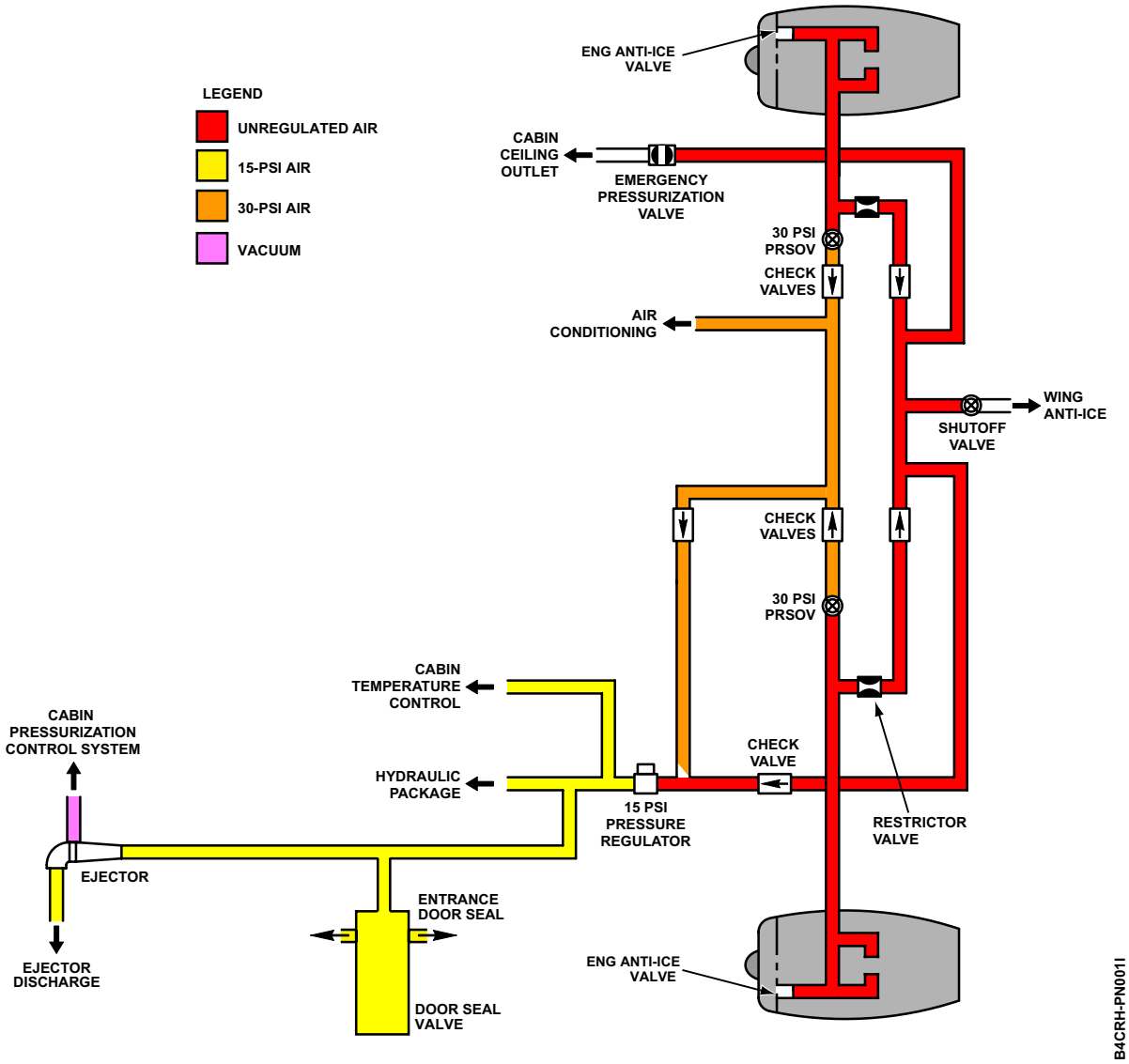
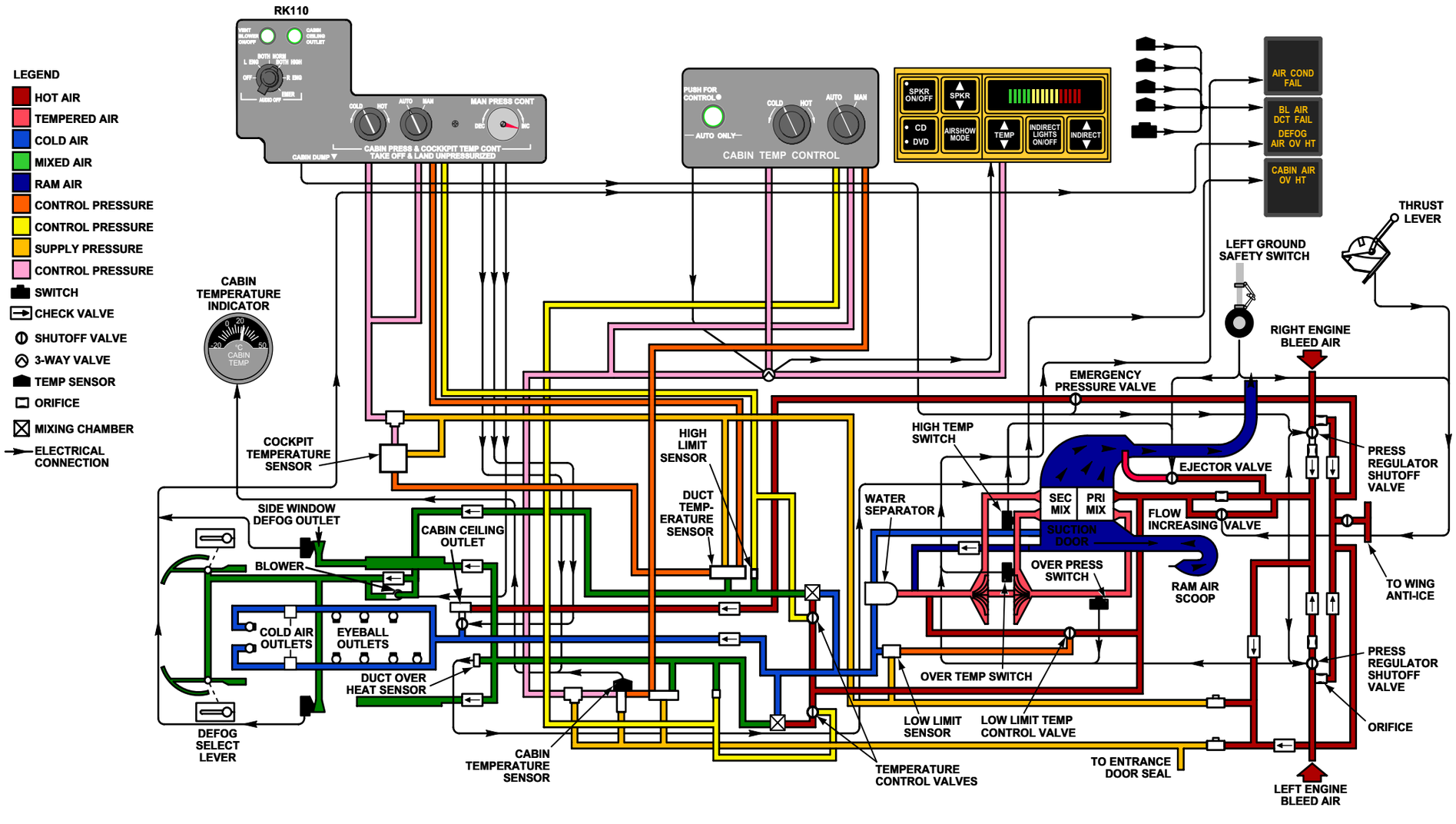
