21 Environmental Systems

CHAPTER 21

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GENERAL - DESCRIPTION AND OPERATION

PRESSURIZATION SYSTEM

Pressurized air for the cabin is taken downstream from the turbocharger compressor of each engine and reduced to a usable flow by a sonic nozzle (or venturi). When sonic velocity is reached by the air flowing through the throat of the nozzle, each engine is producing the maximum flow rate of 4 to 5 pounds per minute. Total air flow from both engines will deliver approximately 8 to 10 pounds per minute and maintain a cabin pressure differential of 4.6 psi.

The air then passes through a firewall shutoff valve, through an intercooler and into the cabin beneath the pilot and copilot floorboards. The intercooler reduces the heat acquired by the air during pressurization with a flow of ram air from a scoop at the leading edge of each wing root. Within the cabin pressure vessel a check valve is installed at each pressurization outlet. In the event of an engine failure at altitude the check valve will close on the dead engine side, preventing a loss of cabin pressurization.

Located on the forward side of the aft pressure bulkhead (P-3 through P-246) and on the aft side of the aft pressure bulkhead (P-247 and after) are two valves; the differential control valve and the safety/dump valve. A pressurization controller on the right subpanel pneumatically regulates the differential control valve to maintain the selected cabin altitude.

AIR CONDITIONING SYSTEM

The optional air conditioning system is a recirculating air cooling system containing a 16,000 BTU refrigerative type cooler. The unit is controlled by an automatic temperature control and three sensing elements.

A six position mode switch controls the heater and air conditioner system; however, each system operates independently of the other. When placed in AUTO position, the temperature is automatically controlled through the temperature controller located on the forward pressure bulkhead above the pilot pedals. It also regulates the cabin temperature variations monitored at the sensing units. The sensing units are located in the ram air inlet, heater outlet duct and forward of the two pressure control valves on the rear pressure bulkhead. When placed in the MANUAL COOL HI position, the switch bypasses the automatic controls and allows maximum air conditioning output. The maximum output is limited by an evaporator thermal switch and an overpressure switch. The MANUAL COOL LO position allows a hot-gas bypass valve (if installed) to be cycled on and off by a timer. The bypass valve regulates the flow of the refrigerant to the condenser allowing partial cooling of the cabin.

On serials P-123, P-127 and after, and prior airplanes which have complied with Service Instructions 0320-426 a MANUAL COOL position replaces the MANUAL COOL HI and LO positions on the mode selector switch. Two BLOWER positions are placed on the mode switch to allow the blower to be selected without cycling through the opposite mode.

The air scoop and ramp assembly located in the upper RH nacelle controls the air circulation through the condenser compartment and is completely automatic. The air scoop and ramp assembly has three positions; "closed" (when the air conditioning is not in use), "flight" (air scoop extended about 2 inches above the nacelle), and "ground" (air scoop fully extended). When the air conditioning is turned on, a switch incorporated on the landing gear selects air scoop position; gear down, the air scoop will open to the "ground" position; gear off the ground, the air scoop will open or lower to the "flight" position. The condenser fan, which is wired in circuit with the landing gear uplock switch, operates only when the air conditioning mode is selected and the airplane is on the ground.

The air conditioning system is similar to many home and automotive units and consists of six major components. The belt-driven compressor, which is coupled by a magnetic clutch, compresses the refrigerant to a high pressure, high temperature gas. This gas passes through the condenser where cooling air removes heat from the gas, condensing it to a liquid state. The liquid is then passed through the receiver-dryer where any moisture or foreign material is removed from the system. The refrigerant flows to the expansion valve where it is metered into the evaporator at a rate which allows all the liquid to return to a gas. The heat required for evaporation is absorbed from the cabin air passing over the evaporator coils. After passing through the evaporator, the refrigerant returns to the compressor at a reduced pressure. For partial cooling, a hot gas bypass valve allows a portion of the gas to bleed off from the condenser, cycling back through the compressor.

NOTE

Beginning with airplane serials P-123, P-127 and after, and prior airplanes having installed Kit Number 60-5006, the hot gas bypass valve, line and suction accumulator were removed from the system.

An overpressure switch and a pressure relief valve are incorporated into the system to regulate system (compressor discharge) pressure. The overpressure switch is located in the condenser compartment of the right nacelle and is set to actuate at 375 ± 10 psi. When this switch is actuated, power is removed from the compressor magnetic clutch and the 3 amp fuse is shorted through a resistor to the airplane structure. The fuse is thus opened, preventing further operation of the compressor magnetic clutch and the compressor until the system has been serviced. A pressure relief valve, located on the compressor discharge line immediately before it enters the condenser, is set to bleed off pressure at 450 psi.

On airplane serials, P-275 and after, and on those prior airplanes which are in compliance with the Service Instructions 0599-427, a low pressure switch is installed on the evaporator. This switch is designed to actuate when the refrigerant pressure drops to 7 ± 1 psi. The actuation of the low pressure switch shorts the 3 ampere fuse to airplane structure through the resistor located near the evaporator. The fuse, located in the right nacelle, is thus opened, preventing further operation of the compressor magnetic clutch and the compressor until the air conditioner system has been serviced.

NOTE

The low pressure switch which was originally installed on airplane serials P-275 through P-292 and P-294, prior to compliance with Service Instructions 0599-427, actuated at a pressure of 18 ± 2 psi.

HEATER SYSTEM

The heater system consists of a 45,000 BTU combustion air heater, (located under the nose baggage compartment floor), a six position mode switch, vent air blower, combustion air blower, heater fuel pump, five outlets, an automatic temperature control and three sensing elements.

In flight, when pressurized, the vent blower obtains air through the cabin air check valve, forces it through the heater and to the cabin outlets. In the unpressurized mode, in flight and for ground operations, the vent blower obtains air from the cabin and the ram air plenum chamber and forces it through the heater and to the cabin outlets.

On serials P-3 through P-126, except P-123, a vent air distribution bypass valve, located on the forward pressure bulkhead, allows air to be directed into the pilot's compartment area and is regulated by a control knob on the pilot's left subpanel.

"END"

TROUBLESHOOTING PRESSURIZATION SYSTEM (P-3 THRU P-307)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
1. Unable to pressurize	a. Cabin altitude control inoperative.	a. Check by isolating control from system (see PRESSURIZATION TEST PROCEDURE in this chapter).
	b. Differential control valve inoperative.	b. Check by isolating control valve from system (see PRESSURIZATION TEST PROCEDURE in this chapter).
	c. Dump solenoid stuck in open position.	c. Cycle pressure circuit breaker, listen for operation of dump solenoid; replace if inoperative.
	d. Vacuum solenoid stuck in open position.	d. Cycle pressure circuit breaker, listen for operation of vacuum solenoid; replace if inoperative.
	e. Cabin altitude control sense line restricted.	e. Disconnect sense line at both ends and purge.
	f. Differential control valve seats dirty.	f. Clean the valve seats with a lint-free cloth moistened with alcohol. For additional information relating to overhaul and cleaning procedures refer to Component Maintenance Manual P/N 60-590001-27.
	g. Firewall shutoff valves pulled closed.	g. Open valves.
	h. Hole in flex ducts from engine.	h. Inspect and repair or replace as required.
	i. Excessive pressure leaks in cabin, (door seal etc.)	i. Check cabin for leaks; repair as required.
2. No pressure indication on ground.	a. Press-to-test switch inoperative.	a. Replace switch.
	b. Rate-of-climb indicator inoperative.	b. Replace indicator.
	c. Dump switch in dump position.	c. Place switch in pressure position.
	d. Manifold pressure too low during check.	d. Increase manifold pressure to a minimum of 20 in. Hg.

TROUBLESHOOTING
PRESSURIZATION SYSTEM (Cont'd)
(P-3 THRU P-307)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
3. Maximum cabin differential pressure exceeds 4.6 psi.	a. Differential control valve inoperative.	a. Clean valve as described in the Component Maintenance Manual, P/N 60-590001-27, or replace valve.
	b. Cabin altitude and differential pressure indicator inoperative.	b. Replace indicator.
	c. Ambient air sense line between safety and differential control valve leaking.	c. Inspect lines and fittings; tighten or replace as required.
4. Maximum cabin differential pressure exceeds 4.9 psi.	a. Safety valve and differential control valve inoperative.	a. Clean valve as described in the Component Maintenance Manual, P/N 60-590001-27, or replace valve.
	b. Ambient air sense line between safety and differential control valve ruptured, loose fittings.	b. Inspect lines and fittings; tighten or replace as required.
5. Cabin pressure slow to respond to change in selected cabin altitude.	a. Cabin altitude control sense line kinked or restricted.	a. Inspect and repair or replace as required.
	b. Cabin altitude control filter clogged.	b. Replace filter.
6. Cabin altitude higher than selected altitude.	a. Cabin altitude controller out of adjustment.	a. Adjust controller.
	b. Cabin altitude indicator inoperative.	b. Replace indicator.
	c. Cabin altitude control sense line kinked or restricted.	c. Inspect and repair or replace as required.
	d. Cabin altitude control inoperative.	d. Replace control.
	e. Cabin altitude control filter restricted.	e. Clean filter.
7. Cabin altitude lower than selected altitude (not exceeding maximum cabin differential pressure).	a. Cabin altitude controller out of adjustment.	a. Adjust controller.
	b. Cabin altitude control sense line leaks.	b. Inspect and repair or replace as required.

TROUBLESHOOTING
PRESSURIZATION SYSTEM (Cont'd)
(P-3 THRU P-307)

TROUBLE	PROBABLE CAUSE	REMARKS
7. Cabin altitude lower than selected altitude (Not exceeding maximum cabin differential pressure).	c. Cabin altitude indicator inoperative.	c. Replace indicator.
8. Cabin pressure fluctuation.	a. Valve seats dirty.	a. Clean the valve seats with a lint-free cloth moistened with alcohol. For additional information relating to overhaul and cleaning procedures refer to Components Maintenance Manual P/N 60-590001-27.
9. Cabin pressure fluctuates when deice system is cycled (with dump switch in either dump or pressure mode).	a. The check valve in the differential control valve vacuum line is installed backward.	a. Install check valve properly.
	b. Check valve is dirty.	b. Clean check valve.
10. Cabin pressure fluctuates with dump switch in dump mode.	a. Vacuum solenoid inoperative	a. Replace vacuum solenoid.
	b. Dump solenoid inoperative.	b. Replace safety valve.
11. Pressure circuit breaker tripped.	a. Dump solenoid shorted.	a. Locate cause, repair and reset circuit breaker.
	b. Vacuum solenoid shorted.	b. Locate cause, repair and reset circuit breaker.
	c. Press-to-test switch shorted.	c. Locate cause, repair and reset circuit breaker.
	d. Landing gear safety switch shorted.	d. Locate cause, repair and reset circuit breaker.
	e. Wire harness shorted.	e. Locate cause and repair.
	f. Wire harness improperly installed.	f. Inspect and rewire as required.
	g. Pressure circuit breaker inoperative.	g. Replace circuit breaker.
12. Airplane pressurizes on ground.	a. Landing gear safety switch inoperative.	a. Replace switch.
	b. Open lead in wire bundle.	b. Locate and repair.

TROUBLESHOOTING PRESSURIZATION SYSTEM (Cont'd) (P-3 THRU P-307)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
12. Airplane pressurizes on ground.	c. Circuit breaker tripped.	c. See "11" above.
	d. Press-to-test switch inoperative.	d. Replace switch.

TROUBLESHOOTING PRESSURIZATION SYSTEM (P-308 AND AFTER)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
1. Unable to pressurize.	a. Cabin altitude controller inoperative.	a. Check by performing PRESSURIZATION TEST.
	b. Outflow valve inoperative.	b. Check by performing PRESSURIZATION TEST.
	c. Dump valve solenoid stuck in open position.	c. Cycle pressurization system circuit breaker, check for operation of solenoid; replace if inoperative.
	d. Shutoff solenoid in cabin controller supply line stuck in closed position.	d. Cycle pressurization system circuit breaker, check for operation of solenoid; replace if inoperative.
	e. Outflow valve control line restricted.	e. Check for restrictions; repair or replace.
	f. Outflow valve and safety valve seats dirty.	f. Clean the valve seats with a lint-free cloth moistened with isopropyl alcohol.
	g. Firewall shutoff valves pulled closed.	g. Open valves.
	h. Hole in flex ducts from engine.	h. Inspect and repair or replace as required.
	i. Excessive pressure leaks in cabin (door, seal, etc.)	i. Check cabin for leaks; repair as required.

TROUBLESHOOTING
PRESSURIZATION SYSTEM (Cont'd)
(P-308 and after)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
2. No pressure indication on ground.	a. Pressurization system switch inoperative.	a. Replace switch.
	b. Rate-of-climb indicator inoperative.	b. Replace indicator.
	c. Manifold pressure too low during check.	c. Increase manifold pressure to a minimum of 20 in. Hg.
3. Maximum cabin differ-ertial pressure exceeds 4.6 psi.	a. Cabin altitude and differential pressure indicator inoperative.	a. Replace indicator.
	b. Safety valve and out-flow valve out of adjustment.	b. Replace valves.
	c. True static air vent tubes loose or damaged.	c. Inspect lines and fittings; tighten or replace as required.
4. Cabin pressure slow to respond to change in selected cabin altitude.	a. Cabin pressurization control supply line or the outflow valve control line kinked or restricted.	a. Inspect lines and fittings; repair or replace as required.
	b. Cabin pressurization controller filter restricted.	b. Clean filter.
5. Cabin altitude higher than selected altitude.	a. Cabin altitude con-troller out of adjustment.	a. Replace controller.
	b. Cabin altitude indicator inoperative.	b. Replace indicator.
	c. Cabin pressurization controller inoperative.	c. Replace controller.
	d. Cabin pressurization controller filter restricted.	d. Clean filter.
	e. Outflow valve control line kinked or restricted.	e. Inspect, repair as necessary.
6. Cabin altitude lower than selected altitude. (Not exceeding maximum differential pressure).	a. Cabin pressurization controller out of adjustment.	a. Replace controller.

TROUBLESHOOTING
PRESSURIZATION SYSTEM (Cont'd)
(P-308 and after)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
6. Cabin altitude lower than selected altitude (not exceeding maximum differential pressure).	b. Cabin altitude controller supply line or outflow valve control line leaks.	b. Inspect, repair or replace as required.
	c. Cabin altitude indicator inoperative.	c. Replace indicator.
7. Cabin pressure fluctuation.	a. Valve seats dirty.	a. Clean the valve seats with a lint-free cloth moistened with isopropyl alcohol.
8. Cabin pressurization system circuit breaker tripped.	a. Dump valve solenoid shorted.	a. Locate cause, repair or replace defective component, reset circuit breaker.
	b. Shutoff solenoid in cabin pressurization controller shorted.	b. Locate cause, repair or replace defective component, reset circuit breaker.
	c. Pressurization system circuit shorted.	c. Locate cause, repair or replace defective component, reset circuit breaker.
9. Airplane pressurizes on ground.	a. Landing gear safety switch inoperative or improperly rigged.	a. Replace or adjust the RH landing gear safety switch.
	b. Open circuit in cabin pressurization circuit.	b. Locate cause, repair or replace defective component.

TROUBLESHOOTING
HEATER SYSTEM

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
1. Heater fails to light.	a. Master switch or circuit breaker off.	a. Turn on master switch or close circuit breaker.
	b. Low voltage supply.	b. Apply external power supply. Attempt to start heater.
	c. Fuel cut off from tank.	c. Turn on manual shutoff valve (if used) or master solenoid.
	d. Suction leak ahead of pump.	d. Secure all fittings.
	e. Insufficient fuel pressure.	e. Low or no current to fuel pump. Check for operation of pump and remove for repairs if not operating.
	f. Regulator not operating properly.	f. Check for low pressure or replace regulator.
	g. Fuel pump operating but not building up sufficient pressure.	g. Remove and repair or replace fuel pump.
	h. Restriction in fuel nozzle orifice.	h. Remove the nozzle and clean or replace it.
	i. Fuel heater solenoid not operating.	i. Remove and check solenoid. Replace if faulty.
	j. Fuel lines clogged or broken.	j. Inspect all lines and connections. It may be necessary to disconnect lines at various points to determine where the restriction is located.
	k. Fuel filter clogged.	k. Clean fuel filter element.
	l. Ignition vibrator inoperative.	l. Replace vibrator; check for defective radio noise filter.
	m. Manual reset limit (overheat) switch open.	m. Press reset button firmly and recheck to determine reason for switch opening.
	n. Combustion air pressure switch open. (Defective switch or low combustion air blower output.)	n. Check for low blower output due to low voltage and correct it. If switch is defective, replace it.
	o. Cycling switch open.	o. Replace if defective.
	p. Duct switch open.	p. Operate control to see if switch will come on. Replace switch if defective.

TROUBLESHOOTING
HEATER SYSTEM (Cont'd)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
2. Ventilating air blower fails to run.	a. MASTER switch OFF. Broken or loose wiring to motor.	a. Energize the MASTER switch. Check and repair wiring.
	b. Circuit breaker open.	b. Close circuit breaker.
	c. Worn motor brushes.	c. Replace motor brushes.
	d. Blower wheel jammed.	d. Remove and check the ventilating air blower wheel and realign if necessary.
	e. Motor burned out.	e. Remove blower assembly and remove motor.
	f. Defective radio-noise filter.	f. Replace filter.
3. Combustion air blower fails to run.	a. Faulty wiring to motor.	a. Inspect and replace faulty wiring.
	b. Poor ground connection.	b. Tighten ground screw.
	c. Worn motor brushes.	c. Replace motor brushes.
	d. Blower wheel jammed. (Usually indicated by hot motor housing.)	d. Overhaul the combustion air blower.
	e. Defective radio-noise filter.	e. Replace filter.
	f. Faulty or burned-out motor.	f. Remove combustion air motor for overhaul or replacement of motor.
4. Heater fires but burns unsteadily.	a. Insufficient fuel supply.	a. Inspect fuel supply to heater including shut-off valve, solenoid valve, fuel filter, fuel pump and fuel lines. Make all necessary repairs.
	b. Spark plug partially fouled.	b. Replace spark plug.
	c. Loose primary connection at ignition assembly.	c. Tighten the connection.
	d. Faulty vibrator.	d. Replace the vibrator.
	e. Combustion air blower speed fluctuates. (Can be caused by low voltage, loose blower wheel, worn brushes or motor.)	e. Remove and overhaul the combustion air blower assembly as required or correct low voltage condition.

