

COMPRESSOR BLEED AIR HEATER - DESCRIPTION AND OPERATION

1. General

- A. The temperature and volume of air flow to the cabin is regulated by the cabin heating, ventilating and defrosting system. In the heating system, hot compressor outlet air and interstage compressor bleed air ($P_{2.5}$ and P_3 bleed air extracted from the engine) provide the source of heat. This heat is routed via a gate valve and a mixer/muffler to the cabin air distribution system. Controls are provided to direct the heated air to the forward or aft portions of the cabin for heating and to the windshield for defrosting.
- B. Two configurations of compressor bleed air heater may be used on the airplane. These configurations are described in Description and Operation below.
- C. Schematics and flow diagrams are provided to aid the maintenance technician in system understanding. These schematics and flow diagrams are applicable to both configurations of compressor bleed air heaters. Refer to Figure 1 for a compressor bleed air heater schematic. Refer to Figure 2 for a heating and defrosting flow diagram.

2. Description and Operation (Airplanes 20800001 Thru 20800179 and 208B0001 Thru 208B0209)

- A. Component Descriptions are as follows:

- (1) Temperature Limiter Switch.

- (a) The temperature limiter switch is installed in the cabin heat firewall shutoff valve. The switch will open and de-energize the gate valve solenoid if bleed air temperature exceeds 210°F, +10 or -10°F. The switch will close when the temperature reduces to 196°F.

- (2) Flow Control Valve and Solenoid Valve Assembly.

- (a) The flow control valve acts as a variable (low) pressure regulator. It consists of a pressure operated poppet valve with a solenoid operated control pressure valve. Control pressure from the temperature control valve causes the spring-loaded poppet valve to open as control pressure increases. A diaphragm separates the control pressure cavity from P_3 turbine bleed air which acts in conjunction with the spring tending to close the valve.

- (3) Regulator and Gate Valve Subassembly.

- (a) The regulator and gate valve subassembly consists of a pressure regulator, a gate valve assembly and an interconnecting control pressure line.

- (4) Pressure Regulator Assembly.

- (a) The function of the poppet valve regulator is to reduce P_3 compressor outlet bleed air control pressure to 18.0 PSIG, +1 or -1 PSIG. A relief valve is provided to prevent excess downstream pressure in the event of regulator failure. The relief valve is set to open at 22.0 PSIG, +1 or -1 PSIG, and to reseat at 20.0 PSIG minimum. A small, screened opening below the inlet port allows the unpressurized side of the poppet valve rolling diaphragm to vent to atmosphere. A tapped port on the downstream side of the pressure regulator provides regulated air via the control pressure line to the gate solenoid valve.

- (5) Temperature Control Valve Assembly.

- (a) The needle control valve regulates the control pressure at the gate valve. The control valve has approximately 270 degree rotation. Clockwise rotation closes the valve, increasing control pressure up to 17.0 PSIG and increasing heat. Counterclockwise rotation opens the valve, decreasing pressure and decreasing heat.

NOTE: The valve does not close completely. A bleed of 800 to 1000 CC/minute flow is allowed to vent to atmosphere to accommodate hysteresis of the gate valve.

- (6) Air Ejector Assembly (Mixer/Muffler).

- (a) The air ejector assembly consists of a muffler and bleed air ejector. The assembly combines regulated P_3 air with either $P_{2.5}$ air or cabin recirculation air and routes this flow to the cabin. The ejector configuration ensures complete mixing of the air sources, thereby reducing the P_3 primary flow to a usable cabin heat source temperature. The cavity between the inner perforated tube and the outer shell is insulated with Nomex and fiberglass to attenuate noise and to act as a muffler.

- (7) Valve Assembly - Air Diverter (Mixing Air Valve).

WARNING: This position is not to be used in flight. In the FLT PUSH position, $P_{2.5}$ air is dumped to atmosphere. Cabin air is drawn into the muffler to mix with regulated P_3 air. The FLT PUSH position may be used on the ground if $P_{2.5}$ heat augmentation is not required.

- (a) The diverter valve (mixing air valve) has two doors mechanically linked together, with both doors operated by a single MIXING AIR control. In the GRD PULL position, $P_{2.5}$ interstage compressor bleed air provides heat at power settings below 89 percent N_g and is used to augment the regulated P_3 compressor outlet bleed air on the ground in cold temperatures. In the FLT PUSH position, $P_{2.5}$ interstage compressor bleed air is dumped to atmosphere. Cabin air is drawn into the muffler to mix with regulated P_3 compressor outlet bleed air. The FLT PUSH position may be used on the ground if interstage compressor bleed air heat augmentation is not required.
- (8) Heater Valve, Firewall Shutoff.
 - (a) The two firewall shutoff valves are operated by a single control located on the lower right side of the pilot's control pedestal. With the control pushed IN, both valves are open. The lower valve controls bleed air supply from the mixer/muffler. The temperature limiter switch is installed on the right side of the valve and just above it is a cam operated microswitch in series with the temperature limiter switch. The microswitch is closed when the shutoff valve door is open. The upper valve provides the cabin air return to the mixing valve.
- (9) Controls.
 - (a) The two firewall shutoff valves are operated by a single push/pull control knob, CABIN HEAT FIREWALL SHUTOFF PULL OFF, located on a panel on the lower right side of the pilot's control pedestal. When the knob is placed in the OFF position, it closes firewall doors and flow control valve. With the shutoff knob in this position, heated bleed air from the engine is shut out of the heating system, and heated air from the heating system is kept out of the cabin.