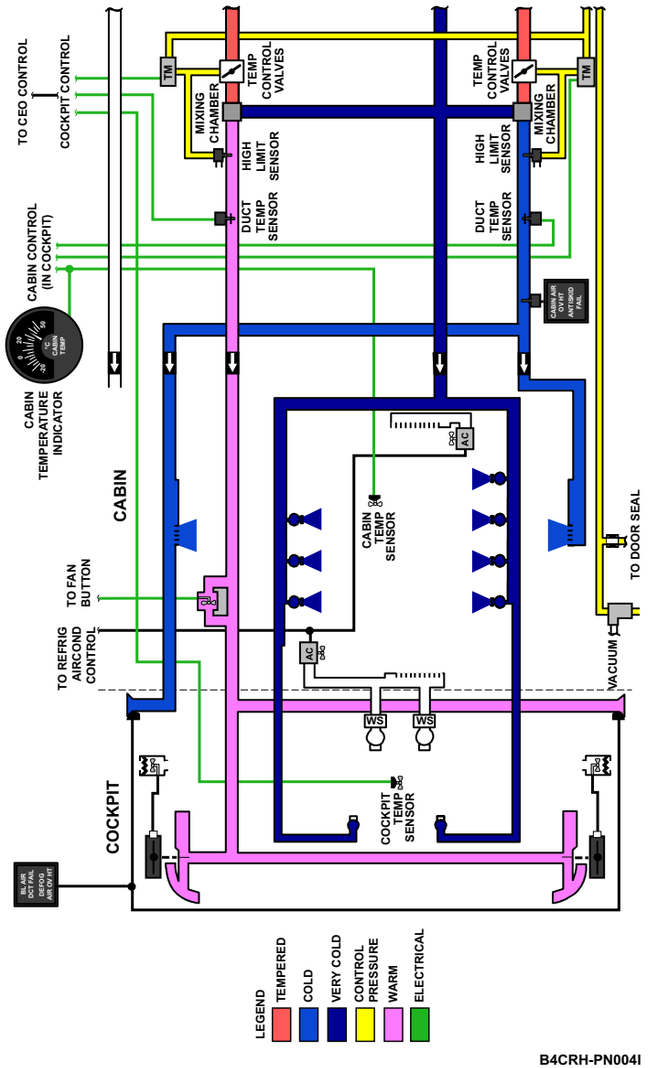
Pneumatic System



