CHAPTER 2

AIR CONDITIONING AND PRESSURIZATION

AIR CONDITIONING AND PRESSURIZATION

GENERAL

The air conditioning system serves four independently controlled zones; the cockpit and three passenger zones. The system provides air that is conditioned by heating, cooling, and dehumidification. Temperature control for automatic or manual conditioning of the four zones is provided on individual temperature selectors. The cockpit, passenger cabin, avionics, center accessory and cargo compartments are pressurized. Engine bleed air is the source for pressurization and is controlled by regulating the outflow of conditioned air from the pressurized section.

DESCRIPTION

AIR CONDITIONING SYSTEM

The air conditioning packs (three air cycle machines) are powered by pressurized air from the pneumatic manifold. This hot, pressurized air is supplied to the packs where it is cooled and routed to a common manifold. This air is then mixed with hot air which has bypassed the packs and distributed to the cockpit, and the three cabin zones. Also, ground connectors are installed to provide preconditioned air from a ground source to the conditioned air manifold.

Pressurized air is supplied by the auxiliary power unit (APU), the engines, or a ground pneumatic source. The APU can provide sufficient airflow to operate all three air conditioning systems with the engine pneumatic supply selectors turned off to achieve high-performance takeoffs and initial climb.

The cooling or heating output of an air conditioning pack is accomplished by automatically or manually modulating the turbine bypass valves and the cooling ram air inlet and outlet doors.

The inlet temperature signals from each of the four zone controllers also influence the three air conditioning pack controllers. The signals are compared in a controller to determine the lowest temperature demand.

When the pack function selectors are in the automatic position, the control of number one pack is determined by the temperature demand of the cockpit. Control of the number two and three packs is determined by the lowest temperature demanded by forward, center and aft cabin.

Individual zone temperature requirements are adjusted by mixing hot, trim air from the pneumatic duct with air from the conditioned air manifold.

A ram air distribution system provides a backup supply of outside ambient air to the conditioned air distribution system if the three air conditioning packs are shut down in flight. The system is located in the left air conditioning compartment and consists of ducting, a valve manually controlled by a cable, and a tee handle. The valve control tee handle (lockwired) is located in the avionic compartment immediately below the access door in the left rear of the cockpit floor. To open the valve, a strong pull is required on the tee handle to snap the lockwire, and then continued until bottomed. The valve is located in pack one and must be closed by ground maintenance personnel, before pneumatic operation of pack one is to be resumed.

AVIONICS COOLING SYSTEM

The avionics cooling system consists of cooling fans, venturi, and the ducting necessary to cool the instrument panels and the electronic and electrical units in the avionics compartment. Cooling fans are installed in the system to provide the necessary airflow when on the ground or at low cabin/ambient differential pressure. An indicator on the center instrument panel provides visual indication that airflow exists at the instrument panels when the airplane is on the ground with normal electrical power applied and the air conditioning packs off. In flight, when cabin/ambient pressure is sufficient, the fans shut off and ventilation is provided by overboard venturis. One cooling fan and a shutoff valve are installed in the avionic compartment overboard venturi duct. The valve is normally open in flight to permit avionic venturi operation and closed on the ground to prevent inflow. Individual overboard venturis are installed for positive inflight cooling of the inertial navigation units (INU) and individual fans are installed for cooling at low differential pressure and ground cooling. INU fan exhaust air is discharged into the avionic compartment. An avionic flow override switch is installed to turn on the avionic cooling fans and close the avionic overboard venturi shutoff valve in case of system failure during pressurized flight or to maintain cabin pressure during single pack operation.

The AVIONIC FLOW OFF light comes on when the cooling airflow through the avionics compartment or main radio rack is below normal. An INS FLOW OFF light comes on when cooling airflow through an INU is below normal.

The DUCT-AVIONIC COMP OVERHEAT light is armed when the trim air switch is positioned to TRIM AIR. If an overheat condition occurs in the trim air system, thermal switches will shut off the source of hot trim air and the DUCT-AVIONIC COMP OVERHEAT light will come on. The overheat light will also come on if an over-temperature condition occurs in the avionics compartment due to excessive trim air duct leakage.

Center Accessory Compartment Ventilation

The electrical equipment in the center accessory compartment is cooled on the ground and in flight by a continuous duty fan drawing tunnel airflow through the compartment. Adequate airflow through the compartment is provided in flight even when the fan has failed. An amber center accessory compartment flow off light comes on when cooling airflow through the center accessory compartment is below normal.

GALLEY/LAVATORY VENTILATION AND CARGO COMPARTMENT HEATING SYSTEM

Air from pneumatic system 2 assist in ventilation of the aft lavatories and galleys by jet-pump action and provides airflow around the center and aft cargo compartments for heating. The aft lavatories and galleys are supplied conditioned air from the cabin area for ventilation. Pneumatic system 1, by jet-pump action, assists in ventilation of center and forward lavatories and center and forward galleys, and provides airflow around the forward cargo compartment for heating.

The forward and aft cargo compartments have individual temperature control systems. Each system consists of bleed air pressure regulators, temperature sensors, a controller, a motor actuated modulating valve, and a circulation system with flow detection.