3. Description and Operation (Airplanes 20800180 and On, 208B0210 and On, and Airplanes Incorporating CAB90-9)

A. Components of the system are as follows:

- (1) Temperature Limiter Switch.
 - (a) The temperature limiter switch is installed in the cabin heat firewall shutoff valve. The switch will open and de-energize the flow control valve solenoid if the bleed air temperature exceeds 210°F, +10° or - 10°F, preventing P_3 air flow into the mixer/muffler and cabin. The switch will close when the temperature reduces to 196°F, +21° or - 21°F.
- (2) Flow Control Valve and Solenoid Valve Assembly.
 - (a) The flow control valve acts as a variable (low) pressure regulator. It consists of a pressure operated poppet valve with a solenoid operated control pressure valve. Control pressure from the temperature control valve causes the spring-loaded poppet valve to open as control pressure increases. A diaphragm separates the control pressure cavity from P_3 turbine bleed air which acts in conjunction with the spring tending to close the valve.
- (3) Pressure Regulator Assembly.
 - (a) The function of the poppet valve regulator is to regulate P_3 bleed air pressure between 17.0 to 20.0 PSIG for instrument vacuum and deice systems operation. It is functionally independent of the heater system. A relief valve is provided to prevent excess downstream pressure in the event of regulator failure to protect the deice boots from over inflation. The relief valve is set to open at 22.0 PSIG, +1.0 or -1.0 PSIG.
- (4) Temperature Control Valve Assembly.
 - (a) The instrument panel mounted valve is an adjustable relief valve which varies flow control valve dome control pressure, thereby changing flow through the flow control valve and cabin air temperature. The control valve has approximately 270 degree rotation. Clockwise rotation closes the valve, increasing control pressure and increasing heat; counterclockwise rotation opens the valve, decreasing pressure and decreasing heat.
- (5) Air Ejector Assembly (Mixer/Muffler).
 - (a) The air ejector assembly consists of a muffler and bleed air ejector. The assembly combines regulated P_3 air with either $P_{2.5}$ air or cabin recirculation air, and routes this flow to the cabin. The ejector configuration ensures complete mixing of the air sources, thereby cooling the P_3 primary flow to a usable cabin heat source temperature. The cavity between the inner perforated tube and the outer shell is insulated with Nomex and fiberglass to attenuate noise and to act as a muffler.
- (6) Valve Assembly - Air Diverter (Mixing Air Valve).

WARNING: This position is not to be used in flight. In the FLT PUSH position, $P_{2.5}$ air is dumped to

atmosphere. Cabin air is drawn into the muffler to mix with regulated P₃ air. The FLT PUSH position may be used on the ground if P_{2.5} heat augmentation is not required.

- (a) The diverter valve (mixing air valve) has two doors mechanically linked together, which are both operated by a single MIXING AIR control. In the GRD PULL position, P_{2.5} air provides heat at power settings below 89 percent N_g and is used to augment the regulated P₃ heat on the ground in cold temperatures.
- (7) Heater Valve - Firewall Shutoff.
- (a) The two firewall shutoff valves are operated by a single control located on the lower right side of the pilot's control pedestal. With the control pushed IN, both valves are open. The lower valve controls bleed air supply from the mixer/muffler. The temperature limiter switch is installed on the right side of the valve; just above it is a cam-operated microswitch in series with the temperature limiter switch. The microswitch is closed when the shutoff valve door is OPEN. The upper valve provides the cabin air return to the mixing valve.
- (8) Microswitch - P₃ Flow Shutoff.
- (a) The microswitch is installed in the cabin heat firewall shutoff valve. The switch will open and de-energize the flow control valve solenoid when the firewall shutoff valves are closed, preventing P₃ air flow to the mixer/muffler and cabin.
- (9) Controls.
- (a) The cabin heat control panel is located at the lower edge of the instrument panel, to the right of airplane centerline. Individual controls are described from left to right.
- 1 Temperature Control. Rotary control needle valve for temperature control. Rotate clockwise to increase flow of heated air; rotate counterclockwise to decrease flow.
 - 2 Bleed Air Heat Switch. ON/OFF switch controls electrical power to the flow control valve solenoid. (P₃ air flow on/off control.)
 - 3 Mixing Air Push/Pull Control. Controls mixing air valve. (Mixing P_{2.5} air with P₃ air - not to be used in flight.)
 - 4 Aft Cabin/Fwd Cabin Push/Pull Control. Controls cabin heat selector valve and diverts heat to forward or aft cabin.
 - 5 Defrost/Fwd Cabin Push/Pull Control. Controls air selector valve to divert heat for defrost or forward cabin.
 - 6 Cabin Heat Firewall Shutoff Push/Pull Control. Located on the lower right side of the pilot's control pedestal. Pull to isolate all nacelle bleed air components and flow to and from the cabin.
 - 7 Bleed Air Heat Circuit Breaker. Located on the left side wall circuit breaker panel. Source of electrical power for the flow control gate valve solenoid.