Environmental System Mechanical

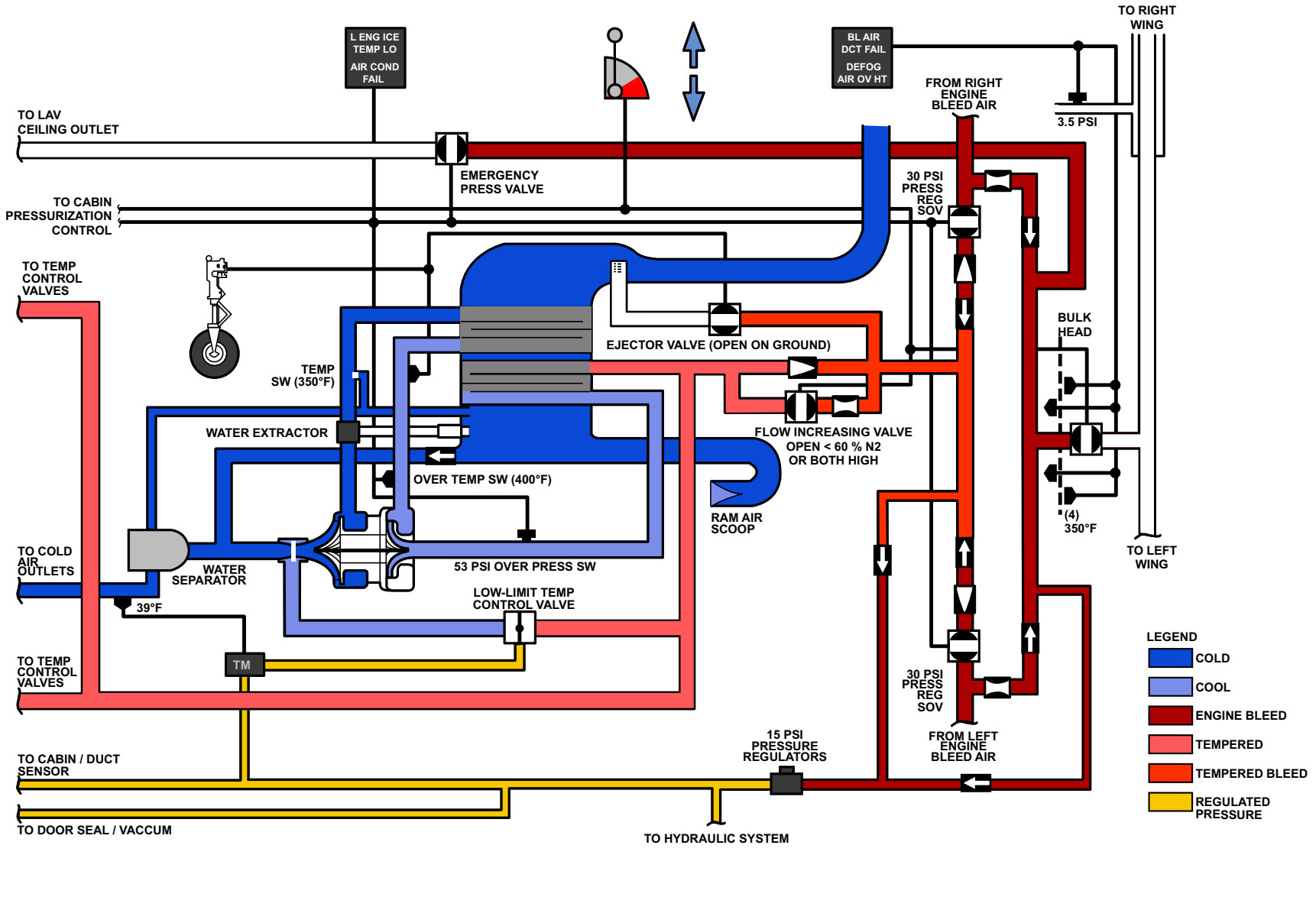


Air Distribution

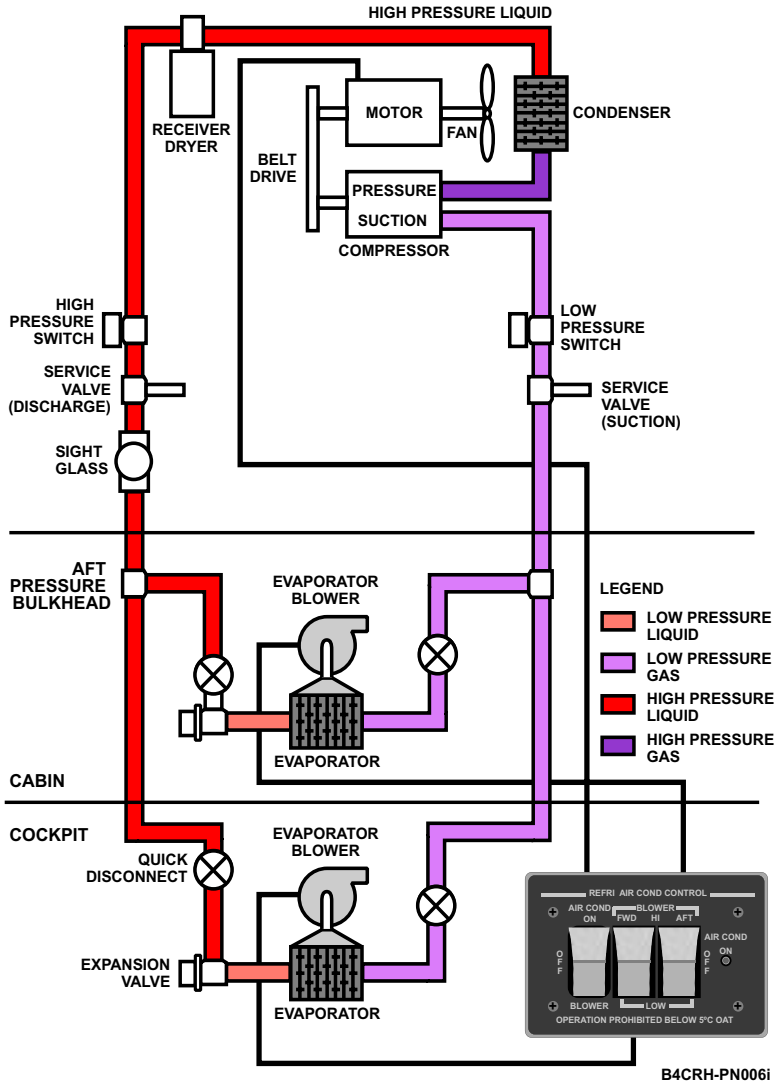


B4CRH-PN004I

Air Cycle Machine (ACM)



Vapor-Cycle Cooling System Mechanical



Pneumatic Systems

The pneumatic system extracts hot engine bleed air and then controls, regulates and distributes it. Regulated air is supplied to the air-conditioning, wing anti-ice, hydraulic reservoir, cabin temperature control, jet pump and door seal systems. Vacuum generated by a jet pump is supplied to the pressurization system controls. Pneumatics, air-conditioning, ventilation and pressurization are closely tied together. The pneumatic system bleed air is supplied to the air-conditioning system, which introduces conditioned air into the fuselage for the passenger's comfort. The cabin is pressurized by controlling the rate at which the air-conditioned bleed air is allowed to escape from the pressure vessel.

System Operation

High compressor discharge air from the engine is tapped off from two extraction pads, located respectively at 5 and 7 o'clock on the bypass duct. This gas generator case air pressure is manifolded and provided for airplane services.

The air is routed from the engines to a manifold in such a way that air from each engine feeds all systems but does not feed into the opposite engine. The use of check valves allows this arrangement, and each system that is fed uses some form of pressure or flow regulation.