PRESSURIZATION

Cabin pressure is controlled and maintained in either an automatic, semi-automatic, standby, or manual mode. Electric power is required for all but the manual mode.

The cabin pressure controller maintains the desired cabin pressure in relation to the altitude set on the landing altitude tape when the automatic or semi-automatic mode is selected. In the automatic mode, cabin pressurization is automatically controlled during takeoff, climb, cruise and descent conditions, to the lowest cabin altitude compatible with aircraft and flight requirements.

Destination altitude is set with the Altitude Set knob and will automatically schedule depressurization during descent to 300 feet below the selected destination altitude when in the automatic or semi-automatic mode.

The descent mode is initiated in the automatic mode when the aircraft descends approximately 1000 feet in one minute. The descent mode is initiated in the semi-automatic mode when the landing field altitude is set in the ALT SET scale.

If destination field elevation is above cabin altitude at start of aircraft descent, cabin altitude will climb at a rate not exceeding the selected rate limit, nominally set to 500 ft per min, until cabin altitude is equal to 300 feet below the destination field elevation.

At nosegear touchdown the aircraft will depressurize at 350 feet per minute.

In the semi-automatic mode, cabin altitude is selected on the altitude-set tape by positioning the altitude set knob to the desired altitude. Desired cabin altitude rate of change can be selected manually by adjusting the rate limit selector.

At the time the standby mode is selected, the standby control system will hold the cabin altitude constant. Rotation of the cabin altitude rate selector will provide the desired climb and descent rates.

If the automatic and standby systems malfunction, manual control of pressurization is possible by direct mechanical control of the outflow valves. An outflow valve position indicator displays the outflow valve position in all operating modes.

When manual control is selected, the control wheel engages a locking mechanism to secure the outflow valve in its existing position. After selection, manual control is achieved by pressing the control wheel inward (to disengage the control wheel locking device) and rotating the wheel to position the outflow valve to attain the desired cabin altitude. When the control wheel is released, the outflow valve is again locked in its existing position. Selecting the valve at more than two thirds open can cause a negative pressure and create a noise in the cabin. At touchdown, the Flight Engineer must manually depressurize the aircraft.

One air conditioning pack will supply adequate pressurization, even at maximum altitude.

CABIN PRESSURE RELIEF VALVES

The cabin pressure relief valves limit cabin differential pressure. Flapper doors at each of the three relief valve over-board exhausts fair with the aircraft skin and are located immediately aft of the forward lower cargo door. The flapper doors open if the associated relief valve opens. The relief valves open any time cabin pressure exceeds the white arc on the cabin differential gage. The valves will limit the cabin pressure to 9.1 psi.

Once a relief valve has opened, the flapper doors will be held open about 1/8 inch by a small rubber tab. This will not affect valve leakage or performance; it is only an indication that the relief valve has previously been open. The edge of the flapper is painted red to enhance visibility from the ground.

CONTROLS AND INDICATORS

The controls, indicators, and annunciator lights are on the Flight Engineer's Upper Panel No. 2 and the overhead panel. Illustrations of these major panels are in Chapter 1. The individual controls and indicators are illustrated and described in another section of this chapter.

AIR CONDITIONING - Controls and Indicators

Air Conditioning Pack Controls and Indicators

PACK OFF Light (1, 2, 3)

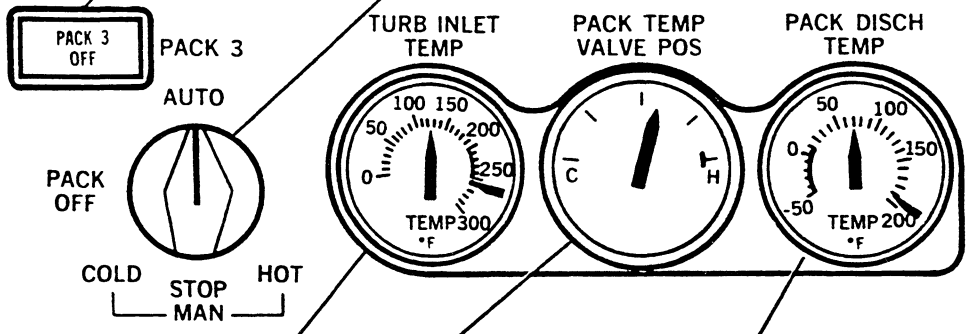
Indicates the respective air conditioning pack is shut off by either an overheat condition or the loss of pneumatic supply pressure. Also indicates that the flow control valve is closed when the pack function selector is in any position but PACK OFF.

PACK Function Selector (1, 2, 3)

PACK OFF — Closes flow control valve which shuts down associated system.

AUTO — Provides automatic control of selected temperature for the air conditioning distribution manifold.

MAN — When the selector is forced through either the left or right detent position it becomes spring-loaded to the STOP position. Holding the selector in the COLD or HOT position will drive its associated turbine bypass valve and ram air doors in the selected direction.



Pack TURB INLET TEMP Gage

Indicates pack turbine inlet temperature.

