Auxiliary Equipment

SECTION IV

TABLE OF CONTENTS

AIR CONDITIONING AND PRESSURIZATION SYSTEM.

The air conditioning and pressurization system utilizes either liquid nitrogen or ram air as a cooling and pressurization medium. The liquid nitrogen is supplied from the X-15 storage tank during free flight and from either the X-15 storage tank or the carrier airplane pylon tank during captive flight. The X-15 tank can supply the entire air conditioning and pressurization system and when used will supply liquid nitrogen for pressurizing and cooling the cockpit and No. 2 electronic equipment compartment, and for cooling for the ac generators, APU upper turbine bearings, stable platform, and ball nose. It will also supply nitrogen gas for inflating the canopy and equipment compartment seals, purging the hydraulic reservoirs, between-panel purging of the windshield, and ventilation of the pilot's pressure suit. The nitrogen gas used for between-panel windshield purging and pilot's pressure suit ventilation is supplied through a common liquid nitrogen supply line which contains a heat exchanger and electric heater for converting the liquid to gaseous nitrogen. The carrier airplane pylon tank and associated controls make up the augmented cooling system. The primary function of this system is to augment the cooling to the stable platform during ground operation and taxiing, when the blowers are circulating compartment air, and when ram air is used during climb to cruise altitude. The augmented system is also used for between-panel windshield purging and pilot's pressure suit ventilation during these times and can be used for cooling the No. 2 electronic equipment compartment and ball nose.

The ram-air system is limited in its operation to cooling the cockpit and the electronic equipment compartment. The ram-air system, with augmented cooling, is used during climb and cruise. The X-15 liquid nitrogen system is turned on at the beginning of cruise-climb to launch altitude.

NOTE

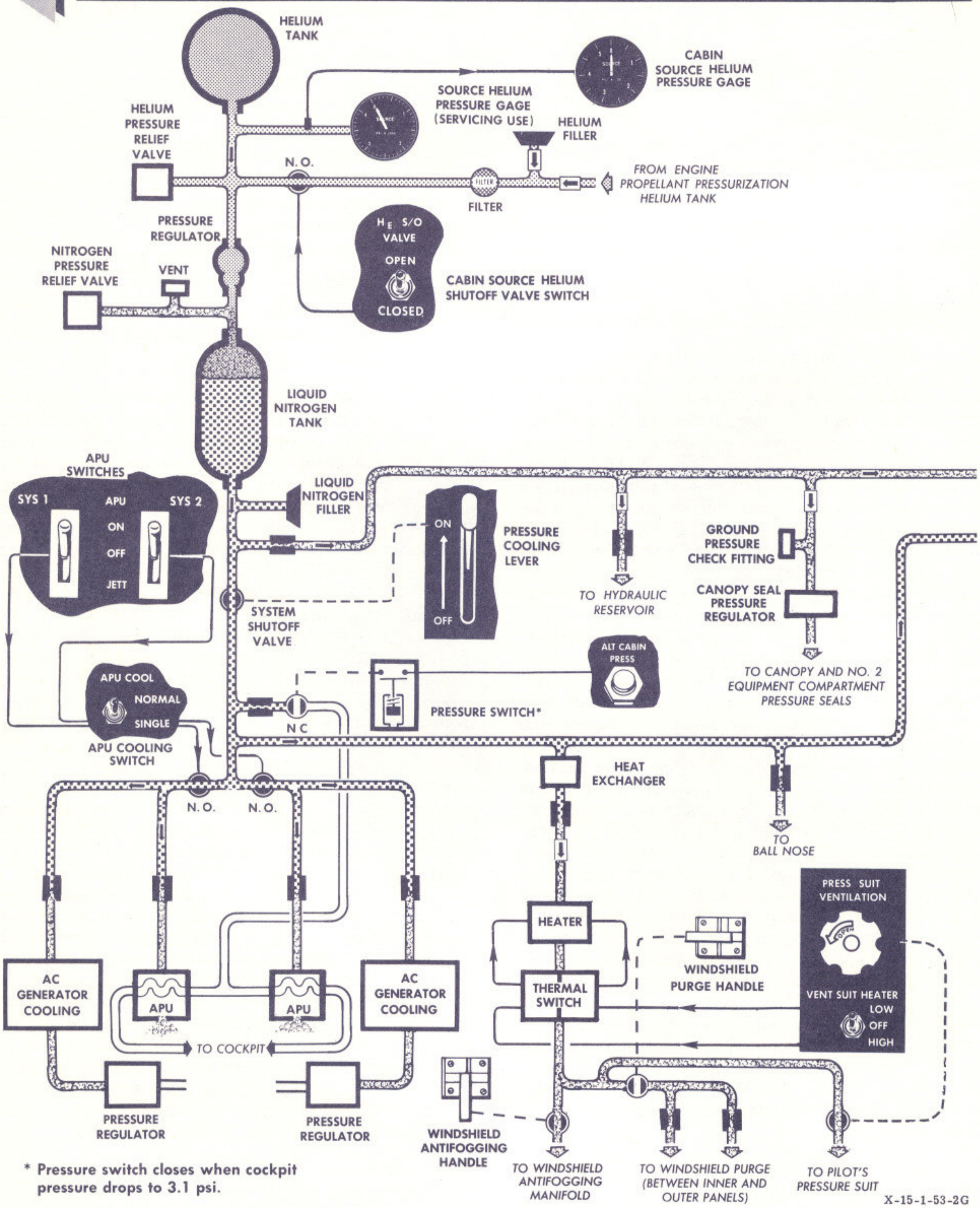
If the ram-air system does not provide adequate cockpit cooling during captive flight at altitude, the augmented cooling system liquid nitrogen supply can be used to increase cooling by turning off the ram-air system and turning on the blowers.

