

CHAPTER 36 - PNEUMATIC

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GENERAL

Compression system includes devices and elements as required for air flow extraction from engines, bleed management, and distribution to diverse systems.

Compression system supplies compressed air to the following systems:

- Compression Rudder Booster System.
- Engine-Oil Cooling System.
- Compression De-Icing System (Wings, Tail and Engine Air-Intakes).
- Environmental Control System.

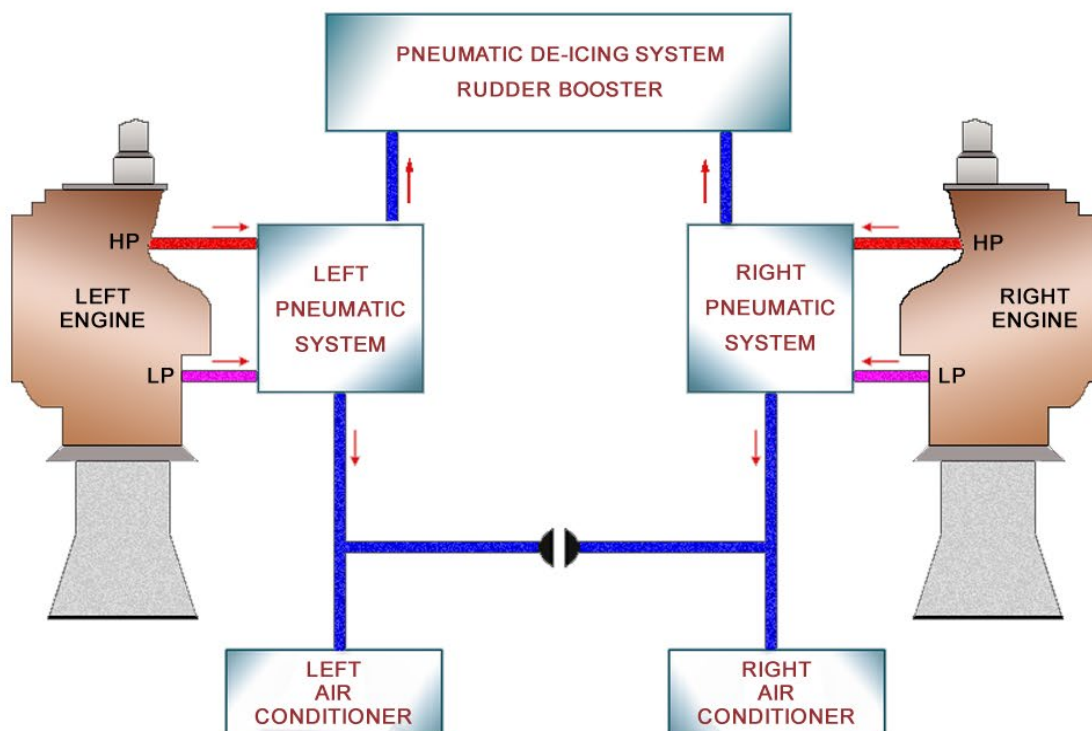


Figure 36-1 Compression System

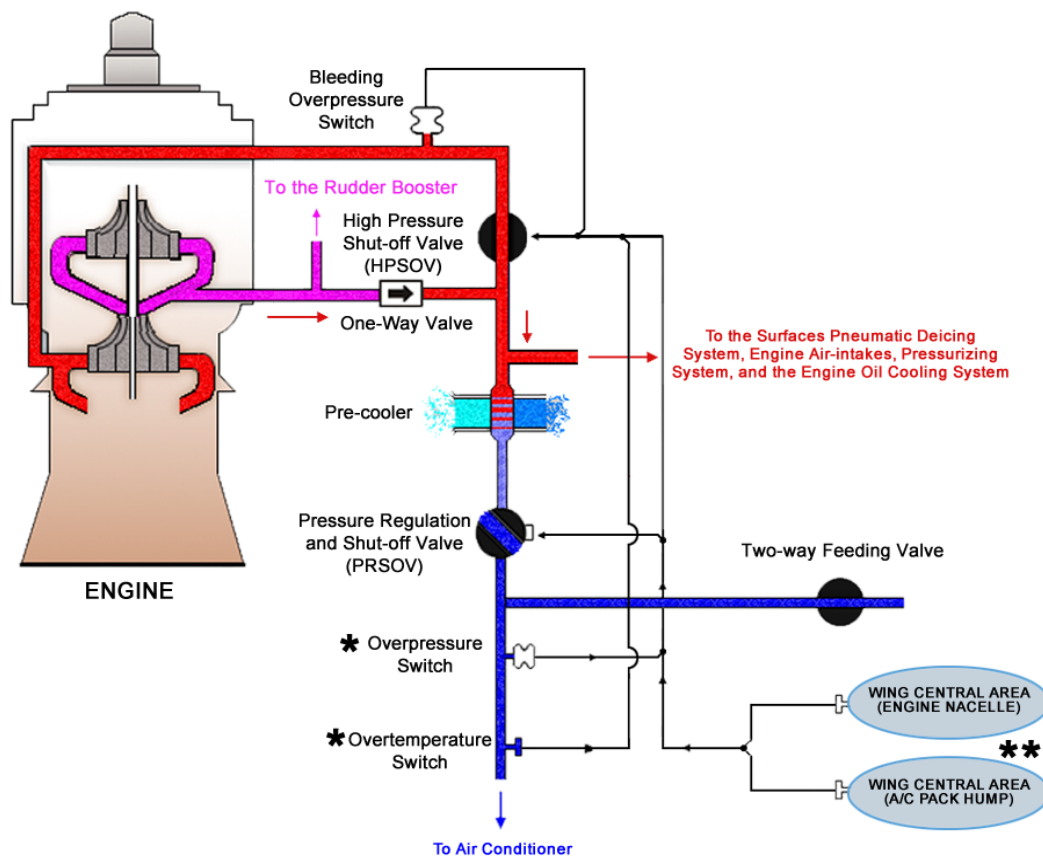
AIR DISTRIBUTION

Air distribution system is intended to supply engine bleed air from high and low pressure air stages, to requiring systems, at both adequate temperature and pressure.

DESCRIPTION

Air Distribution system combines two identical subsystems (left and right) that extract two bleeds from each engine: one low pressure bleed (LP) from the first compression stage, and a second high pressure bleed (HP) from the second compression stage. Each subsystem has a pressure regulating and shut-off valve to allow pressure regulation and to provide system shut-off means and an air to air heat exchanger to cool down the bleed air. Both subsystems can be linked by a crossway feeding system. Main components of the system are:

- **High-Pressure Shut-Off Valve (HPSOV):** an electrically-operated butterfly valve, overpressure- switch operated, to force high-pressure bled air to shut-off.
