle servicing on the sight gauges in the tailcone compartment during preflight inspection.

The fire detection system is equipped with an amber FIRE DET SYS annunciator light on the annunciator panel. if the fire detection system becomes inoperative due to lack of continuity (an open circuit) in the closed loop sensor, the annunciator will illuminate.

All test, detection and extinguishing features are electrically powered from the main Direct Current (DC) buses requiring either external power, the battery switch in BATT, or a generator on the line for operation.