The ram-air system should not be used above 35,000 feet or at speeds in excess of Mach 1.0, because of possible damage to the ram-air scoop and ducting due to high or excessive air loads and temperatures too high for proper electronic equipment cooling. During free flight, ram air may be used as an emergency measure if the X-15 liquid nitrogen system fails or during descent when the liquid nitrogen system has been depleted, but the limitation of Mach 1.0 must be observed. The cockpit and the electronic equipment compartment are pressurized to 3.5 psi by the use of nitrogen after it has been converted from liquid to gaseous state. The X-15 liquid nitrogen is stored under pressure and is converted as required for cockpit and equipment cooling and pressurization. A cockpit pressure regulator automatically maintains a pressure of 3.5 psi at 35,000 feet and above. From the ground up to 35,000 feet, the cockpit pressure remains the same as the outside pressure. If the cockpit pressure regulator does not operate properly, a cockpit safety valve will not allow the cockpit pressure to exceed 3.8 psi; also, during a rapid descent, the safety valve will prevent a pressure differential greater than 0.5 psi. Pilot comfort is provided by the MC-2 pressure suit, which maintains a regulated pressure of 3.6 psi over the entire body. Pressure to the suit is provided by the air conditioning and pressurization system. Temperature control of the nitrogen flow through the suit is maintained by an electric heater which is adjusted to a pilot-selected range. The temperature of the gas supplied to the pressure suit is from 55°F (±5°F) to 90°F (±5°F). The X-15 air conditioning and pressurization system may be considered automatic to the extent that once it has been started and manually regulated for desired flow and temperature, it will continue to operate without further adjustment.

COCKPIT AIR CONDITIONING AND PRESSURIZATION.

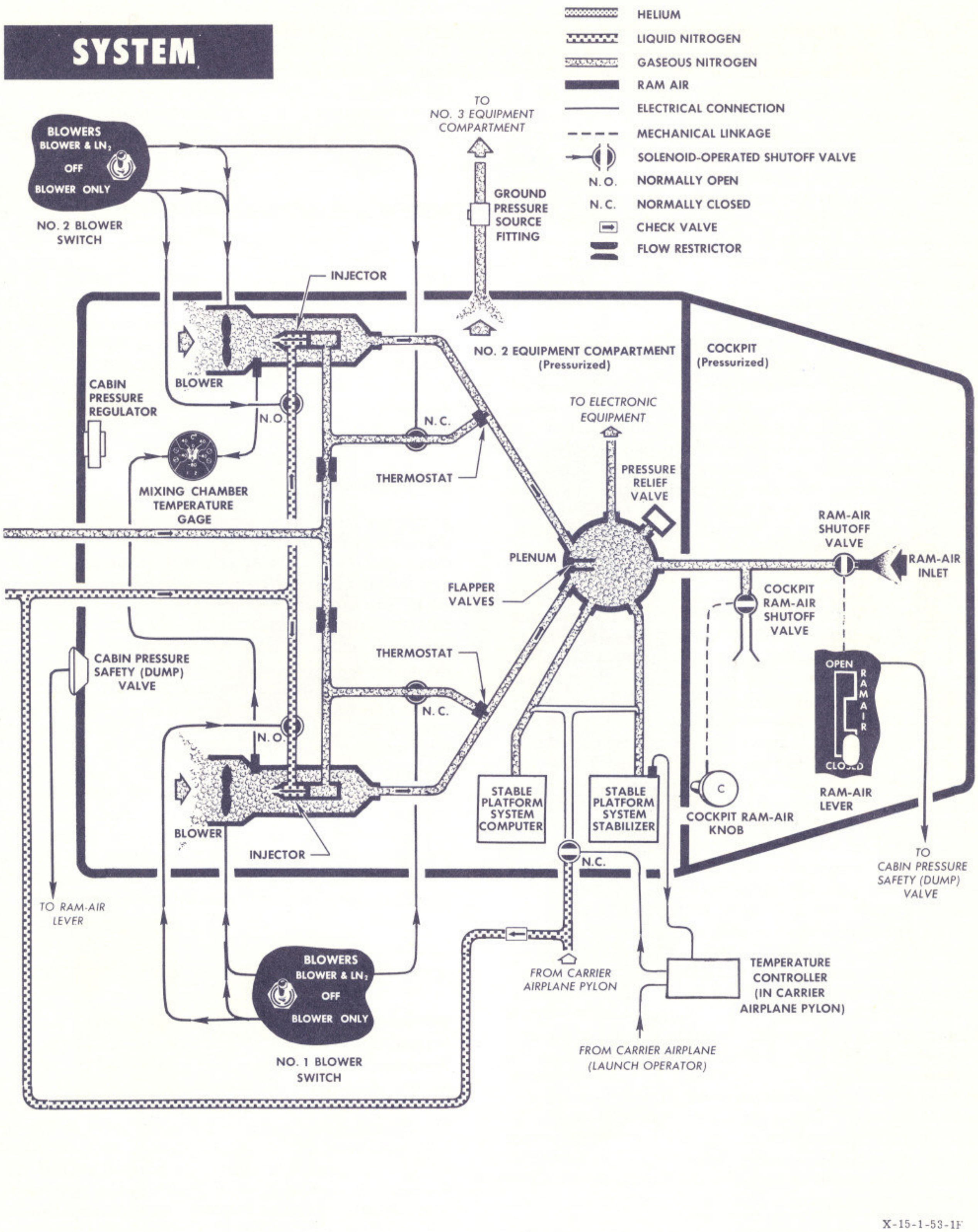
Cockpit air conditioning and pressurization is by either of two systems: the ram-air system, or the liquid nitrogen air conditioning and pressurization system of

AIR CONDITIONING AND PRESSURIZATION



* Pressure switch closes when cockpit pressure drops to 3.1 psi.