- **Precooler:** a one-way heat exchanger for bleed air cooling, with dynamic-pressurised air from an engine hood NACA type air intake.
- **Pressure Regulating and Shut-Off Valve (PRSOV):** an electrically-operated valve that keeps bleed air pressure within Environmental Control System accepted limits, according to flight altitude, and which allows to shut down the system.
- **Crossway Feeding Valve (XFEED):** a two-way electrically-operated valve that allows both Environmental Control Systems to be fed from a single air source when the aircraft is configured in HOTEL mode.
- **Air-conditioning Control Panel:** at its upper half, supports compression system controls and compression indicators.



* They control opening or closing of the valves, in response to the Pressure and Temperature conditions of the air supplied to the Air-conditioner

** Temperature Sensors: its mission is to detect possible bleeding leaks

Figure 36-2 Air Distribution

OPERATION

System operates as follows:

(1) With engine running at low rate and, one subsystem is connected by using the relevant bleed switch, pressure regulating (PRSOV) valve opens. When both pressure regulating valve and high-pressure shut-off valve open, engine high-pressure bleed air is able to feed every system except the rudder actuator one, which is fed from the low-pressure bleed. Although high-pressure bleed line is connected to the low-pressure line, a check valve prevents from high-pressure feeding back to the engine through the low-pressure line.