TROUBLESHOOTING
HEATER SYSTEM (Cont'd)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
4. Heater fires but burns unsteadily (Cont'd).	f. High-voltage leak in lead between ignition assembly and spark plug.	f. Replace ignition assembly.
	g. Inoperative ignition assembly.	g. If vibrator is in good condition, replace ignition assembly only.
	h. Restriction in fuel nozzle orifice.	h. Remove nozzle for cleaning or replacement.
	i. Nozzle loose in retainer or improper spray angle.	i. Tighten or replace the nozzle as required.
5. Heater starts then goes out.	a. Lack of fuel at heater.	a. Check fuel supply through all components from the tank to the heater. Make necessary corrections.
	b. Inoperative or chattering combustion air pressure switch.	b. Check, adjust, or replace switch.
	c. Inoperative overheat switch.	c. Check or replace switch.
	d. Inoperative cycling switch.	d. Adjust or replace the switch.
	e. Low voltage.	e. Attach external power.
6. Heater fails to shut off.	a. Fuel solenoid valve in heater stuck open.	a. Remove and replace solenoid assembly.
	b. Inoperative duct and cycling switch.	b. Check and repair.
	c. Defective MASTER switch.	c. Replace the MASTER switch.

AIR CONDITIONING SYSTEM

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
1. Insufficient cooling.	a. Blower not functioning.	a. Repair.
	b. Obstructed or disconnected air duct.	b. Remove obstruction or repair.
	c. Compressor clutch or belt slipping.	c. Repair or adjust.
	d. Evaporator filter clogged.	d. Replace.
	e. Refrigerant level low.	e. Leak-test and recharge.
	f. Hot gas bypass valve defective.	f. Replace.

TROUBLESHOOTING
AIR CONDITIONING SYSTEM (Cont'd)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
2. No cooling.	a. Loose connection.	a. Check connections, continuity.
	b. Blower not functioning.	b. Repair.
	c. Leak in system.	c. Leak-test and recharge.
	d. Compressor reed valves inoperative.	d. Repair or replace.
	e. Expansion valve stuck open.	e. Replace.
	f. Blown fuse.	f. Service air conditioning system. Check for over-pressure, purge and recharge if necessary. Leak-test and recharge if pressure is low.
3. Air conditioner will not operate in AUTO mode but will function in the MAN COOL mode.	a. Misadjustment of heater control box.	a. Replace.
	b. Malfunction of control box.	b. Replace.
	c. Malfunction of temperature sensing elements.	c. Replace.
4. Air conditioner runs constantly in either AUTO or MAN COOL.	a. Malfunction of temperature sensing elements.	a. Replace.
5. Excessive vibration of unit.	a. Overcharged.	a. Correct refrigerant charge.
	b. Air in system.	b. Purge and recharge system.
	c. Mount or compressor bolts loose.	c. Tighten.
	d. Drive pulley loose.	d. Tighten.
6. Noisy unit.	a. Compressor oil level low.	a. Add oil.
	b. Defective belt.	b. Replace.
	c. Low refrigerant level.	c. Add refrigerant.
	d. Excessive moisture in system.	d. Replace receiver-dryer and recharge.

TROUBLESHOOTING
AIR CONDITIONING SYSTEM (Cont'd)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
6. Noisy unit. (Cont'd)	e. Fan hitting shroud.	e. Align and tighten shroud.
	f. Defective compressor.	f. Replace.
7. Hissing in evaporator case.	a. Low charge.	a. Add refrigerant.
8. Chatter or knock in evaporator case.	a. Defective expansion valve.	a. Replace.
9. Belt slipping.	a. Loose	a. Adjust.
	b. Overcharged.	b. Correct refrigerant level.
	c. Air in system.	c. Evacuate and recharge.
10. Excessive belt wear.	a. Pulleys not in line.	a. Align pulleys.
	b. Belt too tight.	b. Adjust or replace.
	c. Pulley groove wrong size.	c. Replace.
	d. Belt width wrong.	d. Replace.
11. Broken belt.	a. Check all causes above.	a. Replace.

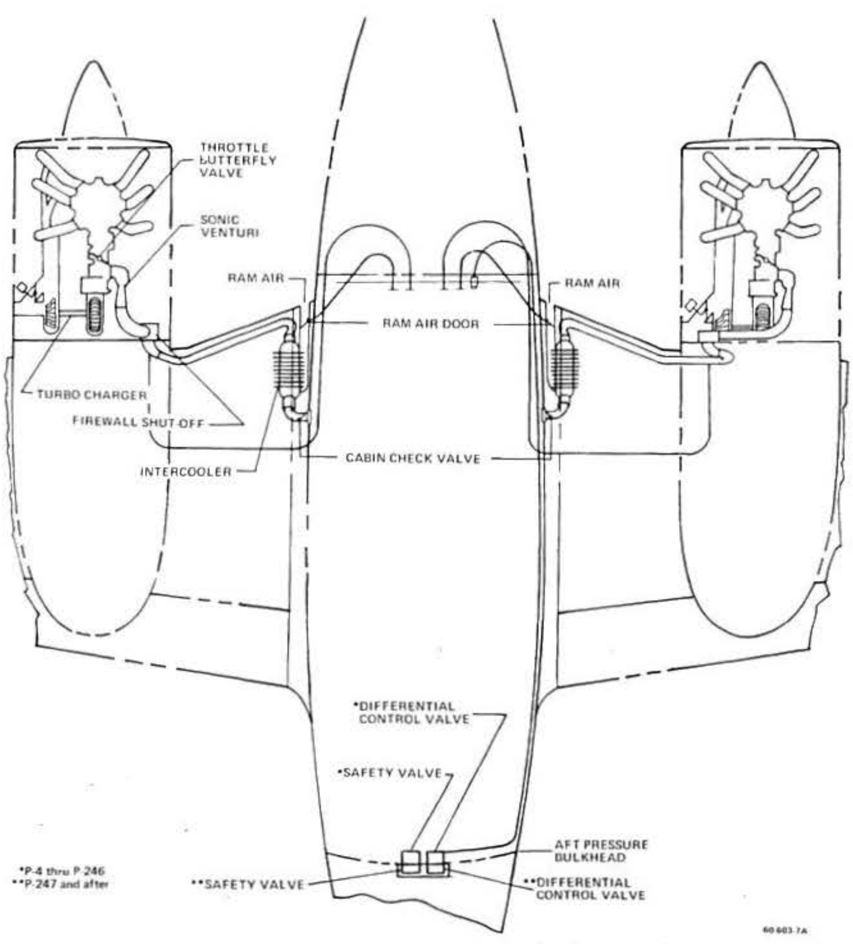
"END"

COMPRESSION - DESCRIPTION AND OPERATION

(Figure 1)

Pressurized air for the cabin is supplied by the turbocharger compressor mounted on the same shaft as the turbocharger. In operation, engine exhaust gas passing over the turbine wheel causes the turbocharger compressor to rotate. Ambient ram air, supplied through the RH cowl door, is filtered and routed to the compressor where it is compressed and delivered to the cabin through a sonic nozzle. When sonic velocity is reached by the air flowing through the throat of the nozzle, each engine is producing the maximum flow rate of 4 to 5 pounds per minute. Total air flow from both engines will deliver approximately 8 to 10 pounds per minute and maintain a cabin pressure differential of 4.6 psi.

A pressurization air intercooler, located in each wing root, is used for temperature control of pressurization air before it enters the cabin. Air flow through the intercoolers is controlled by a butterfly valve located in a ram air scoop under each wing root leading edge. The butterfly valves are manually actuated by the intercooler temperature controls located on the RH subpanel. For maximum temperature control and to reduce the load on the heating and air conditioning system, the intercooler temperature controls should be positioned in the closed position when the air condition system is in the HEAT mode and in the open position when in the COOL mode.



Pressurization System
Figure 1

"END"

COMPRESSION - MAINTENANCE PRACTICES

INTERCOOLER REMOVAL

a. Remove the fiberglass air intake duct located on the lower forward side of the wing stub.

b. Remove the skin panel under the air intake duct.

c. Loosen the clamps attaching the flex duct on each end of the intercooler.

d. Loosen the set screw and remove the push-pull control cable.

e. Remove the three lower screws and the upper bolt attaching the intercooler to the outboard wing stub rib.

f. Remove the intercooler through the bottom access opening.

INTERCOOLER INSTALLATION

a. Position the intercooler in place through the bottom access opening.

b. Install the three lower screws and the upper bolt attaching the intercooler to the outboard wing stub rib.

c. Attach the push-pull control cable and tighten the set screw.

d. Attach the flex duct on each end of the intercooler and tighten the clamps.

e. Install the skin panel under the air intake duct.

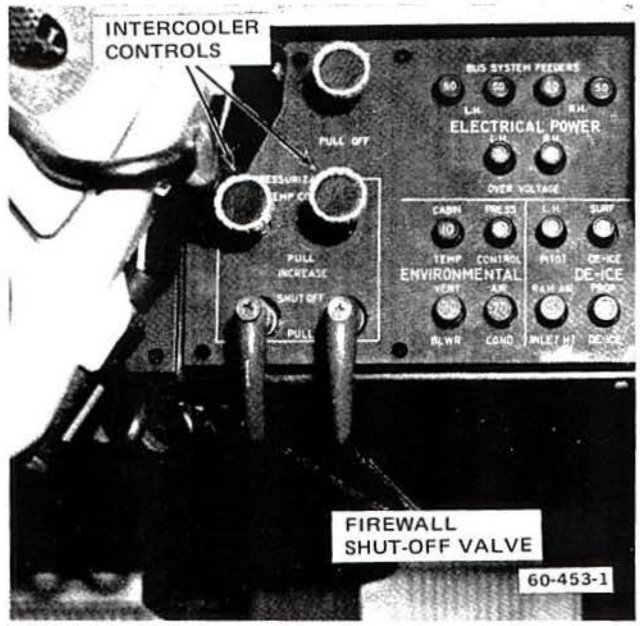
f. Install the fiberglass air intake duct and seal with EC 1792 sealant (Chart 205, Chapter 91-00-00).

INTERCOOLER CONTROL RIGGING
(Figure 201)

The controls used on the intercooler installation are the push-pull type. In the event the control needs minor adjustment, a set pin with a hole provided for the control wire, may be tightened if loose.

NOTE

Make an operational check of the push-pull control for correct adjustment and full travel.



Intercooler and Firewall Shut-off Valve Controls
Figure 201

FIREWALL SHUT-OFF VALVE
(Figure 201)

During normal flight operations, the FIREWALL SHUT-OFF VALVE controls are pushed in against the lower RH subpanel. This will allow maximum airflow to enter the cabin. In the event of a fire inside the engine cowl, immediately pull the red handled control out to the stop. This will shut off the air flow from the inoperable engine. A check valve located just inside the pressurization airflow inlet will close and prevent complete loss of cabin pressurization.

This control is preset at the factory and should not need any further adjustment.

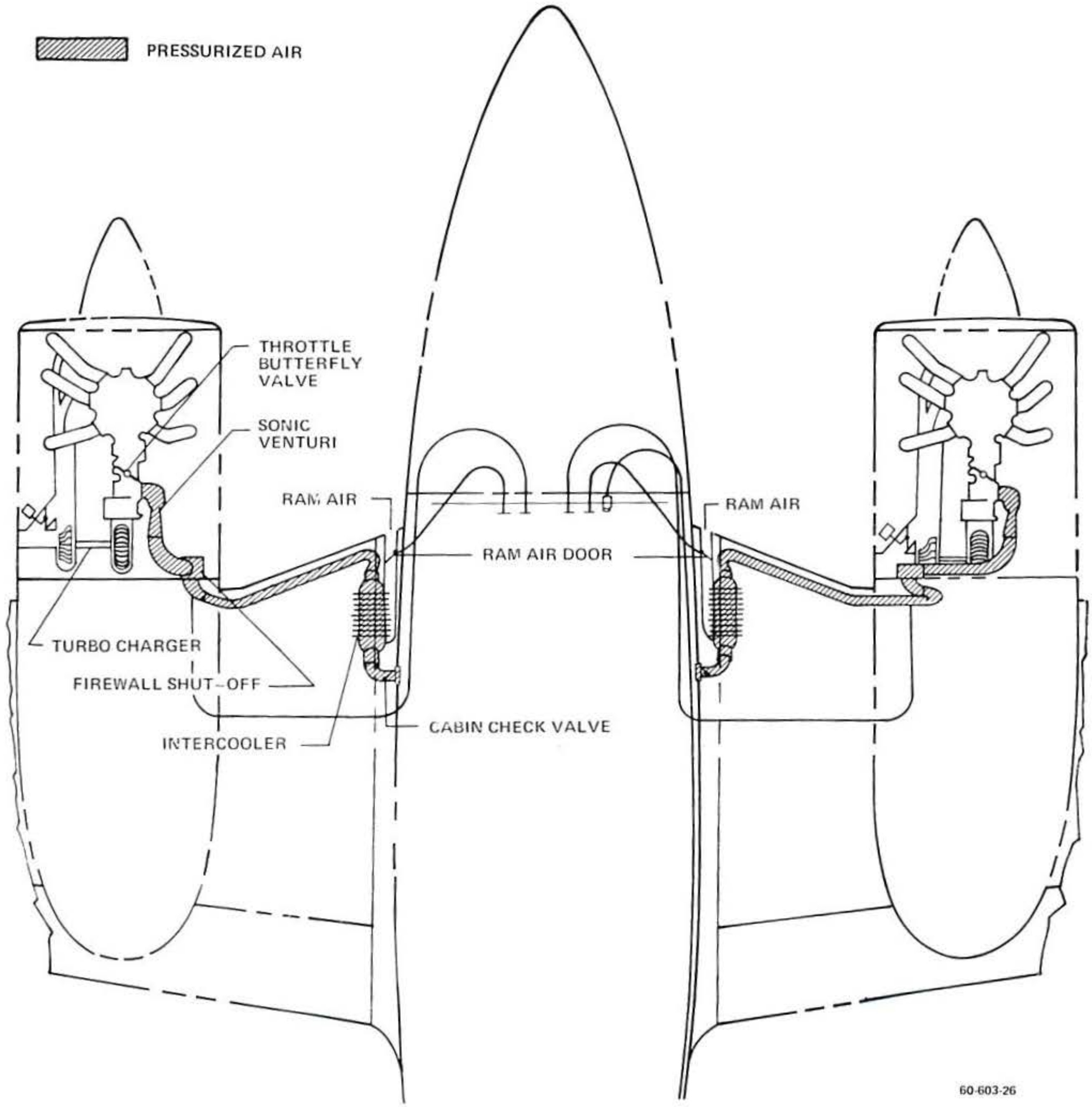
"END"

DISTRIBUTION - MAINTENANCE PRACTICES

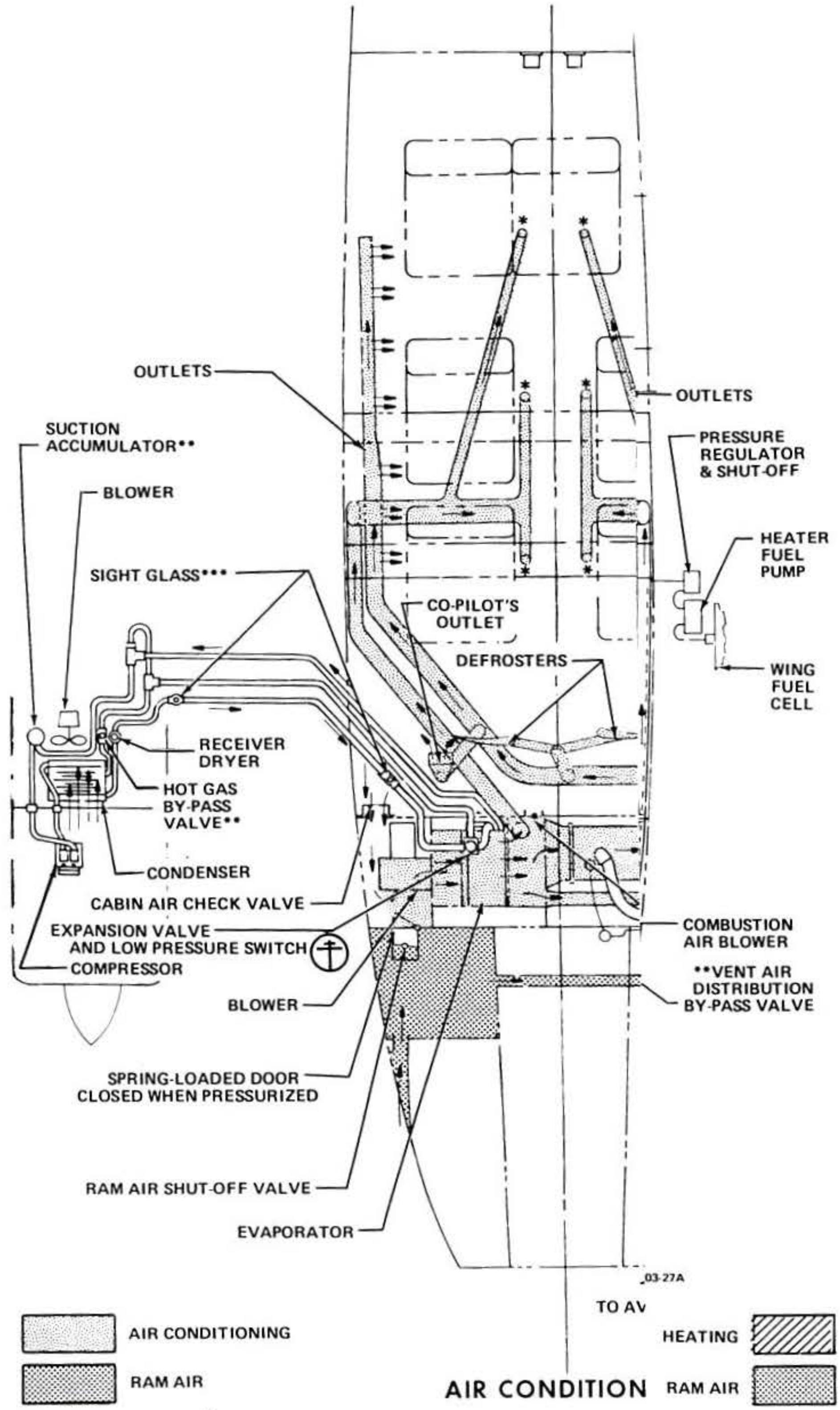
The functional diagrams on the following pages provide a detailed layout of the distribution system utilized by the various series of the Duke.