Figure 4-1


SYSTEM
HELIUM
LIQUID NITROGEN
GASEOUS NITROGEN
RAM AIR
ELECTRICAL CONNECTION
MECHANICAL LINKAGE
SOLENOID-OPERATED SHUTOFF VALVE
N.O. NORMALLY OPEN
N.C. NORMALLY CLOSED
CHECK VALVE
FLOW RESTRICTOR
BLOWERS
BLOWER & LN_2
OFF
BLOWER ONLY
NO. 2 BLOWER SWITCH
TO NO. 3 EQUIPMENT COMPARTMENT
GROUND PRESSURE SOURCE FITTING
INJECTOR
BLOWER
CABIN PRESSURE REGULATOR
N.O.
N.C.
THERMOSTAT
MIXING CHAMBER TEMPERATURE GAGE
NO. 2 EQUIPMENT COMPARTMENT (Pressurized)
COCKPIT (Pressurized)
TO ELECTRONIC EQUIPMENT
PRESSURE RELIEF VALVE
PLENUM
FLAPPER VALVES
RAM-AIR SHUTOFF VALVE
RAM-AIR INLET
COCKPIT RAM-AIR SHUTOFF VALVE
OPEN
RAM AIR
CLOSED
RAM-AIR LEVER
CABIN PRESSURE SAFETY (DUMP) VALVE
STABLE PLATFORM SYSTEM COMPUTER
STABLE PLATFORM SYSTEM STABILIZER
COCKPIT RAM-AIR KNOB
TO RAM-AIR LEVER
TO CABIN PRESSURE SAFETY (DUMP) VALVE
FROM CARRIER AIRPLANE PYLON
TEMPERATURE CONTROLLER (IN CARRIER AIRPLANE PYLON)
FROM CARRIER AIRPLANE (LAUNCH OPERATOR)
NO. 1 BLOWER SWITCH
X-15-1-53-1F

the X-15 Airplane. The ram-air system, although it does not pressurize the cockpit and the No. 2 electronic equipment compartment, will furnish adequate cooling for these areas. Approximately 10 percent of the ram-air flow may be diverted to the cockpit by a cockpit control, with the remaining 90 percent being routed through a plenum, from which it is ducted to the No. 2 electronic equipment compartment. Flapper-type shutoff valves prevent the ram-air flow from entering the mixing chambers and blower ducts of the cooling system. The ram-air system must not be operated at the same time as the X-15 nitrogen system. The X-15 liquid nitrogen system actually cools and pressurizes simultaneously. A vacuum-type contained in the No. 3 equipment compartment stores 176 pounds, or 26.5 gallons, of liquid nitrogen, which is depleted at a normal usage rate of approximately 5 pounds per minute. A pressure relief valve mounted in the nitrogen line between the top of the container and the nitrogen vent and build-up valve is preset to vent at 80 (+0, -4) psi. Helium gas for pressurizing the X-15 liquid nitrogen tank is stored in a spherical tank in the No. 3 equipment compartment. Helium pressure is reduced from approximately 4200 psi at the tank to approximately 67 psi through a differential-pressure regulator. The helium gas is then routed into the top of the liquid nitrogen tank. The liquid nitrogen is forced out of the bottom of the tank and on through the system to the injectors. The liquid nitrogen is forced under pressure through the injectors into a stream of returning gaseous nitrogen within the mixing chambers, where it is mixed and recirculated. The temperature of the air conditioning system is automatically controlled by the two thermostats that regulate the flow of nitrogen vapor from the liquid nitrogen injectors. The thermostats and the liquid nitrogen injectors are part of the system mixing chambers that connect with the plenum from which the regulated cooling gas is ducted to the electronic equipment requiring direct cooling. The air conditioning and pressurization system includes an alternate system which automatically pressurizes the cockpit if component malfunctions result in loss of pressure. The alternate system includes a pressure switch, a solenoid-operated shutoff valve, two heat exchangers, and associated plumbing. When the alternate system is armed and the pressure switch contacts close (cockpit altitude rises above approximately 37,000 feet), the solenoid-operated shutoff valve is energized open. This allows liquid nitrogen to flow to a heat exchanger in each APU compartment. The nitrogen is converted to a gaseous state and expelled into the cockpit. The pressure switch contacts open when cockpit altitude drops below approximately 36,000 feet. The augmented cooling system liquid nitrogen supply in the carrier airplane pylon is contained within a 6-cubic-foot tank. Approximately 292 pounds of liquid nitrogen is pressurized to approximately 63 psi by nitrogen pressure in the carrier airplane gaseous nitrogen system. Flow of the augmented cooling system liquid nitrogen to the X-15 is controlled from the launch operator's panel in the carrier airplane.

AIR CONDITIONING AND PRESSURIZATION SYSTEM CONTROLS AND INDICATORS.

Pressure-Cooling Lever.

The pressure-cooling lever (7, figure 1-4), on the right console, controls both the air conditioning and pressurization of the cockpit and the electronic equipment compartments. The lever has two positions, ON and OFF. When the lever is moved forward to ON, the system manual shutoff valve opens, allowing liquid nitrogen to flow throughout the entire system. With the lever at OFF, the system is inoperative. In free flight, the nitrogen gas for the pilot's pressure suit system is also controlled by the pressure-cooling lever. (Refer to "Pilot's Pressure Suit System" in this section.)

Alternate Cabin Pressurization Switch.

This push-pull, circuit-breaker type switch (5, figure 1-4), on the right console, controls primary dc bus power to the alternate cabin pressurization system pressure switch and to the system shutoff valve. The switch, labeled "ALT CABIN PRESS," is closed when pushed in. Pulling the switch out opens the alternate cabin pressurization system arming circuit.