When engine power is increased above FI, high-pressure also increases and an overpressure switch closes the high-pressure shut-off valve (HPSOV) when pressure exceeds 65 psi. This allows engine low-pressure bleed air to feed several systems. Thus reduces the impact of taking bleed air on the engine power and fuel consumption. It also reduces bleed air temperature while maintaining its pressure. Any time high pressure drops-back below 65 psi, overpressure switch will reopen high-pressure shut-off valve (HPSOV) thus bleed air is again at high pressure.

Bleed air from high/low-pressure lines is divided in two: partially is fed to surface pneumatic de-icing systems, to the pressurization system, to the engine-oil cooling system and to the engine air-intake de-icing boots (refer to CHAPTER 21 - ENVIRONMENTAL CONTROL and CHAPTER 30 - ICE AND RAIN PROTECTION). The rest is fed through a precooler where its temperature is reduced by a ram air flow. It is then fed to the Environmental Control System through the pressure regulating valve (PRSOV), which reduces air pressure according to flight altitude.

The pressure regulating valve (PRSOV) keeps pressure within Environmental Control System acceptable limits and closes automatically if supplied air exceeds pressure or temperature limits in the bleed supply line or temperature limit at the associated air conditioning pack compressor outlet, or in case of hot air leakage from critical zones. Normal valve position is closed (while bus bars are powered but the system is not working). Valve status displays on a cockpit-located two-position magnetic indicator as crossed (horizontal) if closed, and aligned (vertical) if open. During engine start-up valve closes automatically to prevent the engine from overheating due to excessive bleed air being taken.

(2) The system is interconnected by a crossfeed valve (XFEED) allowing both air-conditioning systems to be fed from a single subsystem. To ensure system can only be used on ground, the valve can only be opened while gust-lock lever is in the vertical position. Crossfeed is achieved by pressing-in XFEED pushbutton (ON light comes on). If gust-lock lever is in vertical position, horizontal bar indication will be lightened and valve will open.

To ensure a correct operation of both air conditioning systems when fed from a single engine. It is necessary to increase the bleed air by operating the propeller brake. Then, crossfeed is only used in HOTEL mode.

(3) If temperature rises above 288°C downstream the crossfeed duct, a sensor will close the high-pressure shut-off valve (HPSOV) and AIR CONDITIONING panel amber BLEED O.TEMP light will come on. Then, the subsystem will supply bleed air from the low-pressure inlet. When sensor temperature drops to a normal value ($T < 279^{\circ}\text{C}$) the system can be reset by pressing-in the BLEED O.TEMP pushbutton. The light will go off and the high-pressure shut-off valve (HPSOV) will open.

(4) In case of overpressure ($P > 55$ psi) downstream the regulating valve and/or overheat ($T > 243^{\circ}\text{C}$) at air-conditioning pack compressor outlet, relevant high-pressure shut-off valve (HPSOV) as well as the pressure regulating valve (PRSOV) will close automatically, magnetic indicator will move to the crossed position and relevant amber PCKG BLEED light will come on. The system shall be reset by pressing-in the PCKG BLEED pushbutton. If normal conditions return once system reset is complete, PCKG BLEED light will go off and both HPSOV and PRSOV valves will reopen.

(5) Both relevant high-pressure shut-off valve (HPSOV) and pressure regulating valve (PRSOV) will also close and the associated magnetic indicator will move to the crossed position if there is a hot air leakage around upper air-conditioning pack hump or wings leading edges (close to engine nacelles area). WING OVHT warning will also display on the IEDS. Although is the same warning for both sides, the affected subsystem can be identified by checking-out which magnetic indicator is in the crossed position. Associated bleed switch should be set to OFF.