100-HOUR INSPECTION

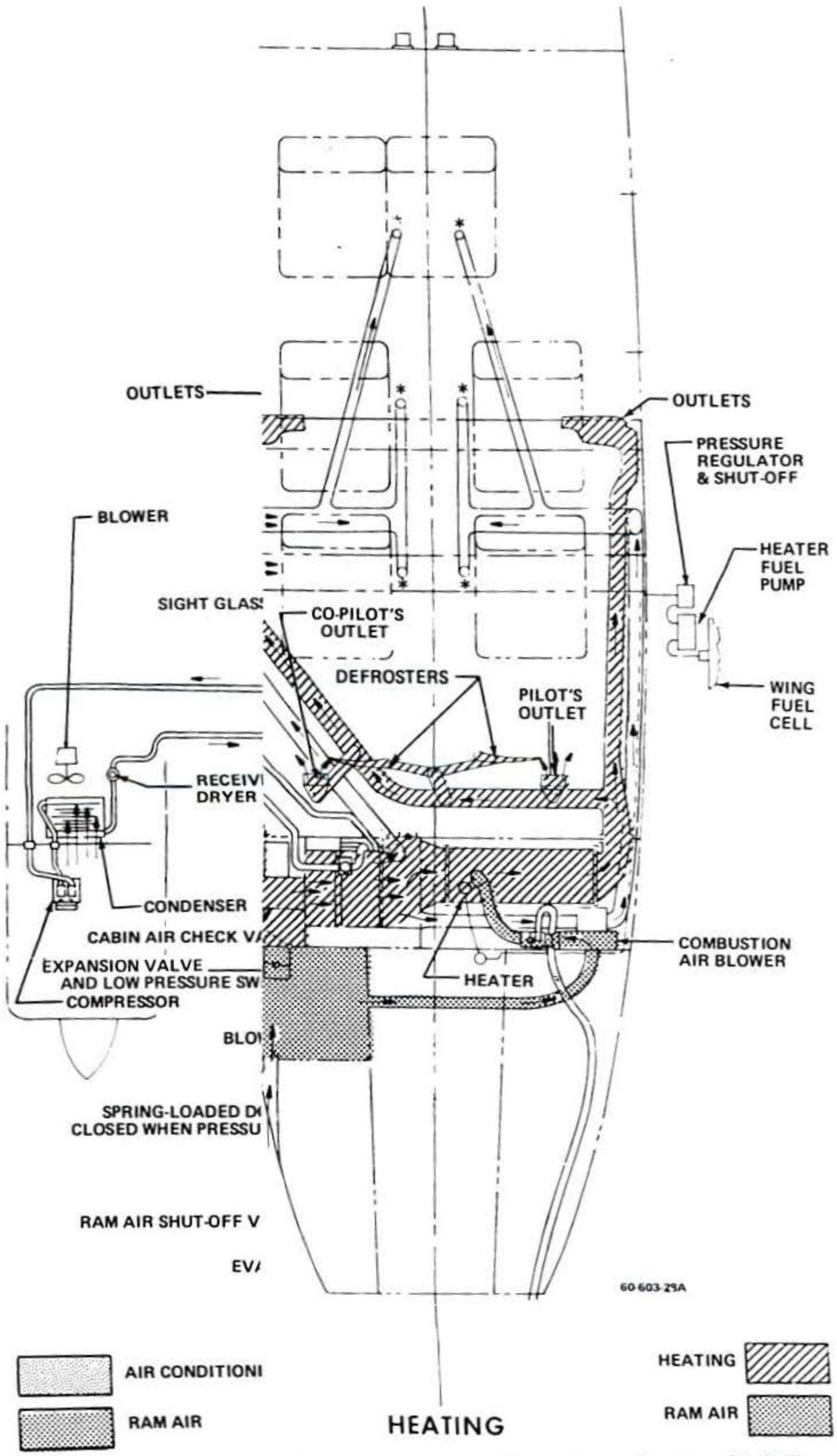
Distribution Ducts - Check cabin hot and cold air outlet valves for condition, obstructions and proper operation; check heating and cooling ducts for condition and attachment.



Pressurization Distribution System
Figure 201



Air Conditioning Distribution System (P-3 thru P-246)
Figure 202



Air Conditioning Distribution System (P-247 and after)
Figure 203

"END"

PRESSURIZATION CONTROL - DESCRIPTION AND OPERATION (P-3 THRU P-307)

Cabin altitude is selected and controlled by the cabin altitude controller, located on the RH subpanel. A standard, manual controller is utilized by the various series of the Duke which do not use the optional motorized controller. The optional motorized controller is utilized by the various series of the Duke as either a factory installed unit or upon compliance with Service Instructions 0479-453. The motorized controller is similar to the manual controller except in the method of changing cabin altitude. Both controllers employ an aneroid bellows-controlled valve to allow a calibrated amount of air flow to the control diaphragm of the differential control valve.

PRESSURIZATION SYSTEM OPERATIONAL CHARACTERISTICS

a. Power Changes - Normal application of power from a standing start or taxiing will produce a momentary fluctuation of the pressure level. A momentary fluctuation of 1,000 fpm (read on the cabin rate-of-climb indicator) is normal and should provide little or no passenger discomfort. This variation is minimized by slower application of power. More rapid application of power will cause a higher momentary fluctuation and is also considered normal.

b. Lift Off - As the airplane leaves the ground, a momentary cabin pressure fluctuation of as high as 1,500 fpm (1,000 fpm for airplane with a dashpot installed on safety valve) is considered normal and again will rarely produce passenger discomfort.

c. Altitude Control - As the airplane reaches and climbs through the pre-set altitude, the cabin rate-of-climb will slowly come to a zero point. As the cabin altitude and the selected altitude begin to come together (at the pre-set altitude), a pressure fluctuation may be noticed (1,000 fpm is normal). Stabilization of the two altitudes within 500 feet of each other can be expected until maximum differential pressure is reached.

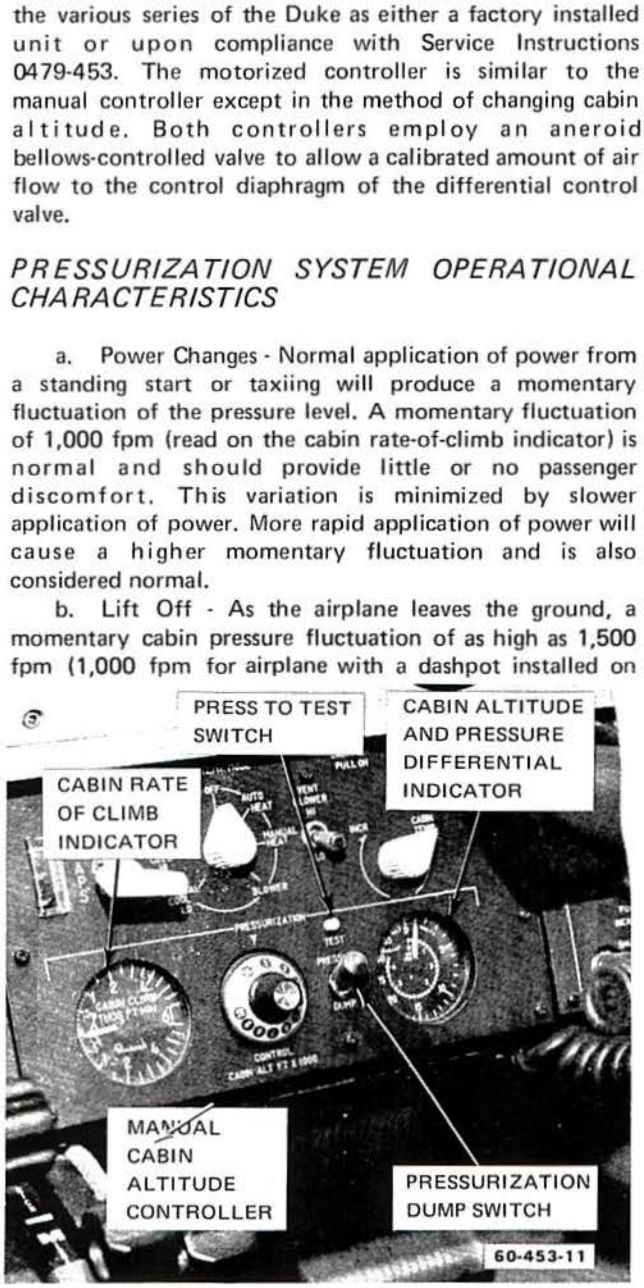
d. Maximum Differential Pressure - As the cabin leaves the isobaric altitude control and goes on maximum differential pressure control, it will make an adjustment and a fluctuation of 500 fpm may be noted before it stabilizes to the normal rate-of-climb of the airplane. Again little or no passenger discomfort should be experienced.

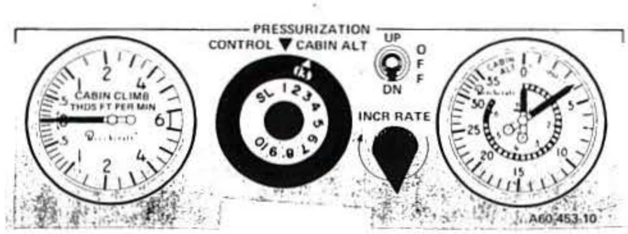
e. Power Reductions - A sudden power reduction or loss of power on one engine below 20 in. Hg MP will cause a change in engine pressurization air flow. Therefore, cabin pressure will be affected and cabin pressure fluctuation will be experienced. A fluctuation of 2,000 fpm is normal under these conditions.

f. Pressurization at Minimum Power - A maximum differential pressure (4.6 psi) may be expected at any throttle setting of 20 in. Hg MP or above on both engines or during single engine operation with the operating engine at 65% power or above, at an altitude of 20,000 feet or above.

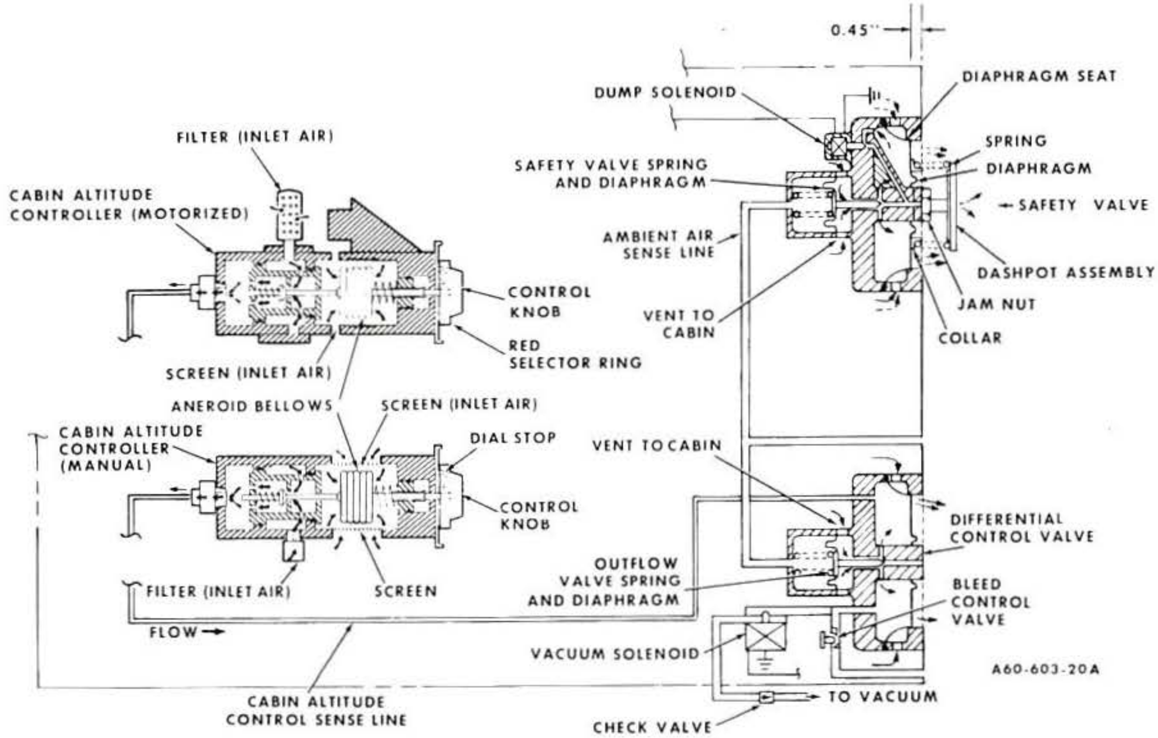
Once the isobaric altitude is set (this is the altitude at which the cabin starts to pressurize), it should be left there until the cabin reaches maximum differential pressure. Once this altitude is reached, the controller can be reset to any lower altitude with no effect on cabin altitude. To change it under any other condition should be done with caution as rapid fluctuations can take place. A recommended practice is, prior to take-off, set the controller to 1,000 feet above the altitude of the departure field or the arrival field whichever is the highest. By doing this the controller does not have to be reset in flight and a smooth comfortable pressurized flight can be expected.

The following graph is provided to determine the relationship between cruise altitude, cabin altitude and differential pressure. The zero differential pressure line



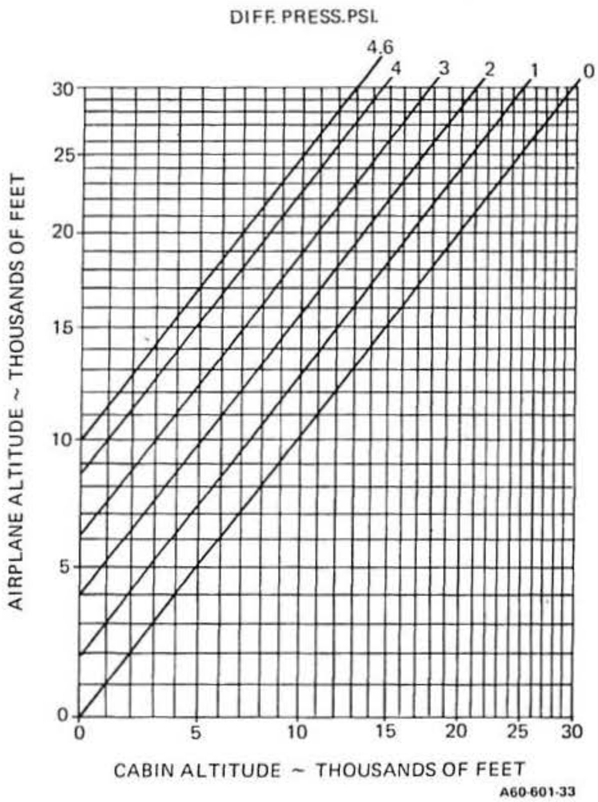


Pressurization Controls
Figure 1



Pressurization Control System Schematic
(P-3 thru P-307)
Figure 2

indicates that the cruise altitude and the cabin altitude are identical (unpressurized). The 4.6 psi line indicates the maximum differential pressure obtainable in the cabin. To determine the lowest cabin altitude which can be maintained for a given cruise altitude: enter the graph at the desired cruise altitude and read right to the 4.6 psi differential pressure line. Then read down the graph to the altitude which can be maintained in the cabin.



Effectual Pressure Graph
Figure 3

CABIN ALTITUDE CONTROLLER (MANUAL) (PRIOR TO P-308)

Cabin altitude is maintained by the cabin altitude controller with the control anywhere from zero pressure to the maximum differential of 4.6 psi.

The controller is rotated until the desired cabin altitude for flight is at the 12 o'clock position under the index mark. Any selected cabin altitude will be maintained during the flight provided the cabin pressure is at or below the maximum differential pressure. If the cabin reaches the maximum differential of 4.6 psi and the airplane is still climbing the cabin altitude will climb with the airplane.

If a cabin altitude change is required in flight it can be accomplished with a minimum of abrupt cabin pressure change by turning the selector dial very slowly and monitoring the rate of change on the cabin pressure indicator. A time lapse of approximately two minutes for each thousand-foot increment change on the dial will effect a comfortable change of pressure. Rapid cabin pressure changes will be experienced if the altitude selector is moved quickly before reaching the maximum differential pressure of 4.6 psi.

CABIN ALTITUDE CONTROLLER (MOTORIZED) (PRIOR TO P-308)

The motorized controller is designed to maintain a constant cabin altitude rate of change during airplane climbs and descents and to make available a means of cabin altitude programming. It can best be described as an adjustable isobaric controller incorporating a variable speed drive motor with automatic shut off. The additional controls for the unit are the red altitude selector ring, the motor rate rheostat and the directional toggle switch. The inner cabin altitude selector is normally operated with the directional toggle switch. The control can be moved to override the motor drive but under normal operation all movement should be made with the toggle switch. The inner scale shows the cabin altitude when read at the index mark (12 o'clock position). The outer scale under the window shows the selected airplane altitude. The inner scale adjacent to the window shows what the cabin altitude will be when maximum differential pressure (4.6 psi) is reached.

To ready the unit for operation, place the rate rheostat knob in the mid-range and insure that the directional toggle switch is in the off position.

CAUTION

In event the directional toggle switch is positioned improperly, the controller will drive to the end of the scale and damage to the slip clutch may result.

Manually set the cabin altitude controller (inner scale) to approximately 1,000 feet above the take-off field elevation. (The red altitude selector ring will turn with the inner scale when this adjustment is made). Now set the window on the red altitude selector ring to 1,000 feet above the planned airplane's cruise altitude. This will avoid reaching maximum differential pressure in the cabin prior to achieving cruise altitude.