Blower Switches.

There are two blower toggle switches (8, figure 1-4) on the circuit-breaker panel on the right console. The three-position switches, powered by the primary dc bus, are labeled "BLOWERS." When the switches are at OFF, the blowers are off, the liquid nitrogen shutoff valves to the injectors are de-energized open, and the pressure control valves are de-energized closed. With the switches at BLOWER & LN_2, electrical power is applied to the blowers, the liquid nitrogen shutoff valves to the injectors are de-energized open, and the pressure control valves are energized open. With the switches at BLOWER ONLY, electrical power is applied to the blowers, the liquid nitrogen shutoff valves to the injectors are energized closed, and the pressure control valves are de-energized closed. Both the No. 1 and No. 2 blowers are powered by the No. 1 primary ac bus. The No. 1 and 2 solenoid shutoff valves are powered by the primary dc bus. The blowers are protected by circuit breakers on the circuit-breaker panel.

Cabin Source Helium Shutoff Valve Switch.

Helium tank pressure to the liquid nitrogen tank is controlled by a two-position toggle switch on the circuit-breaker panel (6, figure 1-4) on the right console. The switch is labeled "CABIN SOURCE H_e S/O VALVE." With the switch at CLOSED, primary dc bus power closes a solenoid-operated shutoff valve in the helium line upstream of the helium tank. With the switch at OPEN (forward), the solenoid-operated shutoff valve in the helium line is de-energized to the open position. The valve is used to isolate the air conditioning and pressurization system helium supply from the main propellant helium source as long as the former remains at or above 3000 psi. If the air conditioning and pressurization system helium supply drops below 3000 psi before launch, the valve should be opened to top off the helium supply.

Windshield Antifogging Handle.

This unlabeled handle is used to position a valve which controls flow of gaseous nitrogen to the inner surface of the windshield inner panels. It is on the right side of the canopy, just below the windshield panel and aft of the windshield purge handle. Flow of the nitrogen is shut off with the handle rotated down. Rotating the handle counterclockwise 90 degrees (to horizontal) opens the valve and permits flow of X-15 or augmented system gaseous nitrogen to the windshield antifogging manifold.

Windshield Purge Handle.

This unlabeled handle is used to position a valve which controls purging flow of gaseous nitrogen between the windshield panels. The handle is on the right side of the canopy, just below the windshield panel and forward of the windshield antifogging handle. Flow of the purging gas is shut off with the handle rotated down. Counterclockwise rotation of the handle 90 degrees (to horizontal) opens the valve and permits purging gas flow.

Ram-air Lever.

A ram-air lever (12, figure 1-5), on the left side of the center pedestal, controls the operation of the ram-air system. It is labeled "RAM AIR" and has OPEN and CLOSED positions. The lever is mechanically linked to the ram-air scoop and the ram-air shutoff valve, and electrically connected to the cockpit safety (dump) valve. When the lever is moved to OPEN, the ram-air shutoff valve and the ram-air scoop are opened to allow ram air to enter the system. At the same time, the cockpit safety valve is opened, allowing the cockpit and electronic equipment compartment pressure to be depleted and the ram air to be circulated through these areas. When the lever is at CLOSED, the ram-air shutoff valve and the ram-air scoop close. The cockpit safety valve is closed when the ram-air lever is at CLOSED. The ram-air scoop is on the lower centerline of the fuselage, just aft of the nose wheel well.

Cockpit Ram-air Knob.

Ram air to the cockpit is controlled by the cockpit ram-air knob (6, figure 1-5), on the center pedestal. The knob is mechanically linked to a shutoff valve that is ducted off the main ram-air line. When the knob is pulled straight out, the two-way shutoff valve opens to allow ram air (if the ram-air lever is at OPEN) to enter the cockpit. Pushing the knob in closes off the ram air to the cockpit.

CAUTION

The cockpit ram-air knob should be pushed in when the X-15 liquid nitrogen system is in use (blower switches at BLOWER & LN_2); otherwise, recirculating cooling gas will be bled from the ducting system.

APU Cooling Switch.

This two-position switch (3, figure 1-4), at the aft end of the right-hand console, is labeled "APU COOL." It is powered from the primary dc bus through the APU switches. With the switch at NORMAL, primary dc bus power is cut off from the shutoff valves which control liquid nitrogen flow to the APU's and ac generators, and the valves are de-energized open. With the switch at SINGLE, each valve will be energized closed if its respective APU switch is OFF, or de-energized open if its respective APU switch is ON. During single-APU operation, if excessive upper bearing temperatures are encountered on the operating APU, the switch should be moved to NORMAL. This will increase the volume of liquid nitrogen flow through individual flow restrictors, thus providing more efficient cooling of the bearing. If the upper bearing temperature of the nonoperating APU is excessively low, the switch should be moved to SINGLE, to shut off cooling nitrogen flow to the non-operating APU.

CAUTION

If moving the switch to SINGLE results in excessive upper bearing temperatures on the operating APU, the switch must be returned to NORMAL, and if necessary, the nonoperating APU restarted.

Cabin Helium Source Pressure Gage.

A cabin helium source pressure gage (35, figure 1-2), on the lower right of the instrument panel, indicates the helium pressure available to operate the air conditioning and pressurization system. The gage is calibrated from 0 to 5000 psi. The gage and pressure transmitters are powered by the 26-volt ac bus and protected by a circuit breaker on the circuit-breaker panel on the right console.

Mixing Chamber Temperature Gage.

The dual-pointer mixing chamber temperature gage (41, figure 1-2) shows the temperature in the No. 1 and No. 2 mixing chambers. Power is supplied by the No. 1 primary ac bus to amplifiers within the gage unit, activating the indicator needles. The gage shows temperature in degrees centigrade and is calibrated in 10°C increments from -80°C to +80°C.