PACK TEMP VALVE POS Indicator

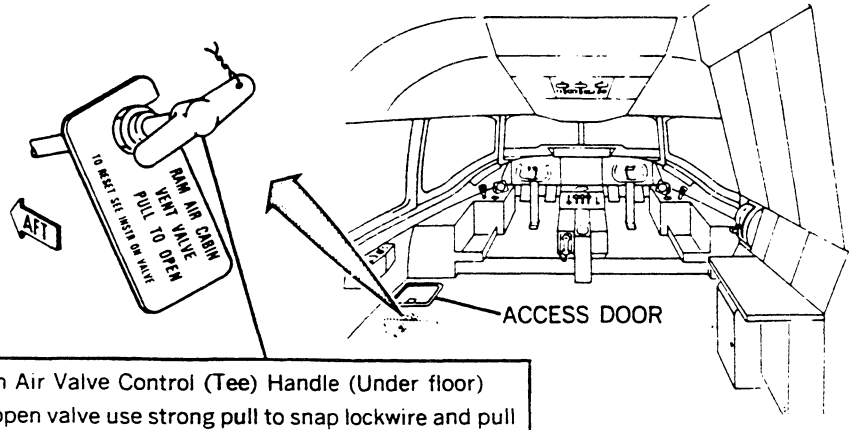
Indicates position of turbine bypass valve and ram air doors. At "C," doors are open. At "H," doors are closed.

PACK DISCH TEMP Gage

Indicates pack discharge temperature.

PACK IND Selector

Selects which respective air conditioning pack turbine inlet temperature, pack temperature valve position, and pack discharge temperature indication will be displayed.

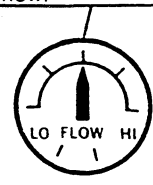


Ram Air Valve Control (Tee) Handle (Under floor)

To open valve use strong pull to snap lockwire and pull until bottomed. Provides a backup supply of outside air to the conditioned air distribution system if all packs are shut down inflight and the cabin is depressurized. The valve must be closed before operating pack 1 and is normally closed by maintenance. The valve cannot be closed by re-setting the handle.

Pneumatic FLOW Gage (3)

Indicates flow through each air conditioning system. Normal is inside the upper half-arc. The pointer at the index mark below LO indicates no flow.