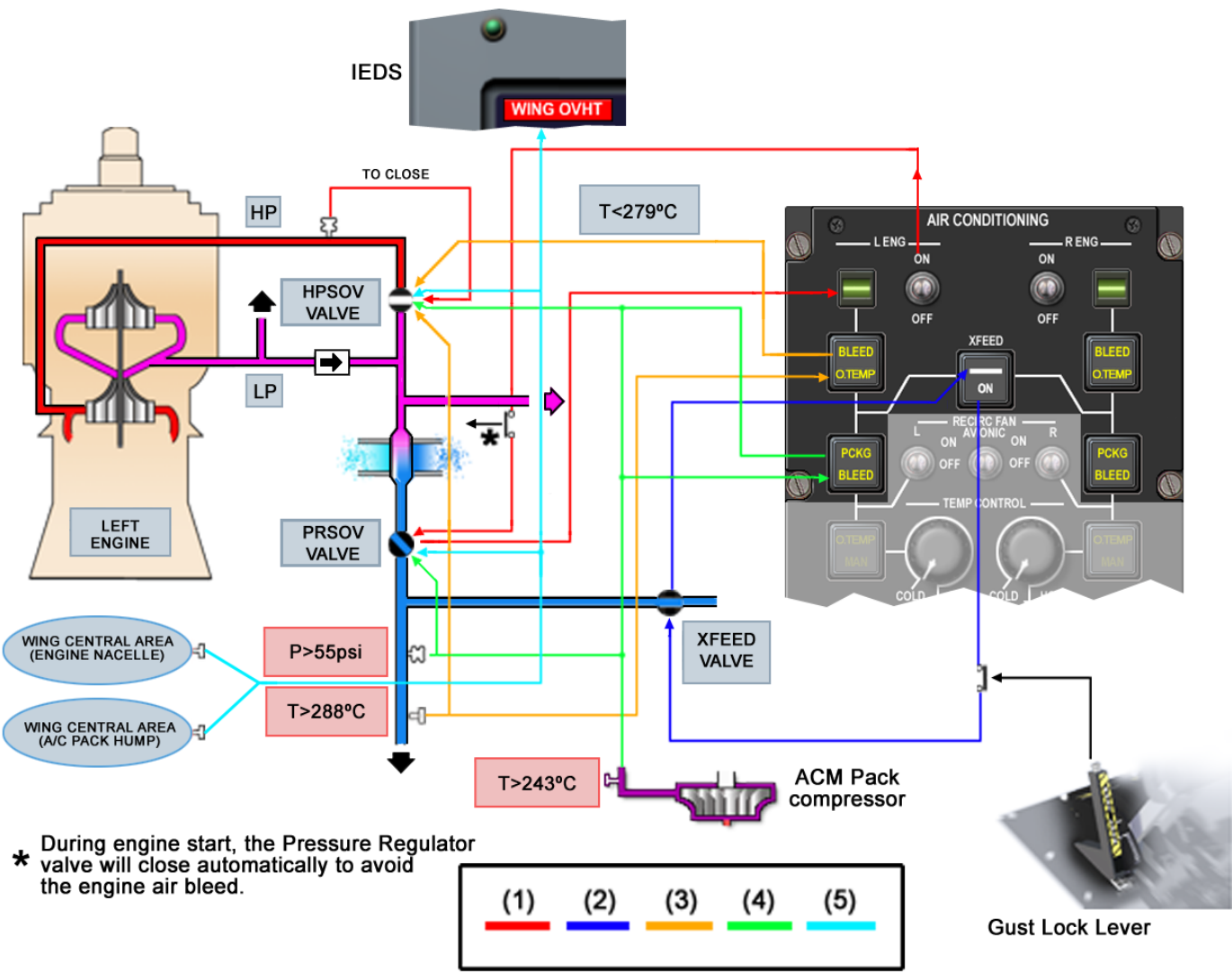


Figure 36-3 Air Distribution - Operation

CONTROLS AND INDICATORS

(1) *Bleed Switch:*

- *ON:* opens PRSOV valve at relevant bleed line.
- *OFF:* closes PRSOV valve at relevant bleed line.

(2) *Pressure Regulation and Shut-Off Valve (PRSOV) Magnetic Indicator:*

- *Aligned (vertical):* the valve is opened.
- *Crossed (horizontal):* the valve is closed.

(3) *BLEED O.TEMP Indicator:*

- *On:* overheating is detected at Compression System supply line to air-conditioning pack. HPSOV valve is closed. Once normal conditions return, valve can be reopened by pressing-in the light.