Cabin Pressure Altimeter.

The pressure altitude of the cockpit is shown by a cabin pressure altimeter (33, figure 1-2) on the lower right corner of the instrument panel. The indicator is vented only to pressure within the cockpit, and operates on the aneroid principle.

OPERATION OF AIR CONDITIONING AND PRESSURIZATION SYSTEM.

Operation of Augmented Cooling System.

To operate the augmented cooling system, proceed as follows:

1. Cabin source helium shutoff valve switch - OFF.
2. APU cooling switch - SINGLE.

3. Pressure cooling lever - OFF.

4. Windshield antifogging handle - OFF.

5. X-15 LN_2 supply switch - Check OPEN.

Check with launch operator that switch is at OPEN.

6. Vent suit heater switch - HIGH or LOW.

7. Pressure suit ventilation knob - As required.

Knob should be open a minimum of one turn.

8. Stable platform LN_2 cooling control switch - Check OFF.

Check with launch operator that switch is OFF.

9. Ram-air lever - CLOSED.

10. Blower switches - BLOWERS & LN_2.

11. Mixing chamber temperature gage - CHECK.

When both chamber temperatures stabilize at -40°C (±5°C), proceed to step 12.

12. Stable platform switch - EXT.

Move stable platform switch to EXT and wait 10 minutes before proceeding to step 13.

13. Blower switches - BLOWER ONLY.

14. Stable platform LN_2 cooling control switch - Check ON.

Check with launch operator that switch is ON.

Operation of Ram-air and Augmented Cooling System (Captive Flight).

To operate the ram-air and augmented cooling systems, proceed as follows:

1. Cabin source helium shutoff valve switch - OFF.

2. APU cooling switch - SINGLE.

3. Pressure cooling lever - OFF.

4. X-15 LN_2 supply switch - Check OPEN.

Check with launch operator that switch is OPEN.

5. Stable platform LN_2 cooling control switch - Check OFF.

Check with launch operator that switch is OFF.

6. Blower switches - OFF.

7. Ram-air lever - OPEN.

Operation of X-15 Liquid Nitrogen System.

To operate the X-15 Airplane liquid nitrogen system at prelaunch, proceed as follows:

1. Ram-air lever - CLOSED.

2. Cabin source helium shutoff valve switch - CLOSED.

3. APU cooling switch - NORMAL.

4. Alternate cabin pressurization switch - ON (down).

5. Pressure-cooling lever - ON.

6. Vent suit heater switch - HIGH or LOW.

7. Pressure suit ventilation knob - As required.

8. X-15 LN_2 supply switch - Check CLOSE.

Check with launch operator that switch is at CLOSE.

9. Blower switches - BLOWER & LN_2.

NOTE

The windshield heater switches should be moved to ON (up) when fogging or frosting of the glass is observed and should remain ON (up) until the airplane is landed.

Emergency Operation of Ram-air System (After Launch).

To operate the ram-air system, proceed as follows:

1. Cabin source helium shutoff valve switch - OPEN.

2. Pressure-cooling lever - ON.

3. No. 1 and 2 blower switches - OFF.

4. Ram-air lever - OPEN.

NOTE

Do not operate the blowers and the ram-air system simultaneously.