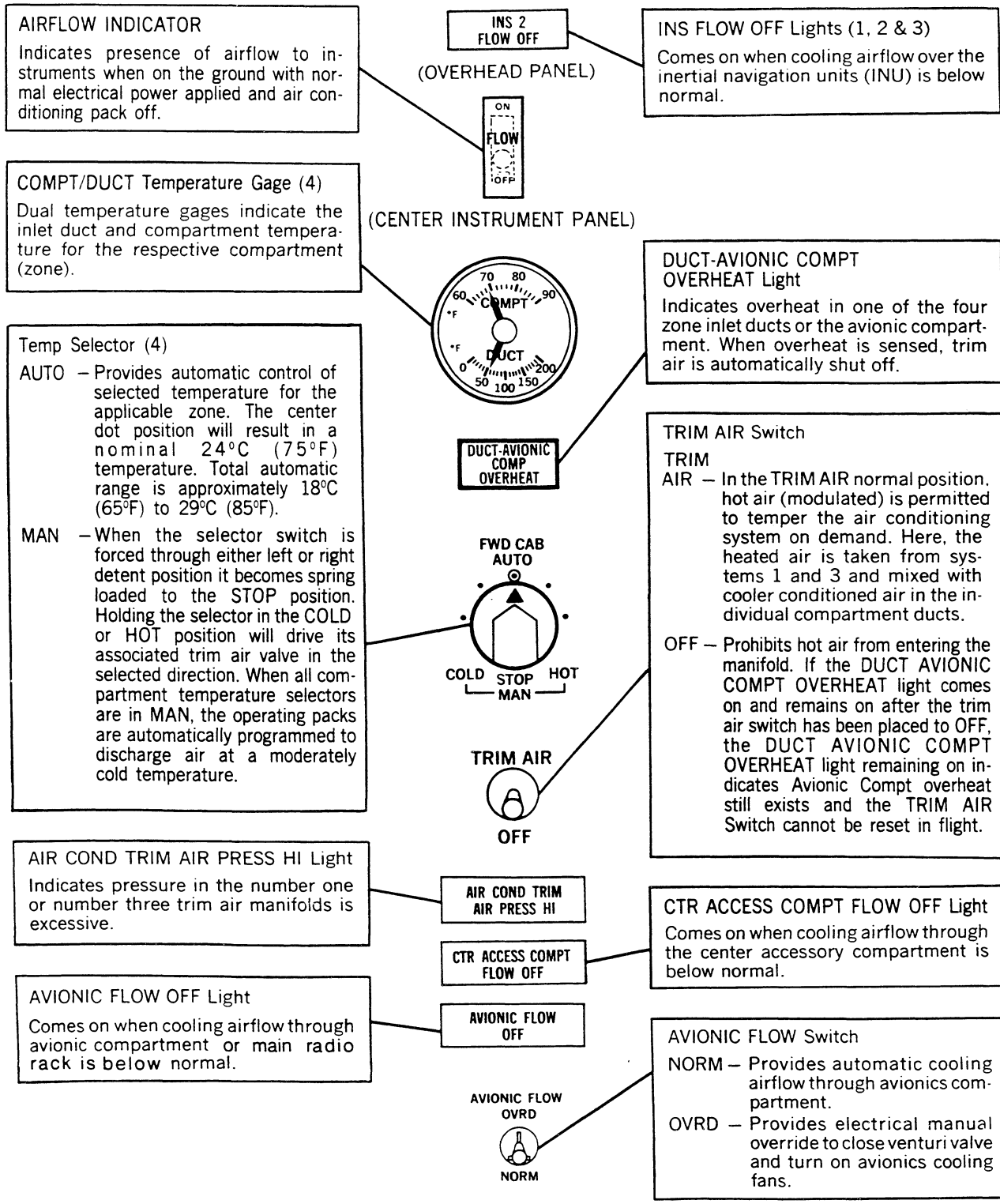


FLIGHT ENGINEER'S UPPER PANEL NO. 2

CA1-129 D

AIR CONDITIONING - Controls and Indicators

Compartment Temperature Controls and Indicators (Sheet 1)



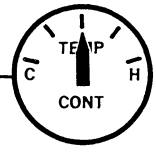
FLIGHT ENGINEER UPPER PANEL NO. 2 CA1-4032D

NOTE: INS FLOW OFF lights effective on international versions.

AIR CONDITIONING - Controls and Indicators
Compartment Temperature Controls and Indicators (Sheet 2)

VALVE POS Indicator (4)

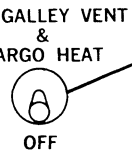
Indicates the position of the trim air valve for the respective compartment (zone).



LAV/GALLEY VENT & CARGO HEAT Switch

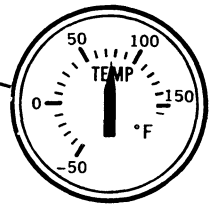
Provides control of galley and cargo ventilation, cargo compartment heat, and lavatory ventilation through jet pump action.

OFF – The OFF position turns off the heating and ventilation system.



CARGO COMPT TEMP Gage (FWD. CTR. AFT)

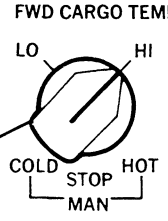
Indicates temperature in the associated cargo compartment.



FWD CARGO TEMP Selector

A controlled temperature of either approximately 4°C (40°F) or 18°C (65°F) is selectable by LO-HI position.

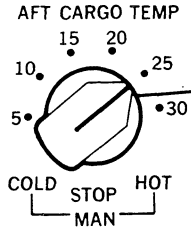
MAN — When the selector is forced through either left or right detent position it becomes spring loaded to the STOP position. Holding the selector in the COLD or HOT position will drive its associated valve in the selected direction.



AFT CARGO TEMP Selector

A controlled cargo compartment temperature of from approximately 4°C (40°F) to 27°C (80°F) is selectable on the upper portion of rotation.

MAN — When the selector is forced through either left or right detent position it becomes spring loaded to the STOP position. Holding the selector in the COLD or HOT position will drive its associated valve in the selected direction.



CARGO VENT (FWD & AFT) Switch (2)

VENT — Provides ventilation airflow control to forward and aft cargo compartments when the LAV/GALLEY VENT and CARGO HEAT switch is on.

OFF — Shuts off cargo ventilation system.

CARGO FLOW OFF (FWD & AFT) Light (2)

Comes on when CARGO VENT switch is on and no airflow is detected through the cargo compartment ventilation ducts.

FLIGHT ENGINEER'S UPPER PANEL NO. 2

CA1-4031 A

AIR CONDITIONING - Controls and Indicators

Cabin Altitude and Rate Indicators

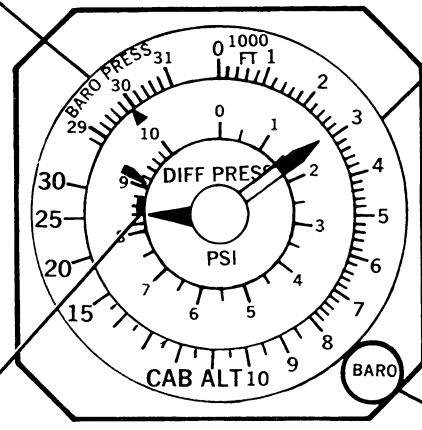
CABIN ALT/DIFF PRESS Gage

The cabin altitude pointer indicates the pressure altitude of the cabin interior dependent upon the setting of the BARO PRESS scale in relation to local altimeter setting.

The cabin differential pressure pointer indicates the difference between internal cabin pressure and ambient atmospheric pressure.

BARO PRESS Scale

When set to local altimeter setting, this scale will cause the CAB ALT pointer to display cabin height in relation to sea level. If set to 29.92" Hg the pointer will indicate cabin pressure altitude.