After take-off and during the climb when the cabin rate of climb has returned to zero, move the directional toggle switch to the up position. This gradually climbs the cabin to the altitude which is opposite the altitude in the window on the red selector ring. The controller should be driven at a rate to arrive at the cabin altitude shortly before the airplane arrives at the cruise altitude. This can be accomplished by increasing or decreasing the rate rheostat knob. A few seconds lag time must be allowed for the pressurization controls to respond and stabilize before reading the cabin altitude rate of climb indicator. The controller will automatically turn off when the window in the red selector ring reaches the 12 o'clock position. However, the directional switch should be placed in the OFF position.

CAUTION

In the event the directional toggle switch is positioned improperly, the controller will drive to the end of the scale and damage to the slip clutch may result.

For normal descent turn the red selector ring until the window is opposite the altitude which is 1,000 feet above the landing altitude. After departing the original altitude, place the directional toggle switch in the down position. In the event that a rapid descent rate is required, set the rate rheostat for an increased rate of descent so as to maintain a higher airplane altitude than cabin altitude throughout the descent.

If the cruise altitude selected is less than 11,000 feet or corresponding cabin altitude (below the window) is less than the take-off field elevation, then the controller need not be moved. However, if the landing altitude is less than the take-off field elevation then the controller can be driven down to the selected cruise altitude.

DIFFERENTIAL CONTROL VALVE AND SAFETY VALVE (PRIOR TO P-308)

A differential control valve and a safety valve are located on the forward side of the aft pressure bulkhead.

NOTE

On airplane serials P-247 and after the outflow valve and safety valve are mounted within a box structure which is a portion of the aft pressure bulkhead.

The differential control valve regulates cabin pressure up to maximum differential pressures of 4.6 to 4.7 psi. A diaphragm in the valve, controlled by the cabin altitude control, closes but allows a preset amount of cabin air to bleed off into the tail section through an adjustable bleed valve. This maintains the selected cabin altitudes up to maximum differential pressure. The differential control feature of the valve maintains cabin pressure at maximum differential pressure (4.6 to 4.7 psi) only. The differential control utilizes a diaphragm that applies pressure against a spring-loaded needle valve. When cabin pressure reaches maximum differential pressure, the diaphragm pushes against the needle valve, allowing cabin air to bleed off into the tail section. As cabin air bleeds off, the diaphragm allows the needle valve to return to its normal position; thus the diaphragm modulates the needle valve between the open and closed position to maintain the proper pressure.

On serials P-3 through P-126, except P-123, the safety valve incorporates a solenoid valve which is wired to the landing gear safety switch. When the airplane touches down, the safety valve will energize and dump the cabin pressure overboard. A manual dump switch, located on the RH subpanel will also energize the solenoid and dump pressure overboard while in flight. On serials P-123, P-127 and after, the dump solenoid is actuated by the dump switch only, while the vacuum solenoid is actuated by the landing gear safety switch. The safety valve functions the same as the differential control section of the differential control valve except that the pressure setting is slightly higher.

A solenoid valve is also located on the differential control valve. The primary function of this solenoid is to eliminate pressurization fluctuation during ground run-up and flight in the unpressurized mode. When energized, the solenoid valve allows vacuum to be applied to the control diaphragm which holds it in the open position allowing cabin pressure to freely dump overboard. The solenoid valve is energized when the manual dump switch is in the dump position or any time the airplane is on the ground. The vacuum source is an ejector, located in the aft fuselage which obtains its air supply from the instrument air or deicer system.

PRESSURIZATION TEST SWITCH

A pressurization press-to-test switch is located on the RH subpanel. The press-to-test switch de-energizes the solenoid valves on the differential control valve and the safety valve so the pressurization system can be checked during ground run-up. Pressurization ground check may be accomplished as follows:

a. Place the manual dump switch in the pressure position and the firewall shut-off valves in the open position.

b. Run the engines at 2,000 rpm and press the press-to-test switch.

c. A momentary indication of a descent in cabin altitude on the cabin rate-of-climb indicator shows that the system will pressurize.

PRESSURIZATION CONTROL - DESCRIPTION AND OPERATION (P-308 AND AFTER)

The pressurization control system consists of a system mode switch, cabin altitude controller, auxiliary volume tank, outflow valve and safety valve. The system mode switch has three positions, TEST, NOR (normal) and DUMP, to permit the operation of the system in the ground test, pressurized flight and unpressurized flight modes.

The controller contains a visual display of the selected altitude, an altitude selector and a rate control. The outer scale of the selected altitude visual display indicates the selected cabin altitude, the inner scale indicates the corresponding altitude at which the maximum differential pressure would occur. The rate control regulates the rate at which cabin pressure ascends or descends to the selected altitude. When the pointer of the rate control knob is set to the 12 o'clock position, the rate of change is approximately 500 feet per minute.

The outflow valve and the safety valve are mounted within a box structure which is a portion of the aft pressure bulkhead. Each valve consists of two sections, a head and a base section. Within the head section of each valve, is a control chamber. The control chamber of the outflow valve is closed except for the pneumatic fitting, designated port "2", which connects the control chamber to the reference pressure developed in the cabin altitude controller. The control chamber of the safety valve is connected to the airplane vacuum system through port "2" and is vented to the cabin air through a filter and orifice. A differential control assembly mounted on the head section of each valve is vented to static atmosphere through the pneumatic fitting designated port "1". The base section of each valve houses the poppet valve, poppet valve seat and noise suppression screen. The poppet valves are spring loaded to the closed position whenever there is no controlling pressure applied.

The following description of the system operation is made, assuming that the system is functioning normally, both engines are operating, bleed air from the turbochargers is flowing normally and the airplane vacuum system is functioning.

Prior to a normal pressurized flight, with the system switch placed in the NOR (normal) position, electrical power is routed to a ram air door magnetic latch and, through a portion of the RH landing gear safety switch, to actuate a pair of solenoid air valves. One, a normally closed air valve, is actuated to open and permit the application of a negative pressure from the airplane vacuum system to the control chamber of the safety valve. The safety valve poppet valve is thus opened to prevent pressurization of the airplane. The second solenoid air valve, a normally open valve, is energized to close the supply line to the cabin altitude controller, permitting it to be preset to the desired cabin altitude, prior to take-off for the flight.

When the airplane leaves the ground, the contacts of the RH safety switch change over, thus, opening the coil circuits of the solenoid valves. The normally closed air valve closes to remove the safety valve control chamber from the airplane vacuum system. Cabin air enters the control chamber of the safety valve through a filter and orifice. This permits the poppet valve return spring to close the poppet valve. Simultaneously, the normally open air valve opens, thus, connecting the cabin altitude controller to the airplane vacuum system. The controller pre-rates to the selected cabin altitude. If the cabin altitude is above the field elevation, the outflow valve poppet valve will modulate open, preventing pressurization of the airplane until the selected altitude is reached. As the airplane reaches the selected cabin altitude, the reference pressure developed within the cabin altitude controller decreases, permitting the outflow valve poppet valve to modulate toward the closed position, thus, restricting the outflow of cabin air. The outflow valve poppet valve will modulate to restrict the outflow of cabin air as required to maintain the selected altitude.

If the flight plan requires an airplane altitude greater than the altitude indicated on the inner scale of the visual display of selected cabin altitude, the airplane cabin will be pressurized at the maximum differential pressure. At this time the differential pressure across the differential pressure control diaphragm assemblies of the safety valve and the outflow valve will cause these valves to modulate open, maintaining the maximum differential pressure of the airplane. As the airplane continues to climb the cabin altitude will climb at the same rate of climb as the airplane climbs.

NOTE

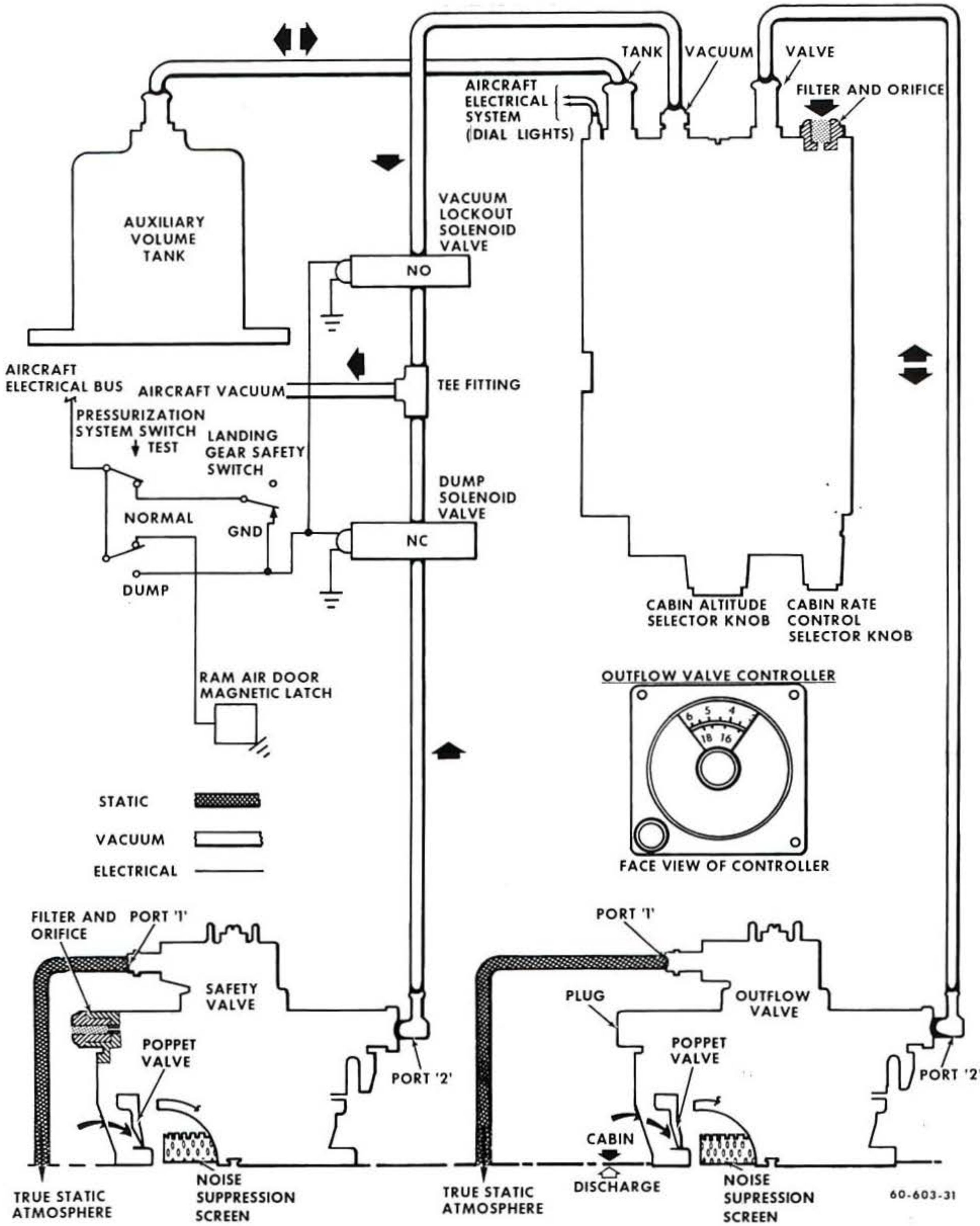
> During a rapid rate of airplane assent, if the cabin rate selector is set at a low rate, the maximum differential pressure could be achieved prior to reaching the selected airplane altitude.

If the cabin altitude is greater than the selected cabin altitude and the airplane decends, the cabin altitude will decend at the selected cabin rate until the selected cabin altitude is achieved.

Should there be a loss of cabin airflow from the turbochargers and the airplane decends to an altitude where the atmospheric pressure exceeds the cabin pressure, a negative pressure differential will exist across the inner diaphragms of both the outflow valve and the safety valve. When the control chamber-to-atmosphere pressure differential is sufficient to overcome the force of the poppet valve return springs, the poppet valves will open permitting air at atmospheric pressure to flow into the cabin counteracting the negative pressure differential.

Depressurizing the cabin for emergencies, such as smoke in the cabin, may be accomplished by placing the mode select switch in the DUMP position. The normally closed solenoid air valve opens to connect the control chamber of the safety valve to the airplane vacuum system. The safety valve poppet valve is thus opened, permitting the cabin air flow to exhaust to the atmosphere without restriction.

When the airplane touches down after a pressurized flight, the actuation of the RH landing gear safety switch will again energize the two solenoid air valves to open the safety valve poppet valve and to block the source of vacuum from the cabin air controller.



Cabin Pressure Control System Schematic
(P-308 and after)
Figure 4

"END"

PRESSURIZATION CONTROLS - MAINTENANCE PRACTICES (P-3 THRU P-307)

CABIN ALTITUDE CONTROLLER FILTER (MOTORIZED)

A cabin altitude controller filter is utilized on Duke serials P-229 and after, and those prior airplane's which have complied with Service Instructions 0528-453 that have the optional motorized cabin altitude controller installed.

The filter is designed to improve filtration and prevent the poppet valve from sticking due to tobacco tars and other contaminents. Under normal operating conditions the average life of the filter is 1,000 hours. This will vary according to extremes in cabin smoke density. An indication of need for filter replacement would be a slow response to variations in altitude.

DIFFERENTIAL CONTROL VALVE AND SAFETY VALVE REMOVAL

a. Remove the upper and middle upholstery panels from the forward side of the aft lower pressure bulkhead making the valve accessible. On airplane serials, P-247 and after, remove the plate which is attached by two AN4-5A bolts and sixteen AN3-5A bolts, to gain access to the differential control valve and the safety valve.

b. Loosen and remove all necessary plumbing from the valve. Cap open plumbing to keep shop soil, dirt and foreign objects from entering.

c. Remove the access door on the lower LH fuselage, just aft of the rear pressure bulkhead.

d. Station a man inside the aft fuselage to remove the six attaching bolts and remove the valve.

DIFFERENTIAL CONTROL VALVE AND SAFETY VALVE INSTALLATION

a. Station a man inside the aft fuselage to position the valve and install the six attaching bolts.

NOTE

Tighten the attaching bolts to a torque of 15 inch-pounds.

b. Remove the caps and install all plumbing to the valves.

NOTE

Tighten the differential control valve ELBOW or the safety valve TEE fitting to 50 ± 10 inch-pounds and secure with safety wire.

c. On airplane serials P-247 and after; install the plate over the differential control valve and the safety valve. Secure it with the two AN4-5A bolts, top and bottom, and sixteen AN3-5A bolts. Tighten the bolts evenly to a torque of 50 to 70 inch-pounds for the AN4-5A bolts, and 20 to 25 inch-pounds for the AN3-5A bolts.

WARNING

The airplane must not be pressurized prior to installation of the plate.

d. Install the access door on the lower LH fuselage.

e. Reinstall the upholstery panel.

DIFFERENTIAL CONTROL VALVE AND SAFETY VALVE ADJUSTMENT

NOTE

Check the differential control valve and safety valve for adjustment every 300 hours or annually.

The differential control valve and safety valve adjustments may be made in accordance with PRESSURIZATION SYSTEM ADJUSTMENT PROCEDURES. For information relating to overhaul and cleaning procedures, refer to Component Maintenance Manual, P/N 60-590001-27.

PRESSURIZATION SYSTEM ADJUSTMENT PROCEDURES

a. Remove the middle upholstery panels from the aft pressure bulkhead to provide access to the differential control valve and safety valve.

b. Open the bleed control valve 1-1/4 turns counterclockwise.

c. Preset the cabin altitude controller to the nearest index mark above field altitude. (Minimum of 1,000 feet.)

d. Adjust the dashpot spring to position the diaphragm approximately 0.45 inch from valve mounting face surface.

e. Check ram air door for resistance to opening by pushing with a long stiff rod with pressurization switch in pressurization mode and power on.

f. Cabin bleed-off rate at 4.6 psi should not exceed 6,000 fpm. (Required only if excessive leak rate is suspected.)

g. Execute a normal take-off and record maximum cabin descent which occurs approximately 20 seconds after lift-off. Acceptable range is 300 to 1,000 fpm.

h. Place the airplane in a 1,000 fpm climb at normal climb power and record maximum cabin descent as the airplane begins to pressurize. Maximum descent rate is 500 fpm.

i. After climbing through an altitude 2,000 feet above the altitude selected on the cabin altitude controller, adjust the bleed control valve (if required) as follows:

1. If the cabin climbs as the airplane climbs, close the bleed control valve to obtain a zero rate-of-climb on the cabin rate-of-climb indicator.

NOTE

Because of the sensitivity of the pressurization control system, the bleed control valve should be moved in increments of no more than 1/8 turn.

2. If the cabin dives as the airplane climbs, OPEN the bleed control valve to obtain a zero rate-of-climb on the cabin rate-of-climb indicator.

j. Level the airplane at an altitude approximately 8,000 feet above the selected cabin altitude and compare the selected altitude on the controller with the indicated cabin altitude on the cabin altimeter. If the difference in the two altitudes is in excess of 500 feet, the control head on the cabin altitude controller should be removed and adjusted to correspond with the altitude on the cabin altimeter.

NOTE

The manual controller should be removed from the subpanel prior to take-off if the need for adjustment is anticipated.

k. After landing, if lift-off descent is excessive and isobaric descent is small, as recorded in steps "g." and "h.", adjust the dashpot clockwise approximately 1/2 turn for each 400 fpm. Maximum clockwise adjustment is one turn.

l. If lift-off descent is small and isobaric descent is excessive, as recorded in steps "g." and "h.", adjust the dashpot counterclockwise approximately 1/2 turn for each 400 fpm.

m. Reinstall the upholstery panels to the aft pressure bulkhead.

CABIN ALTITUDE CONTROLLER REMOVAL (MANUAL)

a. Remove the four attaching screws at the subpanel.

b. Loosen and remove plumbing from the controller. Cap open plumbing to keep shop soil, dirt and foreign objects from entering.

c. Remove the controller.

CABIN ALTITUDE CONTROLLER INSTALLATION (MANUAL)

a. Remove plumbing cap and install plumbing to controller.

b. Position the controller in the subpanel.

c. Install the four attaching screws at the subpanel.

CABIN ALTITUDE CONTROLLER ADJUSTMENT (MANUAL)

a. Make a reference mark on the outer ring of the controller control head to match the triangular mark on the edge light panel directly above the control.

b. Remove the controller from the subpanel.