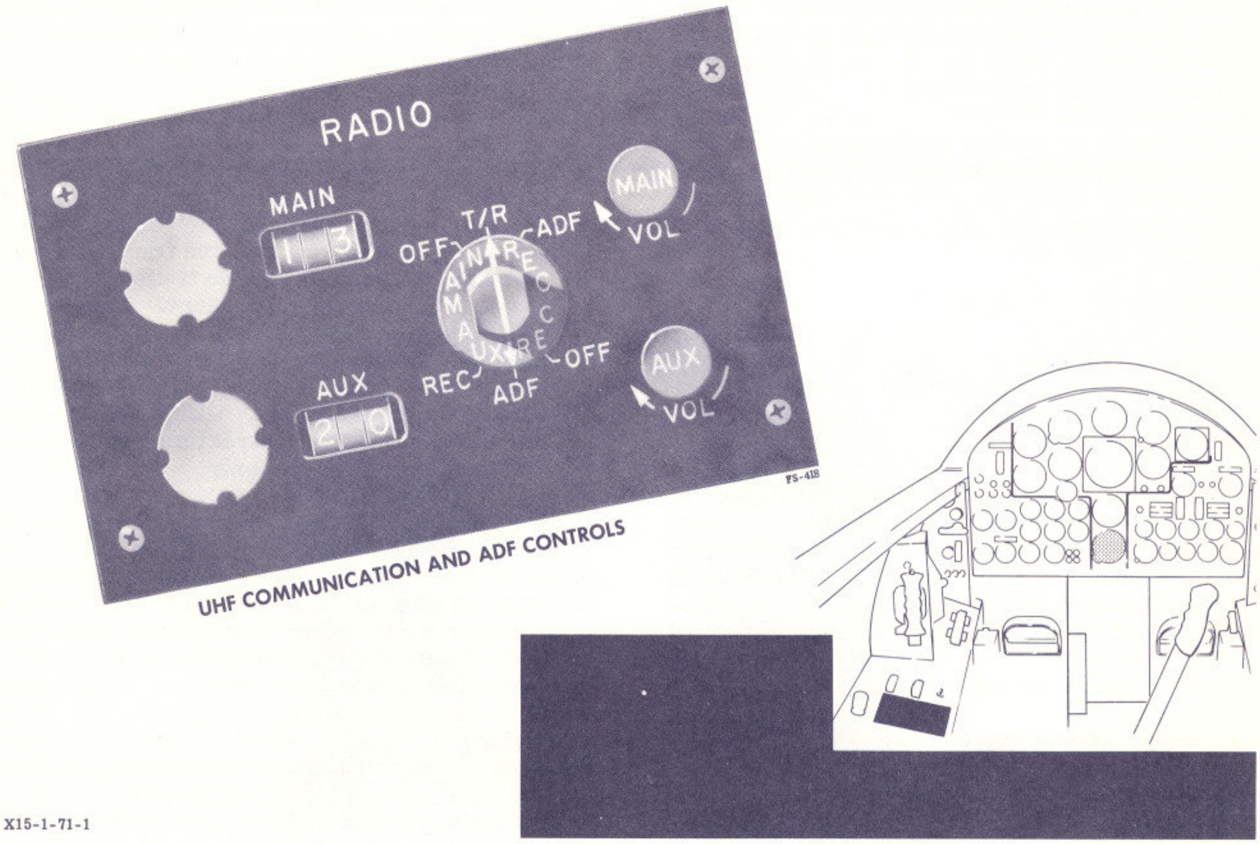
WARNING

- Do not open the ram-air scoop when the airplane is above 35,000 feet or the airspeed is in excess of Mach 1.0; otherwise, the ram-air scoop will be subjected to excessive air loads and be damaged.
- If the ram-air lever is opened, cockpit pressure will be dumped through the cockpit safety valve.

GENERATOR AND APU COOLING AND PRESSURIZATION.

The two ac generators and APU upper turbine bearing areas are cooled and pressurized by gaseous nitrogen

COMMUNICATION EQUIPMENT



X15-1-71-1

Figure 4-2

after it has been converted from a liquid state. When the pressure-cooling lever and cockpit helium switch are ON, X-15 system liquid nitrogen flows to two normally open shutoff valves, one for each generator cooling shroud and each APU upper turbine bearing area. These valves are electrically connected to the APU switches so that when either APU switch is turned OFF while the APU cooling switch is at SINGLE, its respective valve closes. This shuts off the liquid nitrogen supply to the affected units regardless of the position of the pressure-cooling lever. After passing through the shutoff valves, the liquid nitrogen is routed to pressure restrictors, where it is changed to a gaseous state before moving on to the generators and turbines. The gaseous nitrogen, after it has absorbed heat from the generator and APU upper turbine bearing area, is exhausted into the APU compartment.

WINDSHIELD HEATING SYSTEM.

Windshield frost or fogging is eliminated by a combination of heated nitrogen gas between the two glass panels and a heater element within each inner glass panel. A 1/4-inch line from the pilot's pressure suit supply line discharges a constant flow of heated nitrogen gas between the panels to dissipate moisture which may have collected in this area. Each heated inner panel is controlled by a toggle switch.

Windshield Heater Switches.

Two adjacent, two-position toggle switches, labeled "WINDSHIELD HEATER," control primary dc power to the windshield heater elements, one for each side panel. The switches are located in the lower right corner of the instrument panel right wing. (See 29, figure 1-2.) When the switches are moved ON (up), primary dc bus power is applied to the heater elements.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

UHF COMMUNICATION AND ADF SYSTEM.

The UHF communication and ADF system enables the pilot to transmit and receive voice transmissions and to obtain visual course reference on the course indicator. The system has two modes of operation, normal and alternate. During normal operation, the UHF transmitter and main receiver ("MAIN") are used with a UHF antenna for communication, and the auxiliary receiver ("AUX") is used with the ADF antenna for automatic direction finding to operate the course indicator. The alternate mode is used in case one of the receivers fails and it is desired to regain the function of the inoperative receiver. During this mode of operation, the UHF transmitter is connected to the UHF antenna through an automatic lockout feature. The main receiver is connected to the ADF antenna for ADF operation. The auxiliary receiver is connected to the UHF antenna for communication reception. The transmitter and main receiver cover the frequency range of 255.0 to 399.9 megacycles for 1750 channels, spaced at 100-kilocycle increments.

NOTE

> Frequencies below 265 megacycles should not be used, because they are reserved for telemetering channels and the system will not accommodate this frequency range.

The guard receiver, an integral part of the system, operates off the UHF antenna and guards the preset frequency of 279.9 megacycles. The guard receiver has two functions: it operates the automatic antenna selector, and it also provides for reception of voice transmission of the guard frequency (normal guard operation). The auxiliary receiver has 20 channels in the frequency range of 265.0 to 284.9 megacycles, with one channel per megacycle increments. The system has a dual power supply, which gives the equipment continuous operation if one of the power sources fails. The main power source for the system is the three-phase ac and the 28-volt dc systems, and protection is afforded by circuit breakers. Controls for operation of the UHF communication and ADF system are on the radio control panel (figure 4-2), on the left console.

UHF Communication and ADF Controls.

Function Selector Switch. A rotary-knob type selector switch, on the radio control panel, controls the mode of operation, either normal or alternate, and also selects the antenna of best reception. The switch is marked "MAIN REC" and "AUX REC" and has a two-headed arrow across the full diameter of the rotary knob. On the outer perimeter of the knob is the position marking denoting the function of the system. OFF, T/R, and ADF are the positions for the main receiver; REC, ADF, and OFF are the positions for the auxiliary receiver. The switch is designed so that when the arrow indicates OFF on the main system, the opposite arrow is indicating OFF on the auxiliary system. With the switch in the T/R position on the UHF receiver-transmitter, the auxiliary receiver is at the ADF position. This is the normal mode of operation, and the main receiver is connected to the UHF antenna for communication. At the same time, the auxiliary receiver is connected to the ADF antenna for automatic direction finding. When the main receiver is at ADF position, the auxiliary receiver is at REC. In this alternate mode of operation, the main receiver is connected to the ADF antenna for automatic direction finding, and the auxiliary receiver operates from the UHF antenna for reception of UHF voice transmission. The functions of the main and auxiliary receivers are then reversed, provided the main and auxiliary channel selector knobs are reset to the channel that corresponds to the frequency of the desired ADF and UHF signals. In other words, when the function of the two receivers is changed, the channel selectors must be changed to provide the correct operating frequency for the individual receivers.