An ejector-type air pump is mounted in the wall of the cabin just forward of the entrance door. The ejector uses regulated bleed air to produce a vacuum for the pressurization control units. The vacuum serves as a reference pressure for the system. The vacuum is ported to the vacuum regulator in the cabin pressurization control module.

Bleed air to the air cycle machine is controlled by a five-position switch labelled OFF, L ENG, BOTH NORM, BOTH HIGH, R ENG and EMER. Each switch position and its effect on bleed air operation is listed below:

OFF – No bleed air is supplied. Ram air is supplied to the cabin in-flight. No temperature control is provided.

L ENG – Bleed air is supplied from the left engine. The right bleed air is shut off. Normal temperature control is provided.

BOTH NORM – Bleed air is supplied by both engines. Normal temperature control is provided.

BOTH HIGH – Bleed air is supplied by both engines at a greater rate than in the BOTH NORM position by opening the flow increasing valve. Normal temperature control is provided.

R ENG – Bleed air is supplied by the right engine. The left bleed air is shut off. Normal temperature control is provided.

EMER – Bleed air is supplied to the cabin for emergency pressurization. No temperature control is provided.

If contaminated air is suspected from one engine, operating the air-conditioning system on the other engine only isolates the engine. Full cabin pressurization is still available while operating the system on one engine.

Should emergency pressurization be selected or automatically actuated by system failure, hot, unregulated engine bleed air flows from the cabin ceiling outlet. The air temperature depends on altitude and engine RPM, and decreasing thrust may reduce the cabin temperature.

A more detailed discussion on air-conditioning and pressurization can be found in their respective chapters of this manual.

Wing Anti-Ice

Engine bleed air is tapped from the bleed air manifold and routed to the wing anti-ice pressure regulator and shutoff valve. The valve is controlled by the anti-ice system, which uses the air for preventing ice buildup on the wing leading edges. A more detailed discussion on wing anti-ice can be found in the Ice and Rain Protection section of this manual.

Hydraulics

Engine bleed air tapped from the bleed air manifold is used to pressurize the hydraulic system reservoir. This bleed air is regulated to 15 PSI and assures a constant head of pressure on the hydraulic reservoir. A more detailed discussion on hydraulics can be found in the Hydraulic Power Systems section of this manual.

Entrance Door Seal

This system consists of a relief valve, door seal valve and seal, and connecting ducting.

The relief valve regulates the air pressure supplied to the door seal, ejector, and air-conditioning temperature control system. The relief valve is preset to regulate air pressure to 15 ±1 PSI.

The clearances around the entrance door, necessary for proper door opening and closing, do not allow the pressurization system to maintain the desired cabin altitude, so an inflatable seal is installed around the door frame. The door seal is inflated and deflated by the door seal valve. The door seal valve receives regulated air pressure from the relief valve. The door seal valve is a solenoid-operated type that is controlled by the left main landing gear safety switch and the entrance door No. 1 lock switch. If the landing gear safety relay No. 4 is in the air position and the door switch is actuated, the door seal valve is de-energized and allows the door seal to be pressurized. When the door is unlocked or the airplane is on the ground, the door seal valve is energized and stops pressure from going to the seal. Pressure within the seal is dumped into the cabin.

Environmental System

The pressurization and air-conditioning systems utilize bleed air to pressurize and air-condition the cabin, and defog the cockpit windows. During normal operation, most functions are automatic. The only manual adjustments required are for individual comfort, such as cabin rate of climb and temperature. Ram air for cabin ventilation is available when the pressurization system is not in use.

Air Distribution

Cabin air distribution lines are composed of cold air lines and conditioned air lines. Cold air is delivered to the cockpit and cabin overhead eyeball outlets. Conditioned air is fed through check valves at the aft pressure bulkhead to the cabin floor outlets on both sides and to the armrest. The cockpit has a separate but similar system. These bulkhead check valves are used to prevent cabin depressurization in the event of a duct rupture upstream. The cockpit system includes floor outlets and a windshield and side window defogger. DEFOG SELECT levers are provided for the pilot and copilot to select defog, floor outlets, or a combination of both. Thermal switches, installed in the cockpit side window defog ducts, illuminate the DEFOG AIR OVHT annunciator if duct temperatures above 200°F (93°C) are encountered. This is to prevent the side windows from being damaged by heat. Manually controlled air outlets are provided in the upper area of the cockpit to supply cold air to the pilots.

The ventilation blower introduces outside fresh air into the cockpit depending on whether environmental control system OFF or ON operation is selected. An illuminated push button-type switch, located adjacent to the cockpit mode select switch, controls the ventilation blower operation.