NOTE

The controller should be removed from the subpanel prior to take-off if the need for adjustment is anticipated.

c. Loosen the control head retention Allen screw and slide the control head off the bellows shaft without turning the shaft.

NOTE

Do not loosen the slot head screw in the knob on the control head.

d. Hold the outer ring of the control head and rotate the cabin altitude selection knob until the actual cabin altitude, as indicated on the cabin altimeter, aligns with the reference mark (see step "a.").

e. Align the guide pin and slide the control head back on the bellows shaft without turning the shaft.

f. Secure the control head in place with the Allen screw and reinstall the controller in the subpanel.

For proper information relating to overhaul and cleaning procedures refer to Component Maintenance Manual, P/N 60-590001-27.

CABIN ALTITUDE CONTROLLER REMOVAL (MOTORIZED)

a. Remove the four attaching screws at the subpanel.

b. Remove the screw, washer and support clamp, located behind the subpanel, from the controller.

c. Loosen and remove plumbing from the controller. Cap open plumbing to keep shop soil, dirt and foreign objects from entering.

d. Remove the controller.

CABIN ALTITUDE CONTROLLER INSTALLATION (MOTORIZED)

a. Remove plumbing cap and install plumbing to controller.

b. Position the controller in the subpanel.

c. Install the support clamp on the controller and attach with the screw and washer.

d. Install the four attaching screws at the subpanel.

CABIN ALTITUDE CONTROLLER ADJUSTMENT (MOTORIZED)

NOTE

The controller does not need to be removed from the subpanel for this adjustment.

a. Loosen the control head retention Allen screws and slide the control head off the bellows shaft without turning the shaft.

NOTE

Do not loosen the slot head screw in the knob on the control head.

b. Rotate the control head until the altitude in the 12 o'clock position on the selection knob is the same as the actual cabin altitude, as indicated on the cabin altimeter.

c. Align the guide pin and slide the control head back on the bellows shaft without turning the shaft.

CAUTION

Incorrect positioning of the control head on the bellows shaft may cause improper travel clearances and result in damage to the slip clutch.

d. Tighten the Allen screws to secure the control head on the bellows shaft.

For proper information relating to overhaul and cleaning procedures refer to Component Maintenance Manual, P/N 60-590001-27.

PRESSURIZATION TEST PROCEDURE

(Refer to "1.a." and "1.b." under TROUBLESHOOTING PRESSURIZATION SYSTEM.

This test provides a means of isolating the cabin altitude control to determine if it or the differential control valve is defective when the system cannot be properly pressurized.

a. Remove the upholstery panels providing access to the differential control valve at the aft pressure bulkhead.

b. Disconnect the cabin altitude control sense line from the differential control valve.

c. Pull the pressurization control circuit breaker.

d. Start both engines and VERY SLOWLY increase power to a minimum of 20 in. Hg manifold pressure (cabin rate-of-descent not to exceed 1,000 feet per minute).

WARNING

Increasing power rapidly could cause the cabin to pressurize to maximum differential within a short time, to the subsequent discomfort of personnel in the airplane.

e. If the cabin rate-of-climb indicator shows a descent as power is increased above a minimum of 20 in. Hg manifold pressure, the cabin altitude control is defective.

f. If the cabin rate-of-climb does not show a descent as power is increased above a minimum of 20 in. Hg manifold pressure, the isobaric control portion of the differential control valve is defective. The differential control portion of the valve may also be checked by allowing the cabin to pressurize to maximum differential pressure. If cabin pressure stabilizes at 4.6 to 4.7 psi as monitored by the cabin differential pressure gage, the differential control portion of the valve is functioning properly.

g. SLOWLY decrease power until the cabin is depressurized, then shut down both engines.

h. If any components were found defective, replace them and repeat the test.

i. Reset the pressurization control circuit breaker.

j. Reconnect the cabin altitude control sense line to the differential control valve, then reinstall the upholstery panels on the aft pressure bulkhead.

PRESSURIZATION CONTROL - MAINTENANCE PRACTICES (P-308 AND AFTER)

OUTFLOW VALVE AND SAFETY VALVE REMOVAL

The safety valve and the outflow valve are nearly identical. The safety valve is installed in the lower position and the outflow valve is installed in the upper position.

a. Remove the upholstery panel from the aft pressure bulkhead.

b. Remove the plate to gain access to the outflow and safety valves. The plate is secured with two AN4-5A bolts and sixteen AN3-5A bolts.

c. Loosen and remove the plumbing, as necessary, to permit removal of the valve. Tag the plumbing as removed to facilitate reinstallation. Cap all open plumbing and valve fittings to prevent shop soil and foreign objects from entering.

d. Remove the access door on the lower LH fuselage, just aft of the rear pressure bulkhead.

e. Station a man inside the aft fuselage to remove the six attaching nuts and washers securing each valve.

f. Remove the valve.

g. Remove and discard the old gasket.

OUTFLOW VALVE AND SAFETY VALVE INSTALLATION

a. Remove all traces of the old gasket.

b. Station a man inside the aft fuselage to install the attaching washers and nuts that secure each valve.

c. Install the safety valve in the lower position and/or the outflow valve in the upper position, using a new gasket.

d. Secure the valve to the pressure bulkhead structure by installing a washer and a nut at each of the six plates. Tighten the nuts evenly to a torque of 4 ± 1 inch-pounds.

NOTE

Earlier airplane serials have valves with flared fittings, while later serials, equipped with plastic outflow valves, use a beaded tube fitting and clamps to secure the plumbing. Use water only as a lubricant on EVA tubing being installed over beaded tubing or fittings.

e. Remove the caps and install the plumbing as tagged when the plumbing was removed.

f. Install the plate over the outflow and safety valves. Secure it with the two AN4-5A bolts, at top and bottom, and the sixteen AN3-5A bolts. Tighten the bolts evenly to a torque of 50 to 70 inch-pounds for the AN4-5A and 20 to 25 inch-pounds for the AN3-5A bolts.

WARNING

The airplane must not be pressurized prior to installation of the plate.

g. Reinstall the access door on the lower LH fuselage, aft of the rear pressure bulkhead.

h. Reinstall the upholstery panel.

OUTFLOW VALVE AND SAFETY VALVE ADJUSTMENT

The outflow valve and the safety valve are each preset at the factory to regulate the cabin pressurization to a maximum differential pressurization of 4.6 ± .1 psi. Field adjustment of these valves is not recommended. In the event of a malfunction, the valves should be returned to Beech Aircraft Corporation in exchange for an Overhauled-Exchange unit.

OUTFLOW AND SAFETY VALVE CLEANING

CAUTION

The outflow and safety valves are preset at the factory and field adjustment is not recommended. Any time the valve seal is broken, the WARRANTY (6 months in duration) is VOIDED.

Fluctuation of cabin pressure often indicates dirty outflow and safety valves. The seats of these valves should be cleaned at 100 hour inspections, or more frequently if needed. The inspection and cleaning of the valve seat and bellows may be accomplished by the following suggested procedure:

a. Remove the aft fuselage access panel from the lower LH fuselage aft of the aft pressure bulkhead.

b. Compress the bellows to permit inspection and cleaning.

c. Clean the bellows and the inner rim of the valve housing where the bellows contacts the housing when the bellows is extended, using a clean rag dampened with isopropyl alcohol (45, Chart 207, 91-00-00).

SAFETY VALVE FILTER AND ORIFICE CLEANING

The filter and orifice in the head section of the safety valve should be removed, cleaned and inspected every 1,000 hours. The filter may be cleaned by the following suggested procedure:

a. Remove the upholstery panel.

b. Remove the plate to gain access to the safety valve. The plate is secured with two AN4-5A bolts and sixteen AN3-5A bolts.

c. Remove the filter from the head section of the safety valve. Do not lose the packing.

d. Remove the retaining ring from the filter assembly housing. Remove one screen, the copper ribbon and the remaining screen from the housing of the filter assembly.

e. Wash both screens, the copper ribbon, and the filter assembly housing in solvent (15, Chart 207, 91-00-00). Ensure that the orifice of the filter housing is free of foreign material.

f. Install one screen in the housing of the filter assembly. Install the copper ribbon in the filter assembly housing. Do not over compress the ribbon. Install the remaining screen and secure the filter in the housing using the retaining ring.

g. Install the filter assembly in the safety valve, using the packing removed with the filter assembly. Tighten to a torque of 15 to 20 inch-pounds.

h. Reinstall the plate over the outflow and safety valves. Secure it with the two AN4-5A bolts, at top and bottom, and the sixteen AN3-5A bolts around the perimeter of the plate. Tighten the bolts evenly to a torque of 50 to 70 inch-pounds for the AN4-5A bolts and 20 to 25 inch-pounds for the AN3-5A bolts.

WARNING

The airplane must not be pressurized prior to installation of the plate.

i. Reinstall the upholstery panel.

FUNCTIONAL TEST OF OUTFLOW VALVE AND SAFETY VALVE (P-308 and after)

OUTFLOW VALVE FLIGHT CHECK

The following check must be accomplished with the airplane in flight.

a. If the cabin pressure can be controlled at 1/2 psid (pounds per square inch differential) less than maximum differential of 4.6 ± .1 psi, the outflow valve is operating satisfactorily.

b. If the cabin pressure goes to maximum differential and cannot be controlled at 1/2 psid below maximum differential, the outflow valve must be replaced.

c. The outflow valve is removed and installed as described in this Chapter under the headings OUTFLOW VALVE AND SAFETY VALVE REMOVAL and OUTFLOW VALVE AND SAFETY VALVE INSTALLATION.

SAFETY VALVE GROUND CHECK

a. Connect a regulated cabin pressurization test unit to the airplane as outlined under the heading CABIN PRESSURIZATION LEAKAGE TEST (P-4 and after) in this Chapter. (Do not pressurize at this time.)

b. Working through the access opening behind the aft pressure bulkhead, locate the line that connects the dump solenoid valve to the safety valve and disconnect the line from the solenoid valve.

c. Connect a regulated vacuum source to the line which was disconnected from the solenoid valve. (Do not apply vacuum at this time.)

d. Pressurize the cabin to 3 psid.

e. Slowly apply regulated vacuum to the safety valve. If the valve opens before the vacuum reaches 4 inches Hg indication on the test unit, the valve is operating satisfactorily. If more than 4 inches Hg are required to open the safety valve, the valve must be replaced.

CABIN ALTITUDE CONTROLLER REMOVAL

a. Remove the knobs, handles, screws, etc. to facilitate the removal of the edge-lighted panel from the RH inboard subpanel.

b. Tag the plumbing as removed to facilitate reinstallation. Loosen and remove all plumbing from the cabin pressurization controller, as necessary to permit removal of the controller. Cap all open plumbing to keep shop soil and foreign material from entering the plumbing and the controller. Disconnect the electrical wiring from the controller lamp wires.

c. Remove the three screws securing the cabin altitude controller to the printed circuit board of the RH inboard subpanel.

d. Remove the cabin altitude controller.

CABIN ALTITUDE CONTROLLER INSTALLATION

a. Install the cabin altitude controller in the printed circuit board of the RH inboard subpanel. Secure with the three screws.

b. Remove the caps and reinstall the plumbing as tagged during removal. Reconnect the wiring to the controller lamps.

c. Install the edge-lighted panel. Secure with the screws. Replace the knobs and handles.

CABIN PRESSURIZATION CONTROLLER ADJUSTMENT

The cabin pressurization controller is preset at the factory. Field adjustments and maintenance of the controller is not recommended. In the event of a malfunction, the cabin pressurization controller should be returned to Beech Aircraft Corporation in exchange for an Overhauled-Exchanged unit.

CABIN ALTITUDE CONTROLLER FILTER AND ORIFICE CLEANING

The filter and orifice in the cabin altitude controller should be removed, cleaned, and inspected every 500 hours. The filter may be removed and cleaned by the following suggested procedure:

a. Remove the filter assembly from the housing of the cabin altitude controller. Do not lose the packing.

b. Remove the retaining ring from the filter assembly housing. Remove one screen, the copper ribbon and the remaining screen from the housing of the filter assembly.

c. Wash both screens, the copper ribbon and the filter assembly housing in solvent (15, Chart 207, 91-00-00). Ensure that the orifice of the filter housing is free of foreign material.

d. Install one screen in the housing of the filter assembly. Install the copper ribbon in the filter assembly housing. Do not over compress the copper ribbon. Install the remaining screen and secure the filter in the housing using the retaining ring.

e. Install the filter assembly in the cabin altitude controller using the packing removed with the filter assembly. Tighten to a torque of 15 to 20 inch-pounds.

AUXILIARY VOLUME TANK REMOVAL

a. Loosen and remove the plumbing. Cap the plumbing and the auxiliary volume tank to prevent shop soil, dirt and foreign material from entering the auxiliary volume tank or the plumbing.

b. Remove the two screws securing the auxiliary volume tank to the forward cabin pressurization bulkhead. Remove the tank.

AUXILIARY VOLUME TANK INSTALLATION

a. Mount the auxiliary volume tank on the forward cabin pressure bulkhead and secure with the two screws previously removed.

b. Remove the caps and connect the plumbing to the auxiliary volume tank.

PRESSURIZATION TEST PROCEDURE (P-308 AND AFTER)

The pressurization system may be functionally checked for operation by the following suggested procedure:

a. If the outflow valve and the safety valve are to be tested for proper differential pressure operation, proceed as follows:

1. Remove the upholstery panel from the aft pressure bulkhead. Remove the access plate to gain access to the outflow valve and safety valves.

2. Loosen and remove the plumbing from the true static air vent (port 1) on the head section of each valve. (Tag each tube to facilitate reinstallation.) Add a section of tubing to each static air vent of sufficient length to reach through the holes in the access plate after it has been reinstalled, since the airplane must not be pressurized prior to installation of the plate. Provide a means of disconnecting and capping each true static air vent with the plate reinstalled. Tag each tube for identification during the test.

3. Reinstall the plate. Secure the plate and tighten the bolts evenly to a torque of 50 to 70 inch-pounds for the AN4-5A bolts at the top and bottom of the plate and 20 to 25 inch-pounds for the remaining bolts.

WARNING

The airplane must not be pressurized prior to installation of the plate.

b. Close and secure the cabin door.

c. Rotate the cabin rate control selector knob to the 12 o'clock position.

d. Select a cabin altitude that is approximately 500 feet above the field elevation.

e. Set the airplane brakes and start the engines as instructed in the applicable Duke Pilot's Operating Manual. Operate both engines at a minimum power setting of 20 in. Hg manifold pressure to establish a steady flow of cabin air.

f. Open the pressurization system circuit breaker. Note that the safety valve on the aft pressure bulkhead closes and the airplane starts to pressurize.

g. Select a cabin altitude that is approximately 1,500 feet below the field elevation. The cabin will pressurize at a rate-of-change rate to decrease the cabin altitude.

h. Rotate the rate control selector knob counterclockwise and note a reduction in rate-of-change of cabin pressurization.

i. Rotate the rate control selector knob clockwise and note a reduction in the rate-of-change of cabin pressurization.

j. Rotate the cabin altitude selector knob to the full counterclockwise stop and select a rate-of-change that is comfortable. The cabin-to-atmosphere pressure differential will increase. The value of the differential pressure attained will depend upon the field elevation at which the test is conducted.

k. When the cabin pressure has stabilized, disconnect and cap the plumbing from the cabin pressurization controller port labeled VACUUM. Cap the plumbing and the controller port to prevent the entrance of foreign materials.

The cabin-to-atmosphere pressure differential will now increase to the normal positive differential pressure setting of the outflow valve and the safety valve.

NOTE

Cabin pressure will increase to the maximum differential value at an uncontrolled rate when the vacuum line is disconnected.

l. After the cabin pressure has again stabilized, note the readings on the CABIN ALT and DIFF PRESS indicator.

m. Disconnect the true static air vent which is connected to the outflow valve. (Refer to step "a." of this procedure.) The DIFF PRESS indicator shall indicate a change that is no greater than .1 psi.

n. Reconnect the static air vent to the outflow valve and disconnect and cap the true static air vent from the safety valve. The DIFF PRESS indicator should again indicate a change that is not greater than .1 psi. Reconnect the safety valve true static air vent.

o. Reconnect the plumbing to the VACUUM fitting of the cabin pressurization controller. The cabin altitude will return to the altitude selected on the cabin pressurization controller. The cabin altitude, as indicated on the CABIN ALT indicator, should stabilize at an altitude within 500 feet of the selected cabin altitude.

p. Rotate the cabin altitude selector to select an altitude that is approximately 500 feet above the field elevation. After the cabin altitude has again stabilized, reset the cabin pressurization circuit breaker. Shut down the engines as described in the applicable Duke Pilot's Operating Manual.

q. Remove the plate over the outflow and safety valves. Remove the test plumbing installed in step "a.", above. Reconnect the true static air vent tubes to the outflow valve and the safety valve. Reinstall the plate. Tighten the bolts evenly to a torque of 50 to 70 inch-pounds for the AN4-5A bolts at the top and bottom of the plate and 20 to 25 inch-pounds for the remaining bolts.

WARNING

The airplane must not be pressurized prior to installation of the plate.

r. Reinstall the upholstery panel.

CABIN PRESSURIZATION LEAKAGE TEST (P-4 and after) (Figure 201)

Test equipment is available for ground testing the cabin for pressurization leaks and for troubleshooting the pressurization system. Such equipment must be capable of delivering 4.50 psi of air at 80 cubic feet per minute and must be protected by a complete safety system to prevent damage to the airplane. The test unit listed in the following paragraph consists of an electric motor and blower assembly, a dry air filter, a flowmeter, a cabin pressure gage, and a large relief valve to protect the pressure vessel of the airplane.

NOTE

It should be noted that the test unit to be used must be set at the psi of pressurization for which the airplane is designed if the safety system of the test unit is to fulfill its function.

The units listed in the following paragraph, TEST EQUIPMENT, also include a pneumatic air system that delivers from zero to 30 pounds of air at 25 cubic feet per minute for checking the deicer boot system, and pressure instruments.

TEST EQUIPMENT (P-4 and after)

The following pressurization test units, or their equivalent, may be utilized for the cabin pressurization leakage test.

a. Cabin Pressurization Test Unit: Manufactured by Kitco Tool and Die Inc., 21 Water Street, Mill Hall, PA. 17751.