White band (arc) 8.4 to 8.8 psi

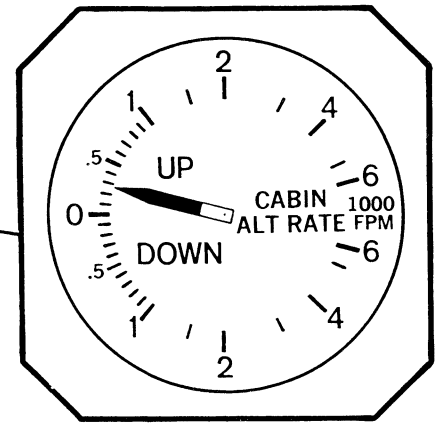
Relief valves start to open any time cabin pressure exceeds white band.

BARO Pressure Set Knob

Controls altimeter setting displayed by the BARO PRESS scale.

CABIN ALT RATE Indicator

Indicates rate of altitude change within the cabin in feet per minute.



FLIGHT ENGINEER'S UPPER PANEL NO. 2

CA1-131A

PRESSURIZATION - Controls and Indicators

Cabin Pressurization Controller

LDG BARO Scale

Indicates barometric pressure setting selected by the landing barometric pressure knob.

ALT SET Scale

Indicates selected landing airport altitude when operating in AUTO mode. Indicates selected cabin altitude when operating in the SEMI-AUTO mode.

SEMI-AUTO ON Light

Light will come on when the SEMI-AUTO mode is selected.

Cabin Press MODE Switch

Switch is normally in the AUTO position.

AUTO — Automatically controls cabin pressurization schedule during climb, cruise, and descent.

SEMI-AUTO — Permits desired cabin altitude to be selected by the altitude set knob and the climb or descent schedule to be programmed by the rate limit knob.

ALT SET Knob

Selects destination pressure altitude at standard atmosphere. Controller will automatically schedule depressurization to this altitude during descent when in AUTO mode.

Selects cabin altitude when in SEMI-AUTO mode, and desired landing altitude at start of descent.

LDG BARO Knob

Corrects selected destination pressure altitude to field elevation when destination altimeter setting is applied.

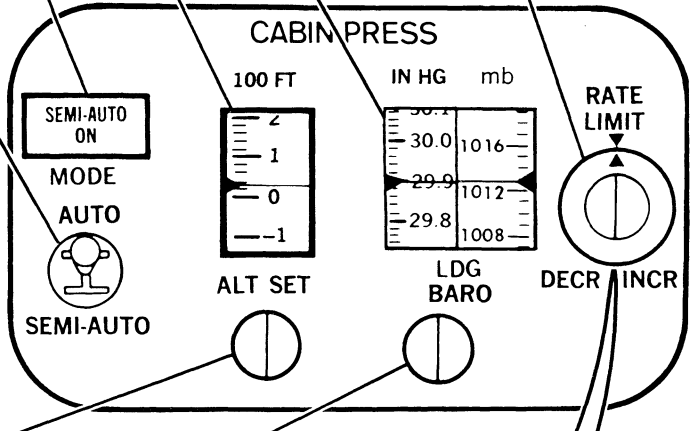
RATE LIMIT Selector

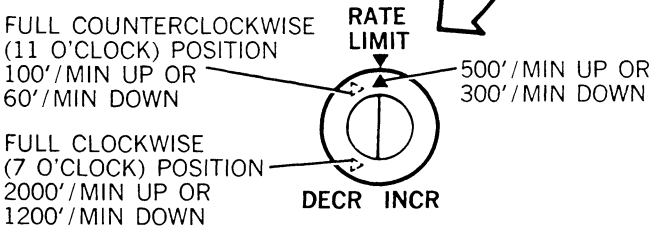
Provides selection of increased or decreased cabin altitude rate limits when cabin pressure mode selector switch is in SEMI-AUTO mode.

Normally left at the rate limit index mark for optimum system operation when in the AUTO mode.

Rate limit selector is ineffective when moved toward INCR when in AUTO mode and on schedule, however, it will work in the DECR direction.

It will work in either INCR or DECR if cabin altitude is off schedule or SEMI-AUTO mode is selected.