Pressurization

The cabin is pressurized by flow of air from the cockpit and cabin air outlets. Cabin pressurization control is accomplished by modulating discharge air from the cabin. The system's major components are the outflow safety valves, cabin air pressure controller, manual control valve, pneumatic relay, altitude pressure regulator, air filters, solenoid valves, and a quick dump valve. This system uses a variable isobaric controller to drive two outflow safety valves through a pneumatic relay. Both outflow safety valves modulate flow of air discharged from the cabin during normal operation. Either or both valves open automatically, as required, to provide positive or negative pressure relief protection. Both valves are connected to cabin altitude pressure regulators that automatically override a valve failure and prevent the cabin altitude from exceeding 12,500 ± 1,500 feet.

The CABIN PRESS switch determines the source of air for cabin pressurization. It is a six-position rotary-type switch with positions placarded OFF, L ENG, BOTH NORM, BOTH HIGH, R ENG, and EMER:

OFF – No bleed air is supplied. Ram air is supplied to the cabin in flight. No temperature control is provided.

L ENG – Bleed air is supplied by the left engine. The right bleed air is shut off. Normal temperature control is provided.

BOTH NORM – Bleed air is supplied by both engines. Normal temperature control is provided.

BOTH HIGH – Bleed air is supplied by both engines at a greater rate than in the BOTH NORM position.

NORM – Position by opening the flow increasing valve. Normal temperature control is provided.

R ENG – Bleed air is supplied by the right engine. The left bleed air is shut off. Normal temperature control is provided.

EMER – Bleed air is supplied to the cabin for emergency pressurization. No temperature control is provided.

The caution annunciators for the pressurization system are:

AIR COND FAIL – Illuminates automatically for bleed air over temperature or overpressure conditions and results in actuation of emergency pressurization. Placing the CABIN PRESS switch to the EMER position will also illuminate this light.

DEFOG AIR OVHT – Illuminates if the air supply to the cockpit side window defog system exceeds 200°F (93°C).

BL AIR DCT FAIL – Illuminates if any four of the sensor switches installed in the aft fuselage detects excessively high temperature due to a rupture of the bleed air duct or leakage of wing anti-ice lines in the cabin.

CABIN AIR OVHT – Illuminates if air supply to the cabin exceeds 390°F.

Cabin Air Pressure Controller

The cabin air pressure controller is mounted on the right instrument panel and controls the cabin altitude and cabin rate of climb. This unit is connected to the vacuum source, the pneumatic relay, and the cabin ambient pressure. The controller face has a cabin altitude selector knob, a cabin rate control selector knob, and a dial showing cabin altitude setting and the altitude at which the airplane will reach maximum differential pressure for the selected cabin altitude pressure. Desired cabin altitude and maximum airplane altitude, at which the cabin altitude can be maintained, is selected by rotating the cabin altitude select knob. The knob, to the left of the dial, controls the rate of change of cabin altitude within a range of approximately 50 to 2,000 feet per minute. When the arrow on the knob is halfway between MIN and MAX (straight up), a rate of approximately 500 feet per minute is obtained.

Pneumatic Relay

The pneumatic relay is mounted in the cabin pressure control module that is installed on the cabin side of the forward pressure bulkhead. The pneumatic relay is a high gain device that operates by a signal from the cabin air pressure controller and from cabin pressure to regulate the outflow safety valve control pressure to the desired level.

Altitude Pressure Regulator

The altitude pressure regulator directly senses cabin pressure. When the cabin altitude pressure reaches 12,500 ±1,500 feet, the poppet valve in the regulator opens to direct cabin pressure to both outflow safety valve control chambers. The outflow safety valves will close to a modulating position, thus preventing excessive exhaust of cabin air.

Outflow Safety Valves

The two outflow safety valves are installed on the forward pressure bulkhead. The outflow safety valves regulate cabin airflow through the pressure bulkhead. The valves are controlled by an air pressure signal from the cabin air pressure controller through the pneumatic relay. The valve contains a positive differential pressure relief (9.1 PSI) and a negative relief.

Manual Control Valve

The MAN PRESS CONT valve, mounted on the instrument panel, is used to manually depressurize the cabin. This valve is connected to a vacuum source and the outflow safety valve control line. The cabin can be depressurized in an emergency by turning the knob counter-clockwise. This action proportionately vents the control chambers of both outflow safety valves to vacuum, resulting in opening of the outflow safety valves. The cabin may be depressurized to an altitude of 12,500 ±1,500 feet.