1. Model 1200 - for domestic use.
2. Model 1300 - for export use.

NOTE

The test equipment hoses, furnished with the test unit, may be connected in only one (either), or both nacelles. The TEST EQUIPMENT text and Figure 201 illustrates the test equipment hoses connected in both nacelles.

b. Use low pressure hose, 2 1/2 inches in diameter, to connect the PRESSURIZING AIR fitting of the test unit to the flexible ducts, forward of the LH and RH firewall's.

c. Two pieces of 1/4-inch high pressure hose is used to connect the PNEUMATIC AIR fitting on the test unit to the pneumatic line in each nacelle, forward of the pressure regulator.

d. High pressure hose, 3/8-inch in diameter, connects the INSTRUMENT AIR or CABIN PRESSURE fitting on the test unit to the brake reservoir sense line at the forward pressure bulkhead, located in the nose baggage compartment.

e. Tee or Y-shaped fittings and clamps to connect the hoses as described in steps "b" through "d".

f. High strength webbing or restraining straps to encompass fuselage doors and windows for safety of testing personnel during performance of test. (P/N 60-000000-D939-1 or equivalent.)

TEST PROCEDURE (P-4 and after)

a. Gain access to the outflow and safety valves at the aft pressure bulkhead. Remove the control port tubing from both the outflow and safety valves.

b. Connect the 3/8-inch high pressure hose from the INSTRUMENT AIR or CABIN PRESSURE fitting on the test unit to the brake reservoir sense line at the forward pressure bulkhead, located in the nose baggage compartment. The air supply must be capable of maintaining 4.50 psi.

NOTE

Ensure that all windows and doors are closed and securely latched.

WARNING

Personnel who work under pressurized conditions must be carefully chosen. Pressurization may prove dangerous to personnel which are overweight, have heart or respiratory disorders, ear infection, or are not emotionally stable.

c. Place high strength webbing, P/N 60-000000-D939-1 or equivalent in position over the pressure vessel (doors and windows).

d. Connect a 2-1/2 inch air supply hose between the test unit (PRESSURIZING AIR fitting) and the flexible ducts, forward of the LH and RH firewall.

e. Connect the PNEUMATIC AIR fitting on the test unit to the pneumatic line in each nacelle, forward of the pressure regulator.

NOTE

Ensure that all connections are secure at the airplane and at the test unit. Ensure that all "T" and/or "Y" fittings are secure.

f. Slowly open the air valve to pressurize the cabin. Monitor the RATE-OF-CLIMB and CABIN PRESSURE indicators. The rate-of-climb should not exceed 1,000 feet per minute to a maximum of 25,000 feet. The cabin differential pressure shall not exceed 4.6 ± .1 psi as observed on the CABIN PRESSURE indicator.

g. Pressurize the cabin to a differential pressure of 4.00 ± .50. Allow five minutes for the cabin pressure to stabilize. After stabilization is established, check the cabin for excessive leakage. A 38 cubic feet per minute leakage is permissible. If the leakage is indicated at more than 38 cubic feet per minute, isolate the cause and repair as described in the following paragraphs.

1. Check all connections to the pressure vessel, test unit, and the "T" and/or "Y" fittings in the test hoses to ensure that no leaks exist. Repair all leaks and repeat steps "f." through "g."

2. If leaks through the outflow or safety valves are suspected, a slight adjustment of the outflow and safety valve mounting screws may reduce the leakage rate considerably. If the outflow and/or safety valves are determined to be defective, replace as necessary. Perform the leak test described in steps "f." through "g".

3. Check around the windows for leaks, remove and replace windows found to be defective.

NOTE

Ensure that the test unit is working properly and all gages are accurate.

4. Gain access to the points where the control cables, electrical wire bundles, plumbing, and landing gear

retract rods enter the pressure vessel by removing the seats, floorboards, and upholstery. Fill the control cable pressure seals with MIL-G-23827 grease (11, Chart 202, 12-20-00 and Chart 207, 91-00-00) and paint the control cables, through-out its full travel through the pressure seals with MIL-G-23827 grease (11, Chart 202, 12-20-00 and Chart 207, 91-00-00). Spread the electrical wire bundles apart and apply EC1239A½ sealant around each wire. After each wire is covered, wrap Scotch #33 vinyl around the wire bundle (butted against seal fitting) and inject EC1239A½ sealant in the notch of the seal fitting. Apply EC1239B½ sealant to all plumbing fittings at the pressure vessel. Ensure that the landing gear retract rods pressure boots are properly installed without damage. Perform the pressurization leak test as described in "a" through "g".

5. Remove all seats, floorboards, and upholstery panels. Check the complete pressure vessel for leaks. Isolate and repair all leaks. Repeat steps "a" through "g".

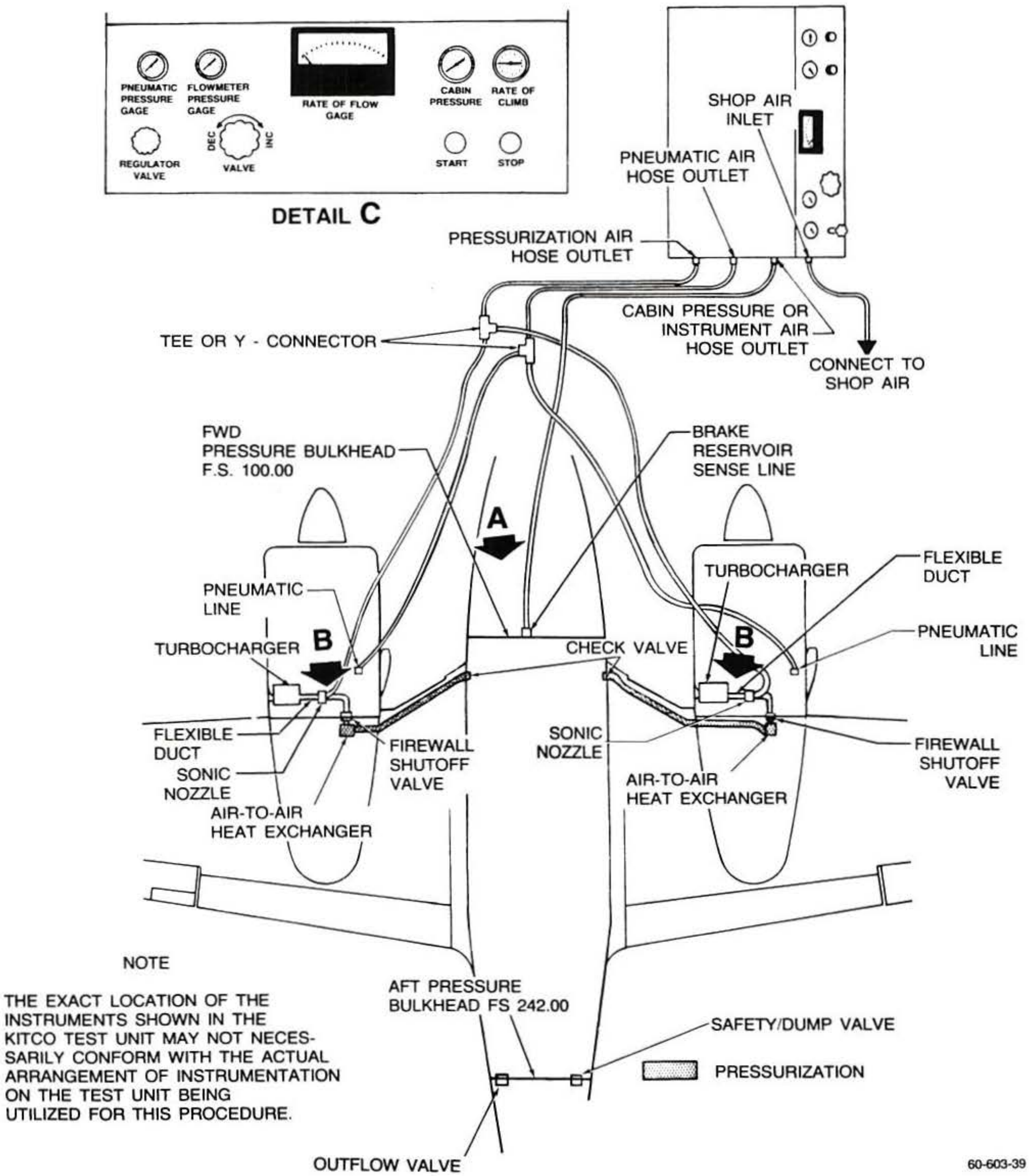
h. With the pressure leak test within tolerance, depressurize the pressure vessel and remove the safety net.

i. Remove all test hoses from the airplane and connect the hoses between the fuselage and the engines.

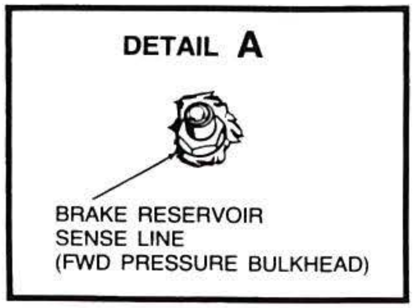
j. Install the control port tubing on each outflow and safety valves.

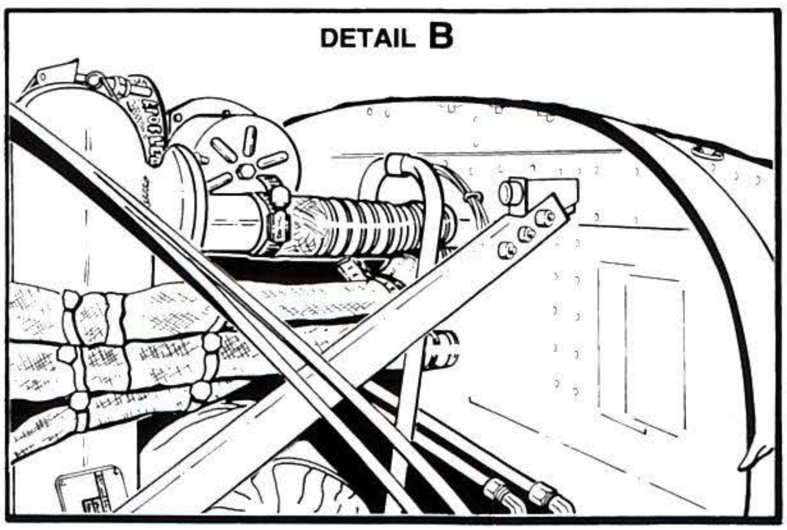
k. Remove the plug from the atmosphere port of the outflow valve and ensure that the back pressure test hose is removed from the atmosphere vent fitting of the safety valve (located on the aft side of the aft bulkhead).

l. Install floorboards, upholstery panels, seats, and access panels which were removed during the test procedure.



Cabin Pressurization Test Hookup (Page 1 of 2)
Figure 201





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Cabin Pressurization Test Hookup (Page 2 of 2)
Figure 202

"END"

HEATING - DESCRIPTION AND OPERATION

The heater system consists of a 45,000 BTU combustion air heater, (located under the nose baggage compartment floor), a six position mode switch, vent air blower, combustion air blower, heater fuel pump, five outlets, an automatic temperature control and three sensing elements.

In flight, when pressurized, the vent blower obtains air through the cabin air check valve, forces it through the heater and to the cabin outlets. In the unpressurized mode in flight and for ground operations, the vent blower obtains air from the cabin and the ram air plenum chamber and forces it through the heater and to the cabin outlets.

On serials P-4 through P-126, except P-123, a vent air distribution bypass valve, located on the forward pressure bulkhead, allows air to be directed into the pilot's compartment area and is regulated by a control knob on the pilot's left subpanel.

Exchanging the cabin air is accomplished by exhausting a controlled amount of air through the isobaric control valve on the aft pressure bulkhead.

HEATER CONTROL SYSTEM

(Figure 1)

The heater controls are located on the copilot's LH subpanel. Serials P-4 through P-126, except P-123, incorporates a six-position switch placarded; AUTO HEAT, MANUAL HEAT, BLOWER, AUTO COOL, MANUAL COOL, HI, MANUAL COOL LO, and OFF. On serials P-123, P-127 and after the mode selector switch differs slightly in that a MANUAL COOL position replaces the MANUAL COOL HI and MANUAL COOL LO positions. In addition, two blower positions are placed on the selector switch to allow the blower to be selected without cycling through the opposite mode. The mode switch controls both the heating and cooling systems; however, each system operates independently of the other. In the manual heat position, the switch bypasses the automatic cabin heat controls and allows maximum heat output. However, the heater output in the manual position is limited by a heater cycling switch. In the automatic heat position a temperature control rheostat placarded CABIN TEMP INCREASE can be set for the desired cabin temperature.

Outlet air velocity may be changed in either MANUAL HEAT or AUTO HEAT mode by moving the VENT BLOWER switch, located in the copilot's LH subpanel to either the HI or LO position.

Cabin Temperature Controls
Figure 1

HEATER OPERATION

a. To place the heating system in operation select an operational mode; either MANUAL HEAT or AUTO HEAT.

b. If the AUTO position is chosen, set the control rheostat for the desired heat. The heater is now set up for normal operation providing thermostatic temperature regulation.

c. If MANUAL heat control is desired or required by a malfunction in the AUTO system, move the switch to the MANUAL position. This removes the automatic controller and the sensing elements from the control system. The heater will then cycle continuously by the preset integral heater cycling switch.

d. The CABIN AIR control which regulates the amount of outside ram air to the cabin is located on the copilot's LH subpanel. Pull the CABIN AIR control full aft for maximum air. The CABIN AIR control is overridden when the cabin is pressurized.

e. For windshield defrosting, operate the heater in either the auto or manual mode and pull out the DEFROST control located on the pilot's LH subpanel.

f. Heated air is normally directed onto the pilot's feet. To shut off this air, pull out the PILOT AIR control located on the pilot's LH subpanel.

g. The COPILOT AIR control, identical to the PILOT AIR control is located on the copilot's RH subpanel.

NOTE

The volume of air available for the pilot outlet and copilot outlet can be divided between the two outlets as desired by adjusting each control individually. More heated air will be available for defrosting by reducing the flow of air from the pilot and/or copilot outlets.

If a malfunction resulting in dangerously high temperatures (300°F. to 400°F.) should occur, the heater over-temperature switch will lock out and blow either the over-temperature fuse (manual mode) or the over-temperature fuse (auto mode) in the heater power circuit. This renders the heater system, except the blower, inoperative. The over-temperature fuses are located behind the LH upper side panel. The heater over-temperature switch is located on the heater assembly. The switch must be manually reset during heater system servicing after an over-temperature condition has occured.

CAUTION

Make certain any malfunction causing an overheat condition is corrected before attempting to operate the heater.

For additional heat, the PRESSURIZATION AIR TEMP CONTROLS located on the copilot's RH subpanel can be pulled out to restrict cooling air flow through the cabin air heat intercooler. For maximum heat in the unpressurized mode, push the CABIN AIR control full forward to stop the flow of incoming cold air.

NOTE

The intercooler doors should be closed during all heating operations to reduce the load on the heater. Conversely, the doors should be open to reduce load during all cooling operations.

"END"

HEATING - MAINTENANCE PRACTICES

HEATER REMOVAL

The heater should be removed from the aircraft and disassembled. All parts should be thoroughly inspected and necessary repairs and parts replacements made every 500 hours of operation.

The heater is removed as follows:

a. Remove the necessary nose baggage compartment floorboards to gain access to the heater.
b. Loosen the clamp and disconnect the duct from the combustion air blower.
c. Tag the wires and disconnect the wire harness from the heater.
d. Loosen the clamps around the fuel inlet line boot and slide the boot up the fuel line. Disconnect the fuel line from the heater.
e. Remove the safety wire and loosen the clamp on the heater exhaust shroud (located under the heater).
f. Remove the clamps, located at each end of the heater.
g. Lift the heater up and out of the aircraft.

HEATER INSTALLATION

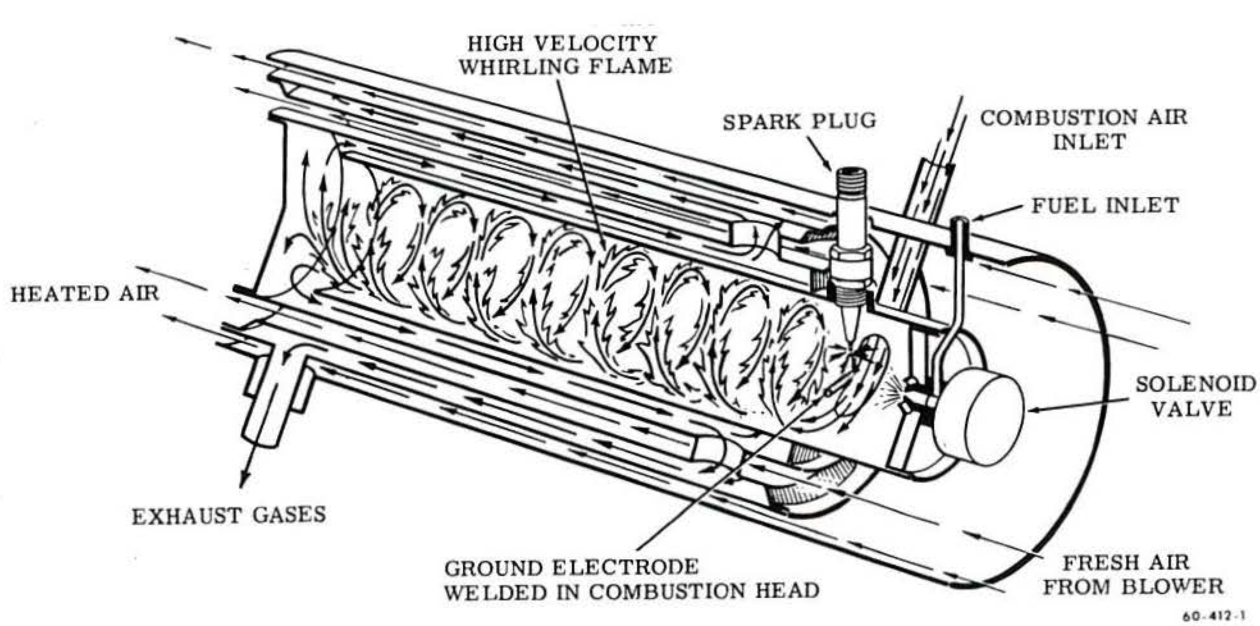
a. Position the heater in the aircraft taking care to guide the fuel drain through the grommet in the skin and the exhaust shroud through its opening.
b. Install the clamps at each end of the heater.
c. Position the clamp on the heater exhaust shroud located under the heater and secure and safety.
d. Install the fuel line to the heater. Slide the boot down the fuel line and secure the clamps around the boot.
e. Install the wire harness to the heater.
f. Connect the duct to the combustion air blower and secure the clamps.
g. Install the nose baggage compartment floorboards.