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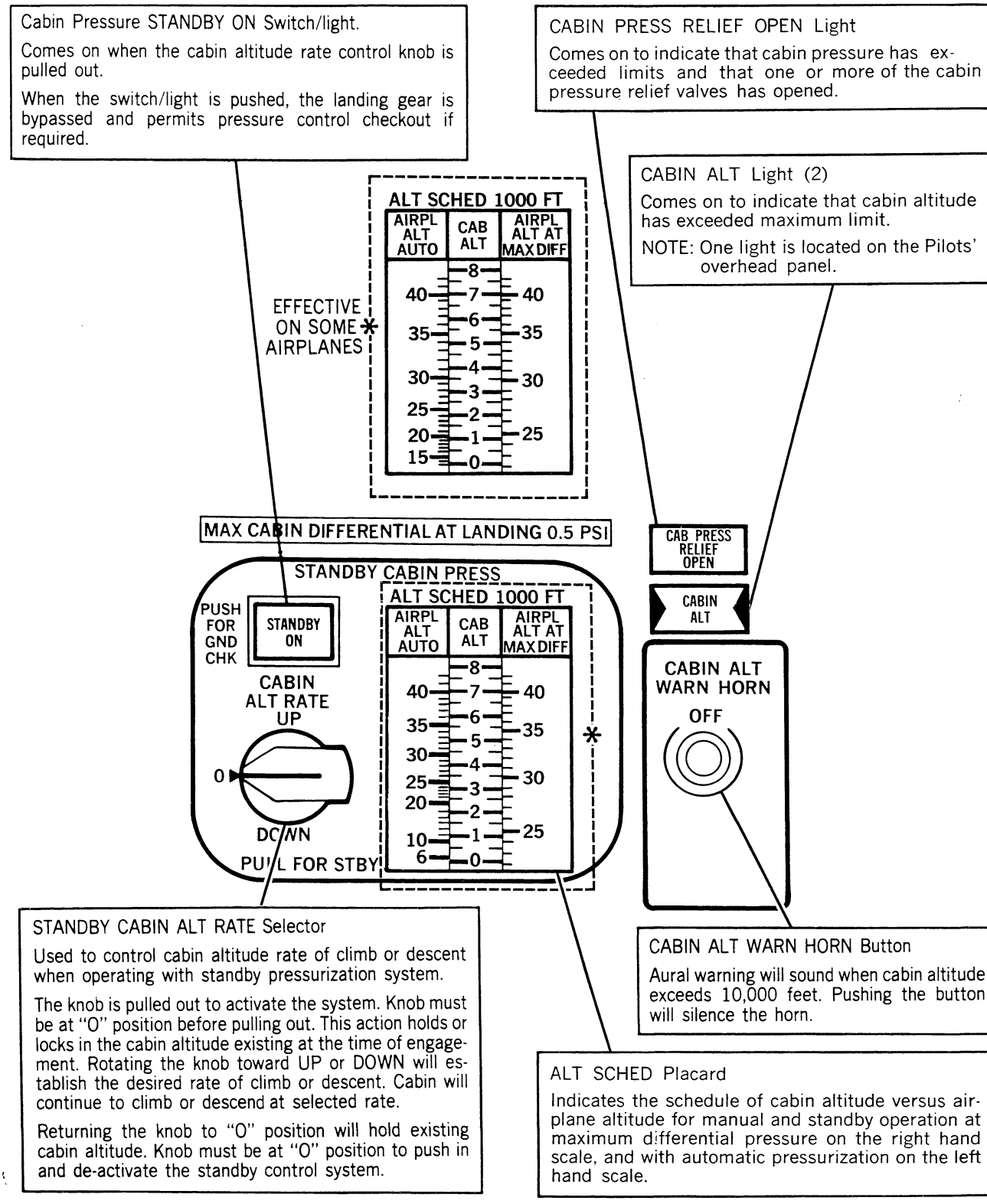
FLIGHT ENGINEER'S UPPER PANEL NO. 2

AIR CONDITIONING - Controls and Indicators

Standby Cabin Pressurization Controller

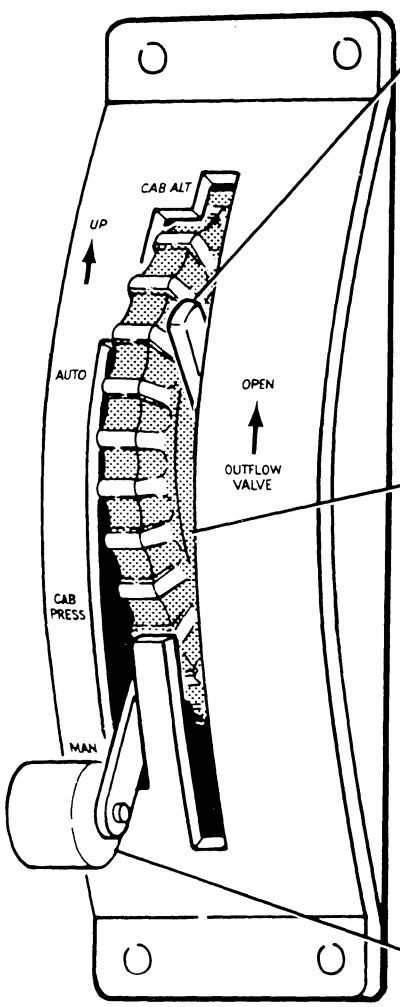


FLIGHT ENGINEER'S UPPER PANEL NO. 2

CA1-6148

AIR CONDITIONING — Controls and Indicators

Manual Cabin Altitude Control



OUTFLOW VALVE Position Indicator

Indicates the relative position of the outflow valve. The indicator will operate in the automatic, semi-automatic, standby and manual control modes. When the indicator is full up, the outflow valve is full open.

Manual CAB ALT Control Wheel

Used to position the outflow valve manually to adjust cabin pressure. When the cabin pressure manual/auto selector is in the MAN position, pushing the control wheel inward and rotating the wheel upward will mechanically cause the outflow valve to move toward open and the cabin altitude to go up. Rotating the wheel downward results in an opposite reaction. When the control wheel is released the outflow valve will be locked until the wheel is again pushed inward and rotated.