NOTE

> The main channel selector control sets up the frequency for the transmitter as well as the receiver. When the main receiver is used for automatic direction finding, the transmitter, if operated, transmits on the ADF frequency, which is not recommended procedure. For proper transmission, the main channel must be set to the proper communication channel before transmitting and then back to the ADF channel for reception of ADF signals. Using the main receiver for automatic direction finding is an emergency procedure only.

Volume Controls. There are two volume controls on the radio control panel, marked "MAIN" and "AUX." When either of these rotary volume controls is rotated in the direction indicated by the arrow (clockwise), the volume of the respective equipment to the pilot's headset is increased. Counterclockwise turning of either volume will diminish the volume of the equipment being adjusted.

Channel Selector Knobs. There are two rotary selector knobs on the radio control panel used in selecting the desired channel frequency of the equipment in use. The UHF transmitter and main receiver channel selector control provides selection of 20 preset channels within the frequency range of the UHF receiver-transmitter. A similar channel control selector enables the pilot to select one of 20 channels on the auxiliary receiver.

Channel Indicators. There is a channel indicator window to the right of each channel selector knob. The upper window, marked "MAIN," shows the channel number that has been selected for the UHF transmitter and main receiver. A similar window, marked "AUX," to the right of the auxiliary receiver channel selector knob, displays the channel selected for the auxiliary receiver.

Antenna Selector Switch. A two-position switch (13, figure 1-3), on the left console in the cockpit, affords the pilot manual selection of either the upper or the lower antenna for both the UHF and the radar beacon system. The switch is marked "AUTO" and "LOWER." With the switch at AUTO, the antenna operating with the greatest signal strength will be in use. When the pilot selects the LOWER position, the lower antenna will be in operation. The switch is powered by the primary dc bus.

Azimuth Indicator. The azimuth indicator (7, figure 1-2), on the instrument panel, consists of a movable compass card, an index marker, a pointer, and an adjustment knob that is used to rotate the compass card to the desired heading. The needle provides visual indication of the ADF station direction from the airplane heading, for homing operation. The indicator also has a synchronizer knob and an annunciator used with the inertial flight reference system. [Refer to "Inertial All-attitude Flight Data System (Gyro-stabilized Platform)" in Section I.]

Operation of UHF Communication and ADF System.

Normal Operation. The normal operating procedure is as follows:

1. Function selector switch - T/R (main system).

2. Main channel selector knob - Select desired channel.

3. Auxiliary channel selector knob - Select desired channel.

4. UHF antenna selector switch - AUTO or LOWER as desired.

5. "MAIN" and "AUX" colume controls - As desired.

Alternate Operation. If the main receiver fails, the auxiliary receiver is used. To use the auxiliary receiver, proceed as follows:

1. Function selector switch - ADF (main receiver). The auxiliary receiver selection will be at REC.

2. Main channel selector knob - Select desired channel.

3. Auxiliary channel selector knob - Select desired channel.

4. "MAIN" and "AUX" volume controls - As desired.

NOTE

If the UHF transmitter is operated while the main receiver is using the ADF antenna, a temporary lockout feature transfers the UHF transmitter to the UHF antenna.

RADAR BEACON SYSTEM (AN/DPN-41 OR AN/APN-65).

Radar beacon system AN/DPN-41 or AN/APN-65, whichever is installed, automatically receives and returns radio-frequency signals from a ground tracking station to enable ground radar crews to track the flight of the X-15 Airplane. The receiver and the transmitter of the radio beacon are tuned independently to a preselected frequency within the 2700- to 2900-megacycle range. The radar beacon is designed to operate dependably from a minimum range of 1200 yards to a line-of-sight range of at least 150 miles when operated in conjunction with a ground radar set SCR-784, or equivalent. There are two antennas for the radar beacon: one on the upper fuselage, just aft of the canopy, and the other on the bottom fuselage, just forward of the UHF antenna. The radar beacon receiver and transmitter use the same antenna. The antenna that receives a usable signal from the ground station is automatically connected to the radar beacon system through the UHF antenna selector switch when it is positioned to AUTO. The radar beacon system is powered by the No. 1 primary ac bus through a switch in the cockpit.

Radar Beacon Switch.

The radar beacon switch (11, figure 1-5), on the center pedestal, controls No. 1 primary bus power to the radar beacon system. The switch has two maintained positions, ON and OFF.

INTERCOMMUNICATION SYSTEM.

The X-15 pilot's microphone button and headset can be connected to the carrier airplane intercommunication system through a switch in the cockpit. Depending on carrier airplane intercommunication system switch settings, the X-15 pilot can communicate directly with the carrier airplane or transmit and receive by means of the carrier airplane command radio.

Intercommunication Switch.

The two-position intercommunication switch (5, figure 1-3), on the left console and labeled "INTERCOM," controls the function of the X-15 pilot's microphone buttons and headset. With the switch at ON, the X-15 pilot can communicate with the carrier airplane through the carrier airplane intercommunication system or transmit and receive command radio signals through the carrier airplane command radio, depending on the position of the carrier airplane intercommunication system function selected. With the switch at OFF, the X-15 pilot's microphone buttons and headset are connected to the X-15 command radio.

NOTE

If the intercommunication switch is at ON at time of launch, the pilot will not be able to use the command radio. This will be readily noticeable by the lack of static background noises or side-tone signals in the headset.

LIGHTING EQUIPMENT.