Quick Dump Valve

The quick dump valve is mounted on the copilot lower instrument panel and provides rapid cabin depressurization in case of emergency. Turning the knob counter-clockwise opens this valve. This results in complete and rapid depressurization of the cabin.

Indicators and Annunciators

The cabin altitude differential pressure indicator and cabin rate of climb indicator are installed on the instrument panel. The CABIN PRESS LO annunciator will illuminate to warn the pilot when the cabin altitude exceeds 9,500 ± 500 feet. The CABIN PRESS HI annunciator will illuminate to warn the pilot any time cabin differential pressure exceeds 9.1 PSI.

Pressurization Control

On takeoff, when the thrust levers are advanced to the T.O. position on the ground, the cabin is pressurized to a positive 80 feet differential. This prevents a pressure bump at liftoff.

During climb, the cabin altitude and rate controls enable the pilot to select the desired cabin altitude and the desired cabin rate of climb. The selected values can be maintained until pressure differential between the cabin and the atmosphere reaches 8.9 to 9.1 PSI.

When preparing to descend, the crew should select the landing field elevation plus 500 feet on the controller. When the cabin reaches the selected landing altitude, the system maintains the cabin at 500 feet above field elevation until the airplane descends below this level. The outflow safety valves are opened while descending through the 500-foot level, assuring an unpressurized cabin during landing.

Air Conditioning

Engine bleed air is used to heat, cool, and pressurize the cabin. Hot compressed air is tapped off the gas generator case of each engine. Bleed air coming from the engine will not normally exceed 600°F (315°C) and 150 PSI at takeoff rated power. The bleed air is routed into the air cycle machine located in the aft fuselage. Prior to reaching the air cycle machine, bleed air passes through a pressure regulator/shutoff valve, a venturi, and a check valve. The pressure regulator/shutoff valve reduces bleed air pressure to 30 PSI and serves as a system shutoff. The inlet venturi is installed to restrict the volume of air that can be extracted from the engine. At low power settings (below 60% N_1 during ground operations) the volume of air flowing through the venturi is inadequate; therefore, a flow-increasing valve is used to increase the airflow. Switches located on the thrust lever quadrant and the squat switch automatically control the flow-increasing valve.

Air Cycle Machine

Hot bleed air passes through the primary heat exchanger, which decreases the bleed air temperature. The heat exchangers are cooled by ram air supplied through the flush scoop on both sides of the dorsal fin. A bleed air ejector augments the ram air. The ejector shutoff valve is an electrical solenoid-type valve that is normally open (powered closed). It is open during all ground operations. Air flowing through the primary heat exchanger is partially cooled and then directed to the compressor where its pressure and temperature are increased. A thermal switch installed in the compressor outlet duct is used to sense abnormally high temperatures that might occur during low speed flight with low ram pressure. If the thermal switch senses a temperature of 350°F (177°C) or above, the ejector shutoff valve opens to allow greater cooling airflow. The valve will close five minutes later, provided the temperature has returned to normal. The air then enters the secondary heat exchanger where it is partially cooled again. After the second

cooling, the air is expanded through the cooling turbine where its pressure and temperature are reduced. Energy from the expanding air is converted to shaft power to drive the compressor. At the cooling turbine outlet, hot engine bleed air is mixed with the cold turbine air to maintain a constant 39°F (4°C) at the water separator discharge. The air temperature control prevents ice buildup at the cooling turbine outlet and prevents icing at the water separator. Some of the cold air is routed to the eyeball, cockpit, and cabin ceiling outlets. The rest is routed to a mixing chamber where it is combined with hot bleed air to achieve the temperature selected by the temperature control.

An overpressure switch located in the inlet of the compressor and an over temperature switch in the outlet duct of the compressor are provided to protect the cooling package from the effects of a system failure. Temperatures above 350ºF (177°C) will open the ejector shutoff valve, allowing the ejector to introduce additional cooling air for the heat exchanger. Pressure above 53 PSI or temperature above 400°F (204°C) will close both pressure regulator/shutoff valves, the emergency pressure valve will open and the AIR COND FAIL annunciator will illuminate.

Vapor Cycle Cooling

Airplanes RK-78, RK-87 thru RK-109, except RK-98

The Vapor Cycle Cooling system uses the refrigerant (R134a) routed through a mechanical system, to cool the airplane cockpit/cabin areas. The main components of the system are the electrically driven compressor/condenser module, a receiver/dryer, thermal expansion valves, evaporator modules, and connecting plumbing. Electrical power for the system may be supplied from an external power source or the airplane's generators.