Figure 1 : Sheet 1 : Compressor Bleed Air Heater Schematic

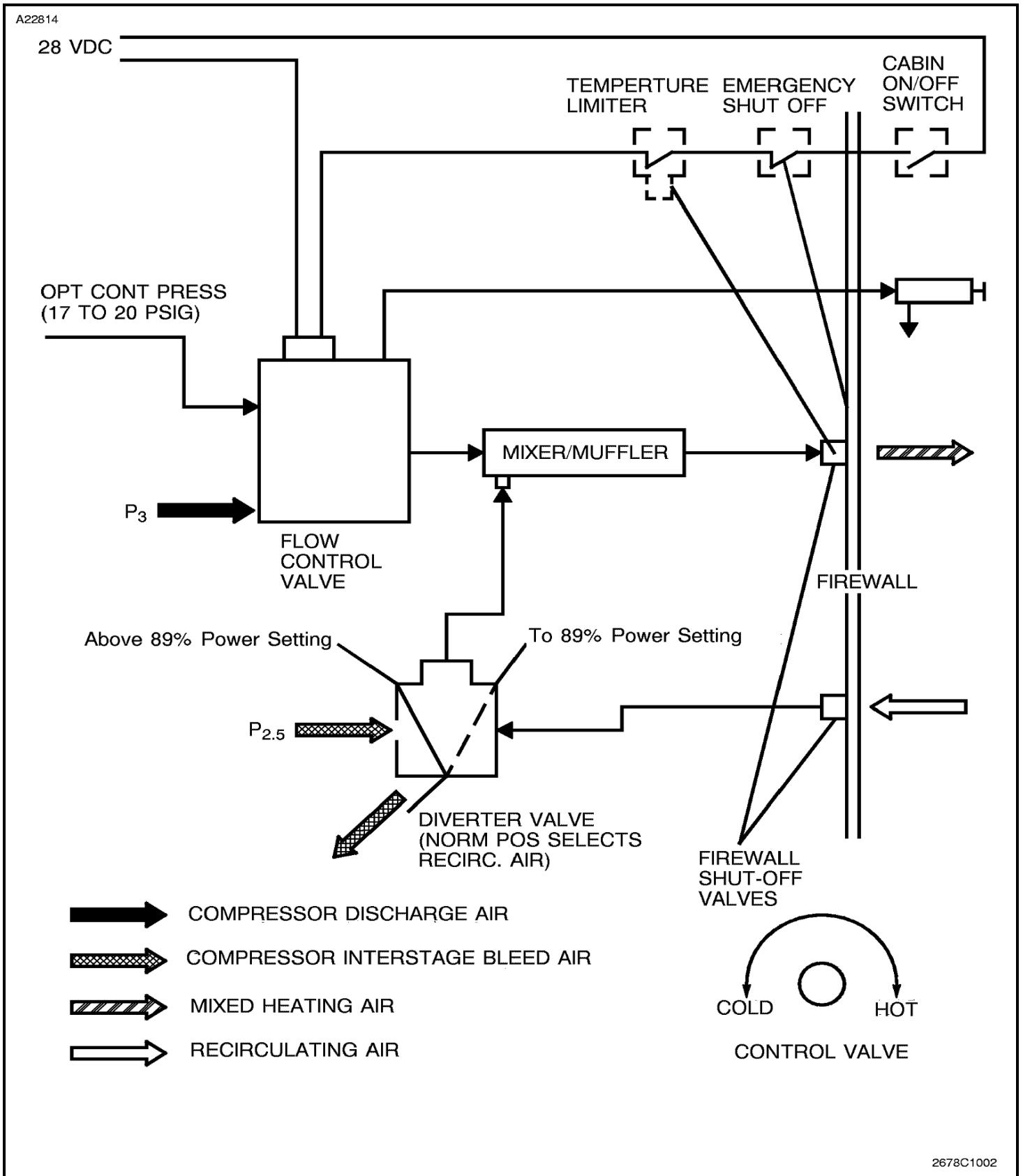


Figure 2 : Sheet 1 : Heating and Defrosting Flow Diagram