(4) *PCKG BLEED Indicator:*

- *On:* associated pack is not working (HPSOV and PRSOV valves are closed) due to over pressure in the line to its pack, or overheating at pack compressor outlet. Once normal conditions return, valve can be reopened by pressing-in the light.

(5) *WING OVHT Warning (IEDS):*

hot air leakage from central wing section (at the hump or leading edge, close to fairing area).

(6) *XFEED Pushbutton:*

- *Pressed:* ON light comes on. If gust-lock lever is vertical (aircraft grounded), Crossway Feeding Valve will open and in that case the horizontal bar indication will be lightened. Press-in again to close the valve.

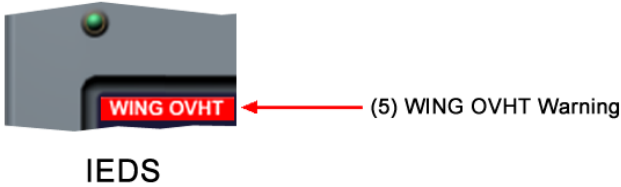
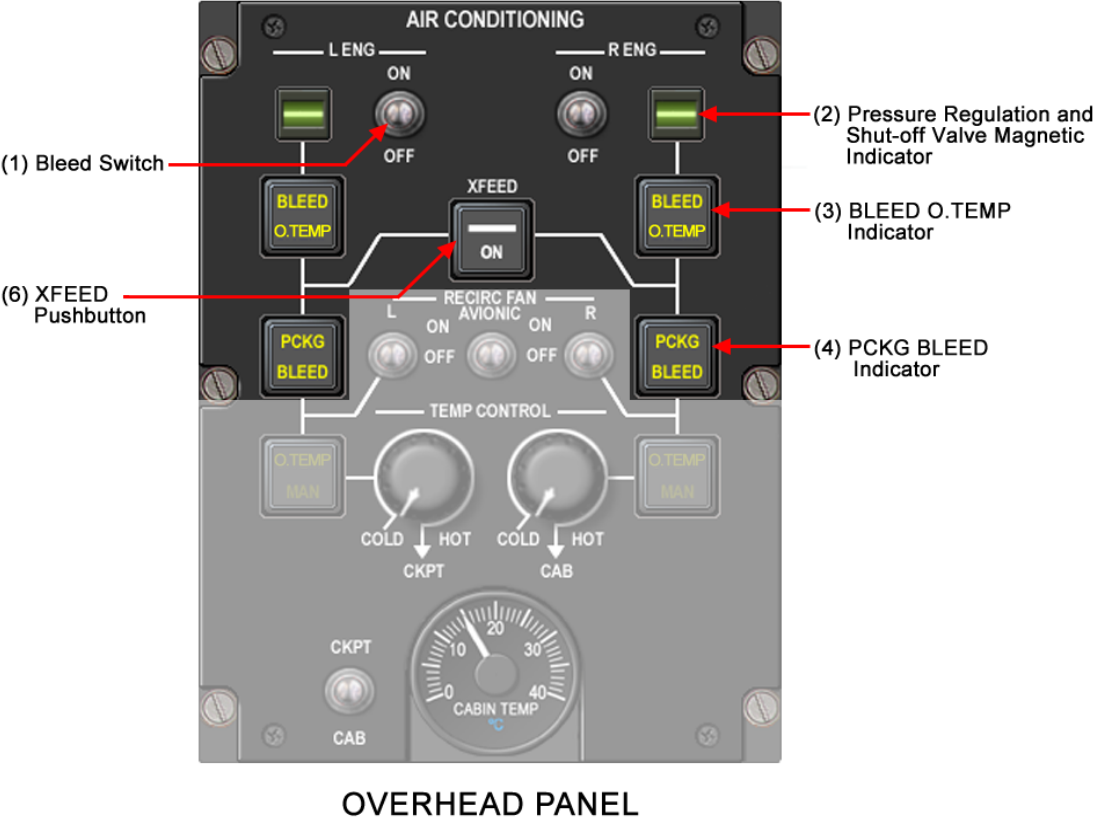


Figure 36-4 Air Distribution - Controls and Indicators