When cabin pressure manual/auto selector is in AUTO position the control wheel follows cabin outflow valve motion, therefore providing an indication of direction and rate of movement.

CAB PRESS MAN/AUTO Handle

Selects either manual or automatic control of the pressurization system. Selector is normally in AUTO position.

AUTO – Permits electrical outflow valve operation by cabin pressure controllers in automatic, semi-automatic and standby modes.

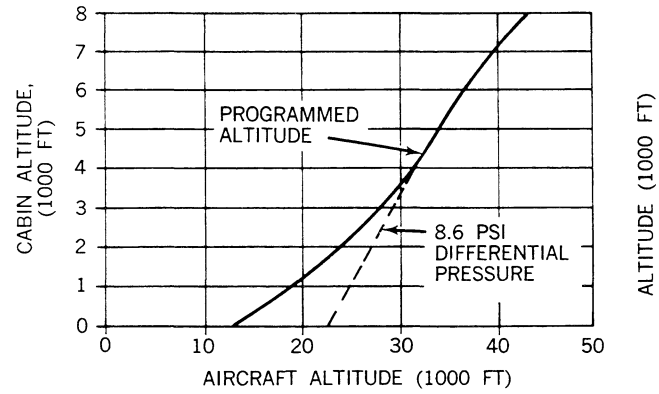
MAN – Positioning the selector to MAN locks the outflow valve in its existing position, and permits manual positioning of the outflow valves.

FLIGHT ENGINEER'S LOWER PANEL

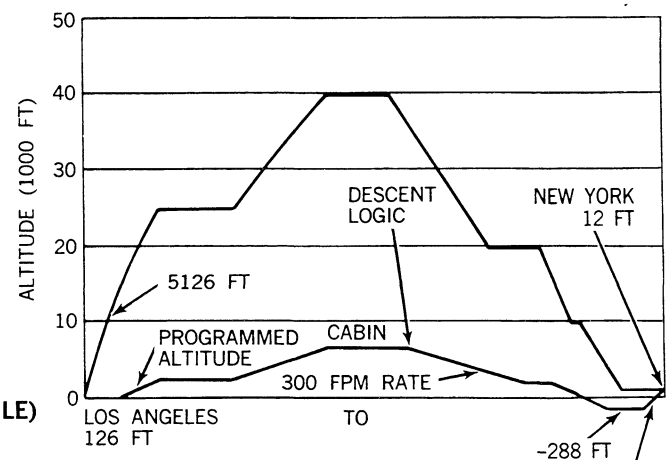
CA1-134 C

AUTOMATIC PRESSURIZATION SCHEDULE

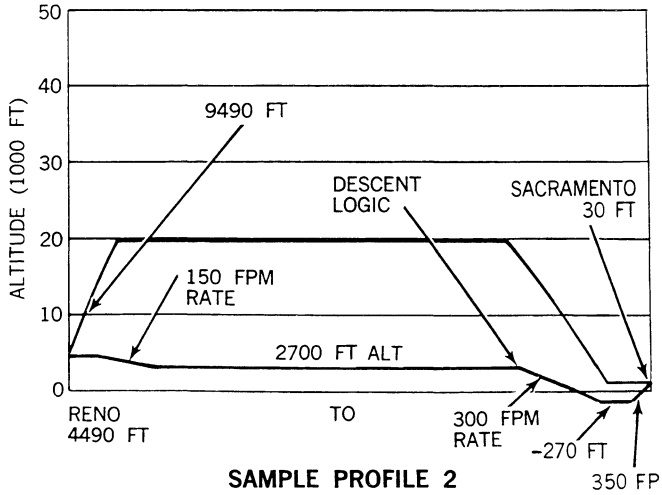
TAKEOFF FIELD ELEV	DESTINATION FIELD ELEV	CABIN ALTITUDE REACTION
BELOW 2700 FT	BELOW 2700 FT	GOES TO DEST FLD ELEV
	2700-4500 FT	CLIMBS TO DEST FLD ELEV
	ABOVE 4500 FT	CLIMBS TO 4500 FT
2700-4500 FT	BELOW 2700 FT	DESCENDS TO 2700 FT
	2700-4500 FT	GOES TO DEST FLD ELEV
	ABOVE 4500 FT	CLIMBS TO 4500 FT
ABOVE 4500 FT	BELOW 2700 FT	DESCENDS TO 2700 FT
	2700-4500 FT	GOES TO DEST FLD ELEV
	ABOVE 4500 FT	DESCENDS TO 4500 FT