COMBUSTION AIR BLOWER REMOVAL

a. Remove the heater.
b. Tag the wires and disconnect the wiring from the combustion air blower and combustion air controller.
c. Loosen the clamps and disconnect the ducts on the combustion air blower.
d. Remove the attaching screws from the combustion air blower and the two controller mounting brackets.
e. Remove the combustion air blower and controller from the aircraft as a unit.

COMBUSTION AIR BLOWER INSTALLATION

a. Install the combustion air blower and controller in the aircraft as a unit.
b. Install the two controller mounting brackets and secure the combustion air blower with the attaching screws.
c. Install the ducts on the combustion air blower and secure with the clamps.
d. Install the wiring to the combustion air blower and



Aircraft Heater
Figure 201

combustion air controller.

e. Install the heater.

HEATER IGNITION
(Figure 201)

The controlled atomized spray from a specially designed spray nozzle, coupled with high-voltage spark plug ignition, insures instant firing and continuous burning under all flight conditions. Heat is produced by burning a fuel-air mixture in the combustion chamber of the heater. Aviation gasoline is injected into the combustion chamber through the spray nozzle. The resulting cone-shaped fuel spray mixes with combustion air and is ignited by a spark from the spark plug. Electric current for ignition is supplied by an ignition unit which converts 24 volts to a high-voltage, oscillating current to provide a continuous spark across the spark plug gap. A shielded, high voltage lead connects the ignition assembly to the spark plug. Combustion air enters the combustion chamber tangent to its surface and imparts a whirling or spinning action to the air. This produces a whirling flame that is stable and sustains combustion under the most adverse conditions because it is whirled around itself many times. Therefore, ignition is continuous and the combustion process is self-piloting. The burning gases travel the length of the combustion tube, flow around the outside of the inner tube, pass through cross-over passages into an outer radiating area, then travel the length of this surface and out the exhaust.

Ventilating air passes through the heater between the jacket and combustion tube assembly outer surface and through an inner passage in the assembly. Consequently, ventilating air comes into contact with two or more heated, cylindrical surfaces.

VIBRATOR REMOVAL

a. Remove the necessary access panels, in the nose compartment, to reach the ignition unit on the heater assembly.

NOTE

Measure the distance the vibrator protrudes out of the ignition assembly to determine when a new unit is inserted properly.

b. Grasp the vibrator and with a slight back and forth movement, pull it straight out of the ignition unit.

NOTE

For a friction grip, it may be necessary to use a piece of masking or friction tape around the exposed portion of the vibrator.

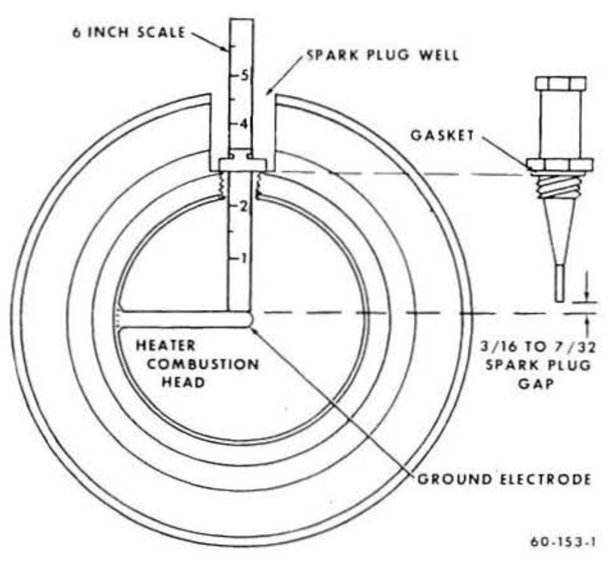
VIBRATOR INSTALLATION

a. To install a new vibrator, carefully rotate the new vibrator until the index marks are aligned and the connector pins on the vibrator can be felt entering the pin sockets in the vibrator socket, then press the vibrator fully and firmly into position.

b. Check the heater for operation and close all access openings.

INSPECTION AND SERVICING (SPARK PLUG)
(Figure 202)

If the spark plug appears to be in good condition, except for a mild coating of oxide on the porcelain and electrodes, it may be cleaned and reused. Cleaning is accomplished on a conventional aircraft type spark plug cleaner, except that it will be necessary to use two or more adapters in order to raise the long extension of the plug far enough out of the cleaner nozzle opening to provide an effective job. Plug the ceramic insert cavity at the terminal end of the plug with a piece of paper or cloth to keep out any of the cleaning sand. Wipe this cavity out thoroughly with a cloth, wet with carbon tetrachloride. If, after cleaning, the spark plug porcelain is white, and the electrode is not eroded, the spark plug gap may be set as follows. Insert a six inch scale with a sliding clip into the spark plug well until it touches the ground electrode welded inside the combustion head. Withdraw the scale and note the dimension between the sliding clip and the end of the scale. Place the scale against the bottom of the spark plug gasket and determine the length of the spark plug positive electrode. The difference



Heater Spark Plug Gap
Figure 202

between the two measurements is the spark plug gap. The gap should be 3/16 to 7/32 (0.188 to 0.218) inches. If the plug gap must be adjusted, the ground electrode may be bent up or down by reaching through the spark plug hole with the appropriate shaped tool.

NOTE

If the spark plug fails to clean up properly and/or if the electrode is badly eroded, it should be replaced.

If a new spark plug is being installed, be sure to measure the gap. Do not bend the positive electrode. Torque the spark plug to 28 foot-pounds.

NOTE

The spark plug can be checked visually for sparking prior to installing the plug as follows: Disconnect the wire from the terminal on the heater wiring side of the terminal strip to de-energize the fuel solenoid valve. Connect the high-voltage lead temporarily and lay the spark plug on the heater jacket.

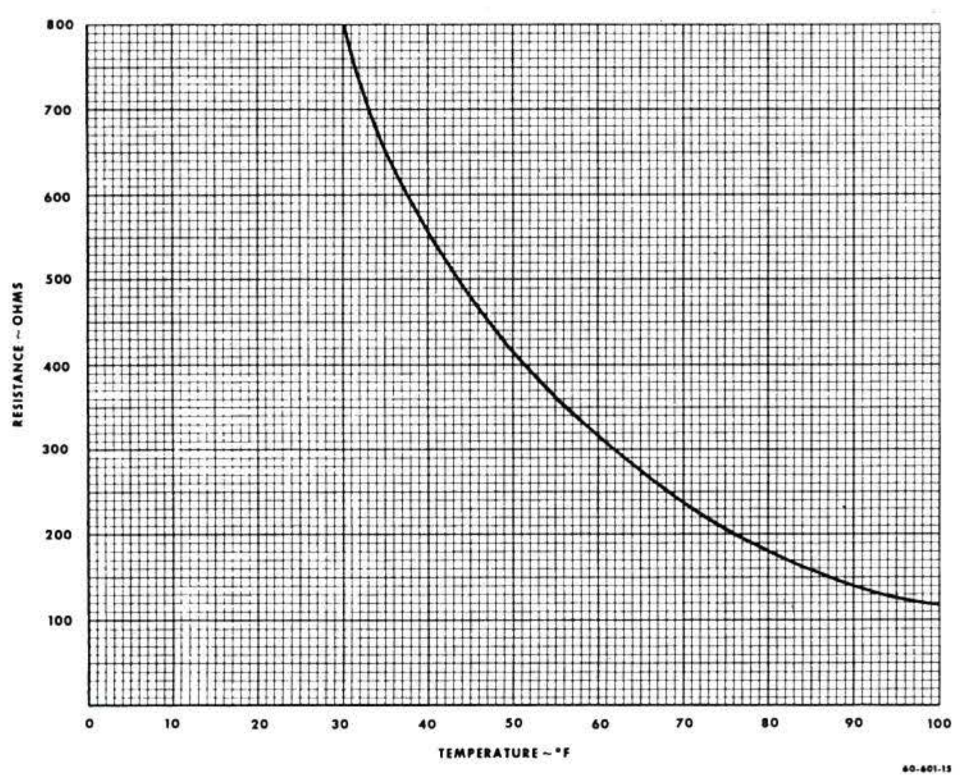
WARNING

Be sure to plug the spark plug hole in the heater to prevent any possibility of residual fuel blowing out and igniting. Do not touch the spark plug while energized because of dangerously high voltage.

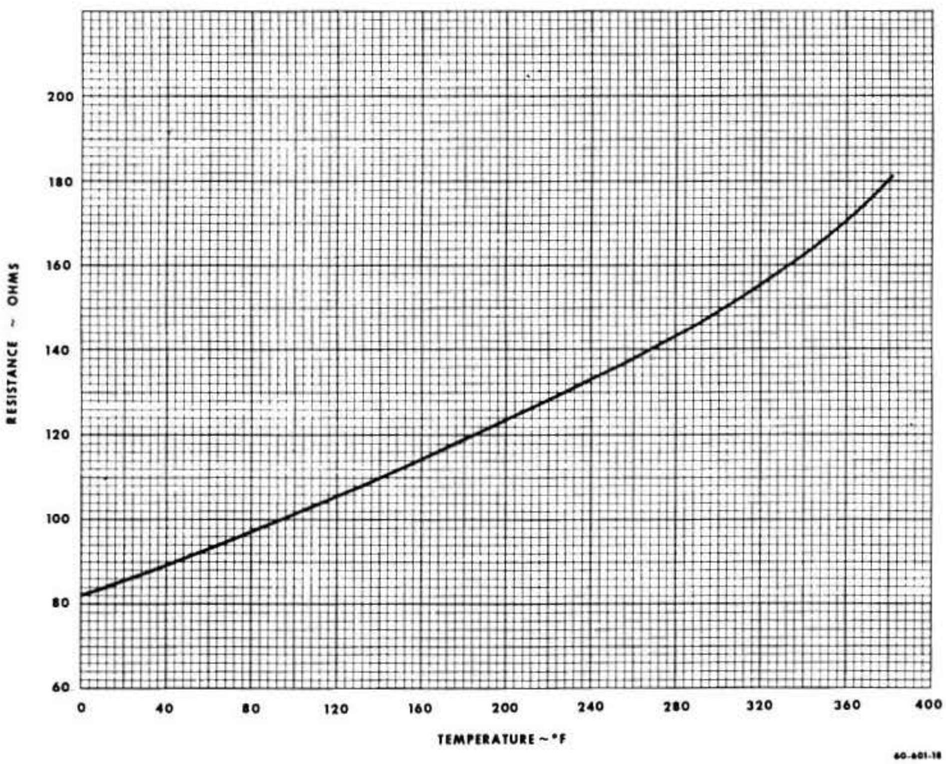
TEMPERATURE SENSORS AND CONTROL RHEOSTAT TEST

NOTE

The aircraft must be in a location, such as a hangar, where temperatures inside and outside of the aircraft are equal and stable. When making the tests, slight variances may occur; however, a defective component will give a definite indication.



Temperature Resistance Curve for Cabin Sensing Element
Figure 203



Temperature Resistance Curve for Heater Discharge Sensing Element
Figure 204

a. Using the graph in Figure 203, determine the correct resistance for the cabin air sensing element. Disconnect wire number H78E18 from terminal "8" of the temperature control box terminal strip. Measure the resistance between the terminal on wire number H78E18 and terminal "6" on the temperature control box terminal strip. Disconnect wire number H75B18 from terminal "5" of the temperature control box terminal strip. Measure the resistance between the terminal on wire number H75B18 and terminal "10" on the temperature control box terminal strip. If the measured resistances do not correspond to the value obtained from the graph, the cabin air sensing element is defective.

NOTE

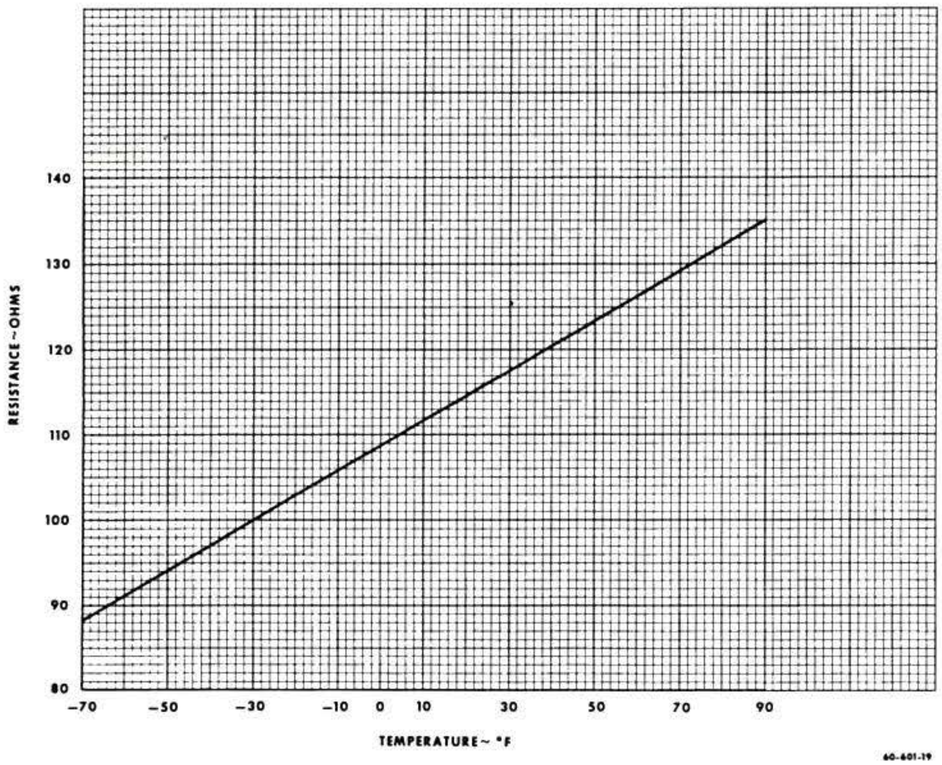
Do not reinstall the disconnected wires on the terminal strip until all tests are complete.

b. Using the graphs in Figures 204 and 205, determine the correct resistance for the heater discharge sensing element and the outside air sensing element respectively, then add these resistance values. Remove wire number H73F18 from terminal "8" of the temperature control box terminal strip. Measure the resistance between the terminal on wire number H73F18 and the terminal on wire H75A18 on terminal "5" of the temperature control box terminal strip. This resistance should equal the added resistance of the two sensing elements. If not, measure the resistance of the two sensing elements. If the resistance does not equal the determined amount, it is defective. If the resistance is correct, the heater discharge sensing element is defective.

c. Rotate the cabin temperature control to the full increase position. Using the graph in Figure 204, determine the resistance for heater discharge sensing element.

d. Disconnect wire number H77B18 from terminal "2" of the temperature control box terminal strip. Measure the resistance between the terminal on wire H77B18 and terminal "1" of the temperature control box terminal strip. If the resistance does not equal the determined value, the heater discharge sensing element is defective.

e. With the test probes still attached as noted in step "d", rotate the cabin temperature control to the full decrease position.



Temperature Resistance Curve for Outside Air Sensing Element
Figure 205

The resistance on the ohmeter should increase 250 ohms. If the resistance increase is higher or lower, the cabin temperature control rheostat is defective.

f. Reinstall all disconnected wires to their respective terminals.

FUEL PUMP

An electric fuel pump, located in the LH wing stub, provides fuel to the heater at a pressure of 7 psi. A solenoid operated fuel regulator regulates fuel pressure and acts as a remote shutoff for the heater, regardless of fuel inlet pressure variations.

"END"

COOLING - DESCRIPTION AND OPERATION

The optional air conditioning system is a recirculating air cooling system containing a 16,000 BTU refrigerative type cooler. The unit is controlled by an automatic temperature control and three sensing elements.

A six position mode switch controls the heater and air conditioner systems: however, each system operates independently of the other. When placed in AUTO position, the temperature is automatically controlled through the temperature controller located on the forward pressure bulkhead above the pilot pedals. It also regulates the cabin temperature variations monitored at the sensing units. The sensing units are located in the ram air inlet, heater outlet duct and forward of the two pressure control valves on the rear pressure bulkhead. When placed in the MANUAL COOL HI position, the switch bypasses the automatic controls and allows maximum air conditioning output. The maximum output is limited by an evaporator thermal switch and an overpressure switch. The MANUAL COOL LO position allows a hot-gas bypass valve (if installed) to be cycled on and off by a timer. The bypass valve regulates the flow of refrigerant to the condenser allowing partial cooling of the cabin.

On serials P-123, P-127 and after, a MANUAL COOL position replaced the MANUAL COOL HI and LO positions on the mode selector switch. Two BLOWER positions are placed on the mode switch to allow the blower to be selected without cycling through the opposite mode.

The air scoop and ramp assembly located in the upper RH nacelle controls the air circulation through the condenser compartment and is completely automatic. The air scoop and ramp assembly has three positions, "closed" (when the air conditioning is not in use), "flight" (air scoop extended about 2 inches above the nacelle), and "ground" (air scoop fully extended). When the air conditioning is turned on, a switch incorporated on the landing gear selects air scoop position; gear down, the air scoop will open to the "ground" position; gear off the ground, the air scoop will open or lower to the "flight" position. The condenser fan, which is wired in circuit with the landing gear safety switch, operates only when the air conditioning mode is selected and the airplane is on the ground.