The compressor draws low-pressure gaseous refrigerant to it from the forward and aft evaporator modules. At the compressor, the refrigerant is compressed into a high-pressure gas and routed to the condenser. At the condenser, aft fuselage air is blown over the condenser coils by a shrouded fan attached to the compressor drive motor. As the air passes over the condenser coils the refrigerant is cooled and changes from a high-pressure gas to a high-pressure liquid. The heat-laden air is then ducted overboard. From the condenser, the high-pressure liquid refrigerant is routed to the thermal expansion valves at the forward and aft evaporators. These valves regulate the flow of refrigerant into the evaporators. As the valves release the refrigerant into the evaporators, the refrigerant expands and becomes a low pressure liquid. Cockpit cabin air, drawn by the evaporator blowers is blown over the evaporator coils. This causes the heat to transfer from the cockpit/cabin air to the refrigerant. This cools the cockpit/cabin air and changes the refrigerant from a low-pressure liquid to a low pressure gas. The refrigerant, as a low-pressure gas, is then pulled to the compressor and the cycle is repeated.

The system switches and operation light are located in the REFRIG AIRCOND CONTROL panel that is mounted on the copilot's side panel. The air-conditioning switch is labeled AIR COND-ON-OFF-BLOWER. In the OFF position the compressor/condenser module and the evaporator blowers are not powered. Selecting the ON position powers the compressor/condenser and the forward evaporator blower. The forward evaporator blower will then operate at the speed selected by the BLOWER-FWD-HI-LO switch. Selecting the BLOWER position powers the forward evaporator blower.

The AIR COND switch in either the ON or BLOWER position supplies power to the aft evaporator blower switch.

NOTE: Do not rapidly cycle the AIR COND switch.

Illumination of the air-conditioning light indicates that electrical power is being supplied to the compressor motor.

The BLOWER-FWD-HI-LO switch controls the speed of the forward evaporator blower and the BLOWER-AFT-HI-OFF-LO switch controls the operation of the aft evaporator blower. Both blower switches receive power from the AIR COND switch when ON or BLOWER is selected.

NOTE: If the ECS and refrigeration air-conditioning are to be operated at the same time, manual temperature control should be selected.

Airplanes RK-98, RK-110 and After

The operation of this vapor-cycle system is the same as that of RK-78, RK-87 thru RK-109, except RK-98 but the evaporators have been redesigned, the control relays and the aft evaporator have been relocated, and the appropriate changes were made to the associated ductwork and wiring harness. The aft evaporator was located in front of the left partition, forward of the aft cabin area. It is now located aft of the right partition, outboard of the right upholstery panel, in the aft cabin. The control relays that were mounted in the evaporator modules are now installed on the aft evaporator riser assembly and on the aft side of the right forward partition, by the forward evaporator module blower.

Temperature Control

The temperature control system is a pneumatically operated system that manually or automatically regulates the temperature of air delivered to the cabin from the air cycle machine. The Beechjet 400A is equipped with a two zone/two mode temperature control system which permits independent control of cabin and cockpit temperatures.

When the cockpit mode select switch on the instrument panel is set to AUTO, the cockpit temperature is automatically controlled between 60 and 90°F (16 to 32°C) by rotating the cockpit temperature control switch located on the instrument panel. When the mode select switch is set to MAN, rotating the cockpit temperature control switch manually controls the cockpit temperature. In this case, the cockpit temperature control switch directly controls the temperature control valve.

When the cabin mode select switch on the copilot's side panel is set to AUTO, the cabin temperature is automatically maintained between 60 to 90°F (16 to 32°C) after rotating the cabin temperature control switch adjacent to the mode select switch. When the mode select switch is set to MAN, rotating the cabin temperature control switch manually controls the cabin temperature. In this case, the cabin temperature control switch directly controls the temperature control valve.

CAUTION: Do not operate the cabin heat in the manual FULL HOT position after takeoff for serials thru RK-226, and RK-228 thru RK-247 unless Kit 128-5043 is installed. Refer to Safety Communiqué No.153.

The PUSH FOR CONTROL button located on the CABIN TEMP CONTROL panel does not allow for the transfer of control to the VIP panel. A passenger seated adjacent to the VIP panel may assume control of cabin temperature by pressing the TEMP button on the VIP panel. This will automatically extinguish the PUSH FOR CONTROL button indicating that control of cabin temperature is being controlled from the VIP panel. The CABIN TEMP CONTROL may be reverted back to cockpit control mode by a crewmember pressing the PUSH FOR CONTROL button. Illumination of the PUSH FOR CONTROL button indicates that CABIN TEMP CONTROL is in the AUTO mode of operation.