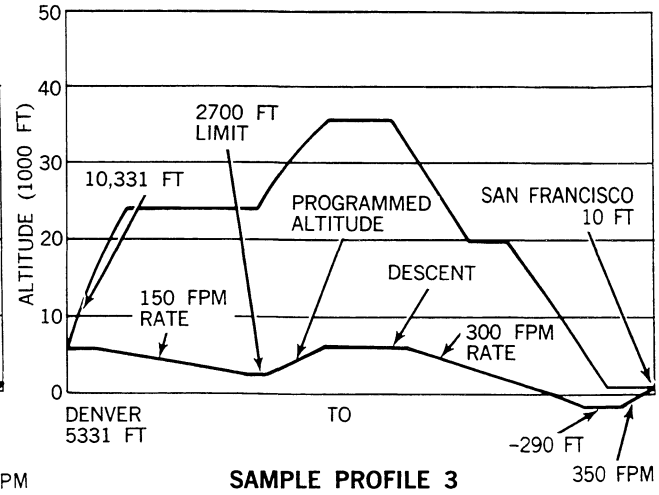
PROGRAMMED ALTITUDE FUNCTION (AUTO SCHEDULE)



SAMPLE PROFILE 1



SAMPLE PROFILE 2



SAMPLE PROFILE 3

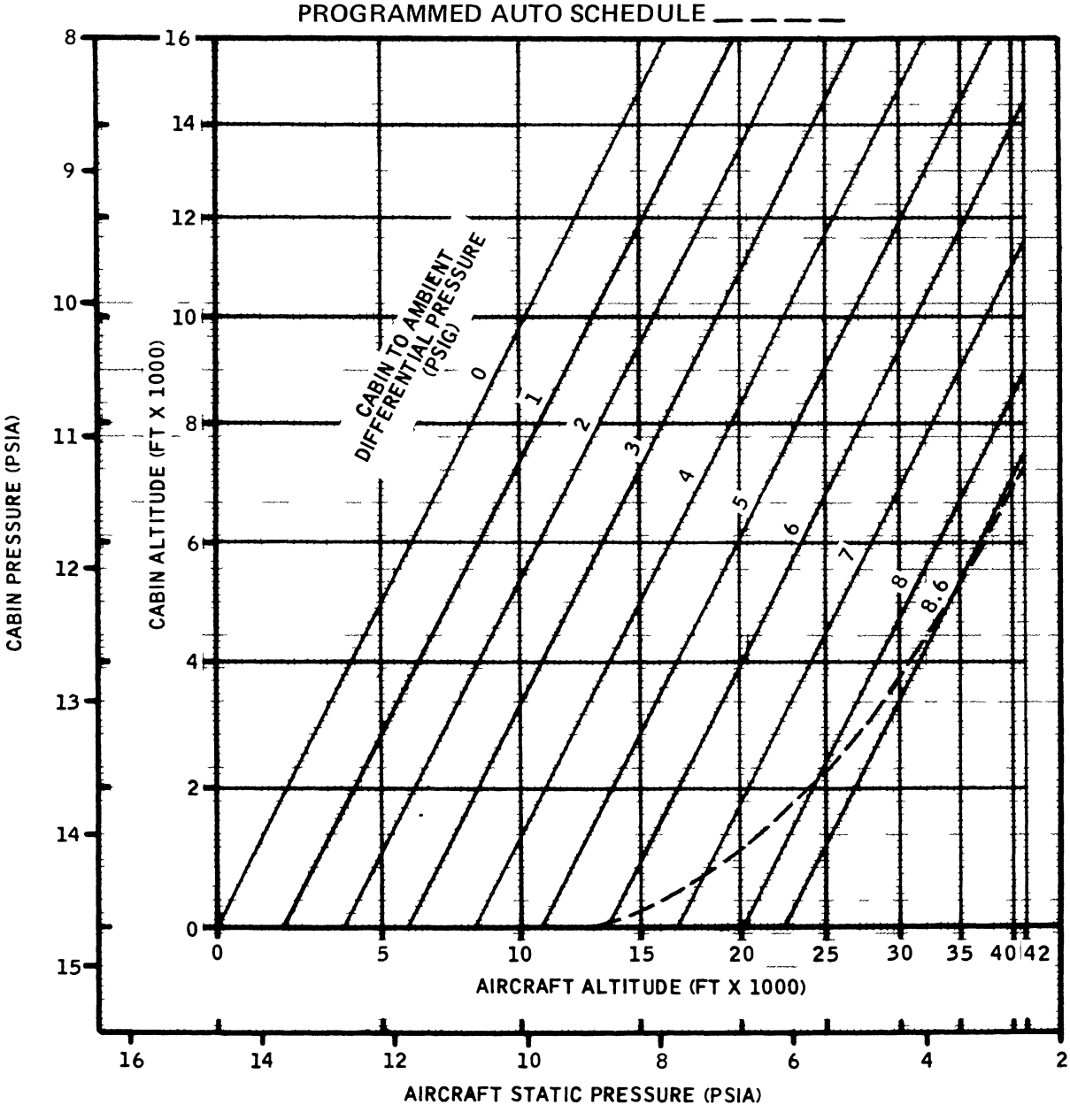
PRESSURIZATION SAMPLE FLIGHT PROFILES

CA1-3099B

CABIN VERSUS AIRCRAFT ALTITUDE CHART

MODEL DC-10

MAX CAB AMB ΔP	MAX A/C ALT	CABIN ALT AT MAX A/C ALT
8 6 PSIG	42,000 FT	7610 FT



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AIR CONDITIONING SYSTEM