REFRIGERATIVE AIR COOLING SYSTEM

The air conditioning system is similar to many home and automotive units and consists of six major components. The belt-driven compressor, which is coupled by a magnetic clutch, compresses the refrigerant to a high pressure, high temperature gas. This gas passes through the condenser where cooling air removes heat from the gas, condensing it to a liquid state. The liquid is then stored in the receiver-dryer where any moisture or foreign material is removed from the system. The refrigerant flows to the expansion valve where it is metered into the evaporator at a rate which allows all the liquid to return to a gas. The heat required for evaporation is absorbed from the cabin air passing over the evaporator coils. After passing through the evaporator, the refrigerant returns to the compressor at a reduced pressure. For partial cooling, a hot gas bypass valve allows a portion of the gas to bleed off from the condenser, cycling back through the compressor.

NOTE

Beginning with airplane serials P-123, P-127 and after, and prior airplane's having installed Kit Number 60-5006, the hot gas bypass valve, line and suction accumulator were removed from the system.

An overpressure switch and a pressure relief valve are incorporated into the system to regulate system (compressor discharge) pressure. The overpressure switch is located in the condenser compartment of the right nacelle and is set to actuate at 375 ± 10 psi. When this switch is actuated, power is removed from the compressor magnetic clutch and the 3 amp fuse is shorted through a resistor to ground. A pressure relief valve, located on the compressor discharge line immediately before it enters the condenser, is set to bleed off pressure at 450 psi.

On airplane serials, P-275 and after, and on those prior airplanes which have complied with Service Instructions 0599-427, a low pressure switch is installed on the evaporator. This switch is designed to actuate when the refrigerant pressure drops to 7 ± 1 psi. The actuation of the low pressure switch shorts the 3 ampere fuse to the airplane structure through the resistor located near the evaporator. The fuse, located in the right nacelle, is thus opened, preventing further operation of the compressor magnetic clutch and the compressor until the air conditioner system has been serviced.

NOTE

The low pressure switch which was originally installed on airplane serials P-275 through P-292 and P-294, prior to compliance with Service Instructions 0599-427, actuated at a pressure of 18 ± 2 psi.

"END"

COOLING - MAINTENANCE PRACTICES

Servicing the air conditioning system consists of periodically checking the refrigerant level, checking compressor oil level and changing the system air filter. Recharge the system whenever the refrigerant level is low, air has entered the system or components carrying refrigerant are replaced. Refrigerant leaks may be detected by inspection with flameless leak detector.

The refrigerant level may be observed through the sight glass located in the RH wheel well (P-4 through P-144) or by removing a plug button from the forward section floorboard forward of the copilot's seat (P-145 and after).

CHARGING THE AIR CONDITIONING SYSTEM

When working on a refrigerative air cooling system, observe the following special servicing precautions:

a. Remember, this is a high pressure system. When disconnecting a line, loosen the fittings just enough to bleed off pressure slowly, then disconnect the fitting.

b. Whenever a line is disconnected, purge the entire system with a vacuum pump operating at the 125 micron level.

c. Use only refrigerant (17, Chart 207, 91-00-00); other refrigerants, particularly those containing methyl chloride, will cause rapid deterioration of the aluminum compressor components.

d. When servicing the system with refrigerant, avoid smoking or working near an open flame. Refrigerant passing over an open flame will produce a highly toxic phosgene gas.

Hook the service unit to the connections on the compressor. The abbreviation DISCH or the letter "D" on the compressor cylinder head designates the discharge service valve. The word SUCTION or the letter "S" on the compressor cylinder designates the suction service valve.

When charging a completely purged system, charge with 5 pounds of refrigerant. After charging, the sight glass should be observed for bubbles or a milky appearance caused by an insufficient refrigerant level.

If it is necessary to add refrigerant to a partially charged system, add refrigerant slowly until a satisfactory condition is observed through the sight glass, then add an additional 1/4 to 1/2 pound of refrigerant.

NOTE

After the system has been charged the compressor oil level should be checked as outlined under CHECKING COMPRESSOR OIL LEVEL.

AIR CONDITIONING FUNCTIONAL TEST

With the compressor running at 1,100 rpm a functional check may be made in accordance with Chart 201. Charge the system as outlined in CHARGING THE AIR CONDITIONING SYSTEM.

CHECKING COMPRESSOR OIL LEVEL

(Figure 201)

The compressor oil level should be checked by a qualified air conditioner man at the following times:

a. After the air conditioner has operated for the first time.

b. At the beginning of each season's operation.

c. When oil is emitted from the compressor during servicing operation.

d. After the air conditioning system has been recharged.

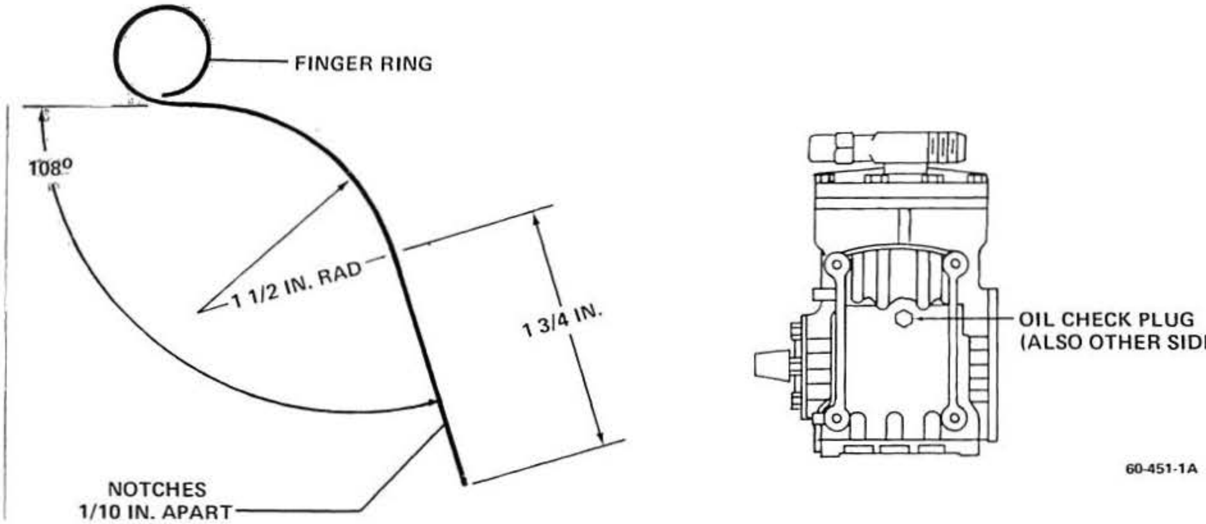
e. If a component is replaced.

The compressor is serviced with oil (18, Chart 207, 91-00-00). Only these or equivalent oils should be used when adding oil. To check the compressor oil level, use the following procedure:

CHART 201
AIR CONDITIONING FUNCTIONAL TEST

TEMPERATURE °F		COMPRESSOR PRESSURE (PSI)	
AMBIENT (OAT)	PLENUM (MAX)*	SUCTION	DISCHARGE
60	45	15 - 20	120 - 170
70	49	15 - 22	140 - 200
80	54	15 - 25	165 - 230
90	59	18 - 30	185 - 260
100	64	20 - 35	205 - 290
110	69	22 - 40	230 - 320

*Measure temperature at outlet nearest plenum



Dipstick and Compressor Oil Check Plug
Figure 201

a. Operate the air conditioner for approximately 15 minutes in which the last 5 minutes should be at low engine rpm (1,000 to 1,100). This allows the oil to accumulate in the compressor for an accurate oil level reading.

b. Attach service gages to compressor service valve ports.

c. With air conditioner operating, slowly close the suction service valve until the suction pressure gage reads 0 or slightly below.

d. Stop the air conditioner and quickly close the suction service valve when the suction gage reads a little above zero.

e. Close the discharge service valve.

f. With both service valves closed, the suction pressure will slowly rise to about five pounds gage pressure.

g. The remaining pressure is relieved by unscrewing the plug for 5 full turns and bled to zero pressure.

h. Remove the oil plug and O-ring.

i. To place the crank throw in the best position for dip stick insertion, point the keyway on the compressor shaft up toward the cylinder head.

j. Insert an oil dipstick until the end contacts the bottom of the crankcase. Remove and measure the oil depth.

NOTE

A compressor oil level depth of 1.5 to 1.8 inches is satisfactory. If the oil level is below 1.5 inches, add oil (18, Chart 207, 91-00-00), then remeasure.

CHART 202
CHECKING COMPRESSOR OIL LEVEL

Dip Stick Depth (In.)	Oil to be Added (Oz.)
.6	8.0
.8	6.5
1.0	5.0
1.2	3.0
1.4	1.5

Oil should be removed when depths greater than 1.8 inch are observed.

Compressor oil level reduces .4 to .7 inches during operation at maximum rpm and also drops slightly with reduced evaporator loads. Approximately 7 oz. of oil is required to initially wet the system and circulate with the refrigerant. When an evaporator or condenser coil is changed, add approximately 2 oz. of oil on installation, then check and adjust the oil level as recommended. A locally manufactured dip stick (see Figure 201) may be fabricated from 1/8 inch diameter rod; a nonferrous material, which is not subject to corrosion, is preferred. Notches cut 1/10 inch apart will aid in visually detecting oil depth.

k. Install the oil plug and O-ring and check for leaks using a flameless leak detector.

l. Unseat both the suction service valve and the discharge service valve and turn to the full aft position.

m. Remove the service gages and install the caps on the service ports.

n. The aircraft may now be returned to service.

EVAPORATOR AIR FILTER REPLACEMENT

The evaporator air filter should normally be replaced annually. Actual replacement may be required more often due to extremely dusty operating conditions.

a. Remove the necessary equipment in the nose compartment to gain access to the floorboards forward of the pressure bulkhead.

b. Remove the screws securing the top of the evaporator filter access plate.

c. Cut the cord securing the filter to the evaporator plumbing.

d. Remove the old filter.

e. When installing the new filter, be sure the reinforced backing of the filter is placed against the evaporator coil.

RIGGING THE AIR SCOOP

(Figure 202)

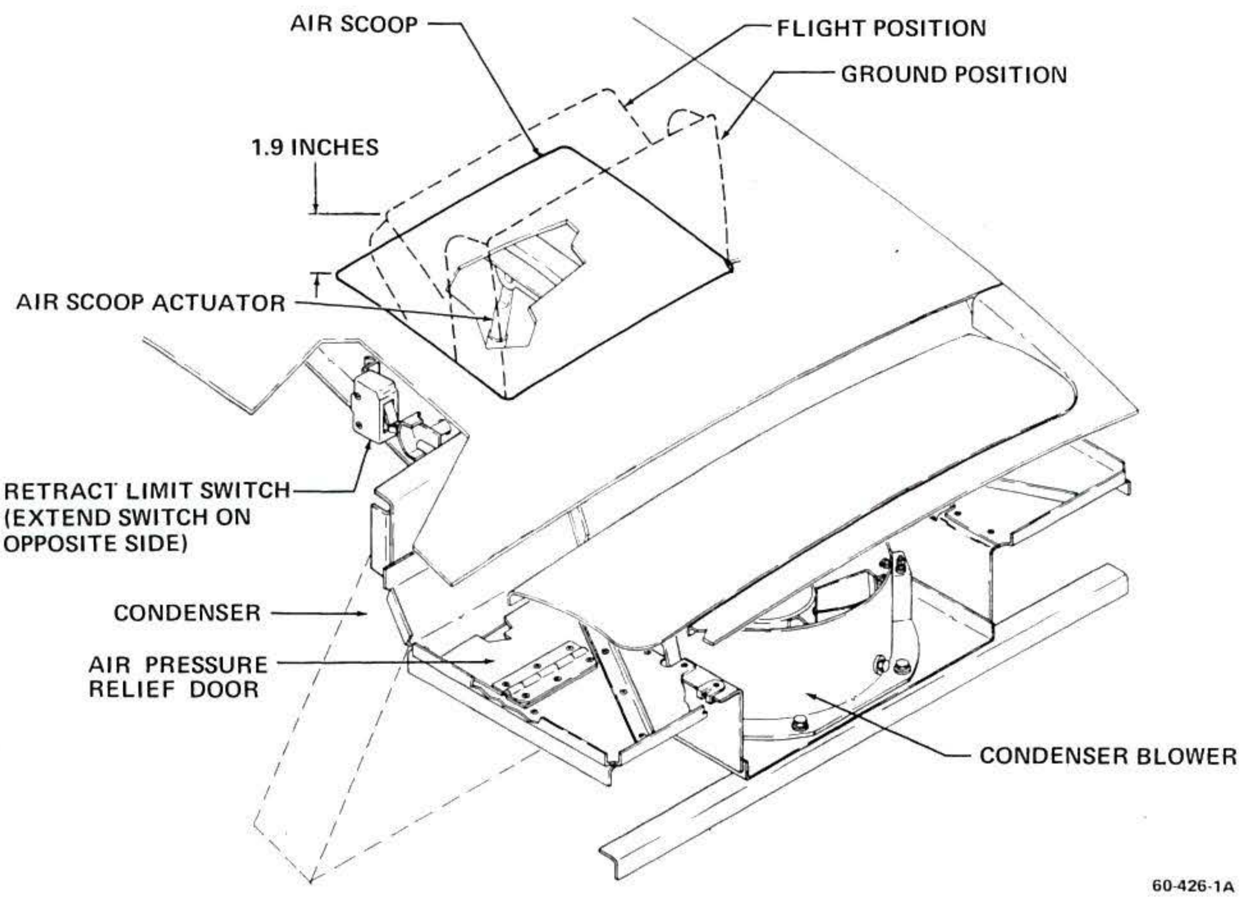
Two limit switches control the air scoop actuator travel for the flight and ground positions. The extend limit switch limits the air scoop travel from the closed position to the flight position. The retract switch limits the air scoop travel from the ground position to the flight position. The air scoop and limit switches may be adjusted as follows:

a. Disconnect the air scoop actuator rod end by removing the attaching bolt and nut.

b. With power on, run the actuator in to its internal limit and loosen the rod end check nut.

c. With the air scoop faired to the nacelle adjust the rod end to the attaching bolt but do not secure the actuator to the air scoop at this time. Tighten the rod end check nut.

d. Manually raise the air scoop 1.9 inches above the top of the nacelle and hold this position while adjusting the switches.



Air Scoop
Figure 202

e. Loosen the attaching screws and move the switches in their slotted mounts until they actuate (a distinct click is audible) in the following order: the extend switch actuates first when the air scoop moves up from the closed position; the retract switch actuates first when the air scoop moves down from the ground position. Secure with the attaching screws.

f. Because the ground position is automatically achieved by the internal limits of the actuator no adjustment is needed.

g. Install the actuator rod end to the attaching bolt and secure the nut.

h. Check for proper operation.

CONDENSER BLOWER REMOVAL

The condenser compartment is located aft of the right nacelle firewall.

a. Remove the screws securing the skin covering the condenser compartment. Position the air scoop and ramp vertically to remove the skin.

b. Remove the pins at the air ramp hinge points and lift the air ramp out.

c. Disconnect the electrical wiring at the terminals on the condenser blower. Remove the screws securing the blower to its mounting bracket and then lift out the blower.

d. Remove the screws securing the blower mount bracket and the two baffles to the condenser compartment. Lift out the mounting bracket and baffles.

e. Disconnect the fittings on the condenser and cap.

WARNING

The lines connected to the condenser are under high pressure. Refer to CHARGING THE AIR CONDITIONING SYSTEM, in this chapter before disconnecting any fitting in the refrigerant system.

f. Remove the screws securing the condenser to its mounting flange and lift the condenser out of the compartment.

CONDENSER BLOWER INSTALLATION

a. Position condenser in condenser compartment and secure with attaching screws.

b. Remove cap and install the fittings to the condenser.

c. Position the two baffles to the condenser compartment and the blower mount bracket and secure with attaching screws.

d. Position the blower to its mounting bracket and secure with attaching screws. Attach the electrical wiring at the terminals on the blower.

e. Position the air ramp to align the air ramp hinges and install the hinge pins.

f. Position the air scoop and ramp vertically to install the skin covering the condenser compartment.

g. Secure the skin with attaching screws.

COMPRESSOR BELT TENSION ADJUSTMENT

After 36 to 48 hours operating time, a new belt will stretch to its normal operating length. The belt tension should be checked at this time and adjusted (by moving the compressor up and down in its slotted mounts) so that a belt tension gage, placed at a point midway between the longest span will register a tension of 100 to 105 pounds. After adjusting the tension on a new belt, be sure the belt has ample clearance on all sides.

COMPRESSOR BELT REMOVAL

a. Remove the RH engine cowling to gain access to the compressor belt.

b. Loosen compressor attaching nuts and slide the compressor upward in its slotted mount to relieve tension on the belt. Roll the belt off the compressor pulley.

c. Remove the bolts attaching the compressor/turbocharger mount support to the engine.

d. Remove the belt from the engine crankshaft pulley and slip it out between the compressor/turbocharger mount and the engine.

COMPRESSOR BELT INSTALLATION

a. Slip the compressor belt between the compressor/turbocharger mount and the engine and position the belt on the crankshaft pulley.

b. Secure the compressor/turbocharger mount support to the engine with attaching screws.

c. Roll the belt onto the compressor pulley. Slide the compressor downward in its slotted mount to apply tension on the belt and secure the compressor attaching nuts.

d. Install the RH engine cowling.

COMPRESSOR REMOVAL

a. Remove the RH engine cowling to gain access to the air conditioner compressor.

b. Disconnect electrical leads to the magnetic clutch.

c. Disconnect refrigerant lines at compressor service valves.

WARNING

The lines connected to the compressor are under high pressure. Refer to CHARGING THE AIR CONDITIONING SYSTEM, in this chapter before disconnecting any fitting in the refrigerant system.

d. Loosen the compressor mounting nuts.

e. Slide the compressor up in its slotted mounting to relieve tension on the drive belt. Roll belt off the compressor pulley.

f. Remove mounting nuts and washers and remove compressor.

COMPRESSOR INSTALLATION

a. Position the compressor in its slotted mounting brackets. Position washers on the compressor studs and loosely install the attaching nuts.

b. Roll the compressor drive belt onto the compressor pulley. For adjustment of the belt refer to COMPRESSOR BELT TENSION ADJUSTMENT.

c. Torque the compressor mounting nuts to 160-190 inch-pounds.

d. Install the refrigerant lines to the compressor service valves.

e. Install the electrical leads to the magnetic clutch.

f. Install the RH engine cowling.

"END"