COCKPIT LIGHTING SYSTEM.

The cockpit is lighted by two floodlights attached to the canopy and located so that the light is directed forward and down, covering the entire cockpit controls and gages. These adjustable lights are shielded to eliminate direct glare to the pilot. A switch on the right instrument console controls the lighting system. The lighting system is powered by the primary dc bus.

NOTE

Loss of the canopy in flight will cause loss of the cockpit lighting system.

Cockpit Lighting Switch.

A two-position switch (32, figure 1-2), on the instrument panel right wing, controls the cockpit lighting system.

The switch has ON and OFF positions and is labeled "COCKPIT LIGHTS." The switch is powered by the primary dc bus.

PILOT'S OXYGEN SYSTEM.

The pilot's oxygen system is a high-pressure (3000 psi), gaseous-type system, completely contained within the ejection seat and pilot's back pan. Two 96-cubic-inch, lightweight cylinders are mounted on the bottom of the seat. The charging valve for both cylinders is about 6 inches above the seat bucket on the back rest. This system will supply 100 percent oxygen to the helmet for approximately 45 minutes at a pressure of 1-1/2 inches of water above the pilot's suit pressure, which varies with altitude. A reducer valve, incorporated in the high-pressure line, reduces the cylinder pressure from 3000 psi to 70 to 90 psi at the pilot's personal-lead quick-disconnect. The oxygen then flows into the back pan through a regulator and into the face mask. The system includes a warning system to indicate when breathing oxygen pressure is approaching the minimum for which the pressure suit is designed to permit normal breathing. No dilution is required in this system. Breathing oxygen is supplied by the carrier airplane from take-off until just before launch, at which time the pilot selects the X-15 Airplane oxygen supply. The oxygen supply is also utilized to pressurize the pilot's pressure suit in case the nitrogen ventilation and pressurization supply should fail.

WARNING

> The oxygen supply to the pressure suit helmet must be on and the helmet visor must be down before the cockpit is pressurized with nitrogen.

If ejection is necessary, the complete oxygen system is retained with the seat. Immediately before ejection, the green ball on the upper right side (chest area) of the pressure suit should be pulled to activate the emergency oxygen system and maintain suit pressurization after separation from the seat. When the green ball is pulled, the oxygen in the back pan flows through a pressure reducer, on through an oxygen regulator and a pressure suit regulator, to the pressure suit and helmet. The emergency oxygen supply, contained in the back pan, has a capacity of about 100 cubic inches at a cylinder pressure of 1800 psi and for a duration of about 20 minutes. During the time interval between seat separation from the airplane and pilot separation from the seat, the breathing oxygen is drawn from the normal system oxygen bottles attached to the seat. This is made possible by a valve in the emergency system, which is kept closed by a pressure differential until the pilot separates from the seat.

PILOT'S OXYGEN SYSTEM SELECTOR AND PRESSURE GAGE.

A three-position oxygen system selector, mounted on the forward end of the left side panel of the seat (figure 1-14), allows pilot selection of two separate oxygen systems. The three positions, labeled "B-52," "OFF," and "X-15," depend on the phase of flight as to which system is selected. The control head is a round, tubular aluminum section with the oxygen pressure gage mounted in the center. The selector is positioned by turning it from the middle OFF position, either right or left, to select the desired system. The gage range is from 200 to 3000 psi. Permanent markings are on the range scale. There is a red radial at 200 and a green arc from 200 to 3000. If the breathing oxygen is depleted to the point where the gage pointer is at 200, the green ball on the pilot's pressure suit must be pulled to actuate the emergency breathing oxygen supply.

PILOT'S OXYGEN-LOW CAUTION LIGHT.

The pilot's oxygen-low caution light is on the instrument panel, directly above the subsonic airspeed indicator. The placard-type amber light is powered by the primary dc bus and when illuminated reads "PILOTS O_2 LOW." It comes on when breathing oxygen pressure downstream of the reducer valve drops to about 60 psi. When the light comes on, the pilot is alerted to the possibility of encountering oxygen supply pressure sufficiently low to ultimately result in breathing difficulty.

NORMAL OPERATION OF PILOT'S OXYGEN SYSTEM.

For operation of the oxygen system, proceed as follows:

1. Upon entry into cockpit, move oxygen system selector to B-52.

2. Before launch, move oxygen system selector to X-15.

EMERGENCY OPERATION OF PILOT'S OXYGEN SYSTEM.

If the pilot's oxygen-low caution light comes on after the X-15 oxygen system has been selected, be prepared to actuate the emergency oxygen supply as soon as you are aware of breathing difficulty. The time between illumination of the light and when breathing difficulty is first encountered is dependent on several factors, including breathing rate, pilot size, and cabin pressure altitude.

MISCELLANEOUS EQUIPMENT.

PILOT'S PRESSURE SUIT SYSTEM.

The pilot's full-pressure suit is ventilated and pressurized by either the X-15 or the augmented cooling system liquid nitrogen supply. The liquid nitrogen flows through a heat exchanger and flow restrictor, where it is converted to gaseous nitrogen, then through a check valve, an electrical heater, and then to the vent suit flow control valve. From the vent suit flow control valve, the gaseous nitrogen is routed through a flexible disconnect hose and coupling to the pressure suit. After launch, ventilation of the pressure suit is maintained by the nitrogen system of the X-15 Airplane. Suit pressure is maintained at 1/10 psi above cockpit pressure at all altitudes above 35,000 feet. If cockpit pressure should fail, the nitrogen supply will pressurize the suit to maintain the 35,000-foot environment. The same routing lines and controls are used whether the nitrogen comes from the carrier airplane or the X-15. The desired volume of flow can be controlled from the cockpit. Temperature of the gaseous flow to the pressure suit may be controlled from approximately 50°F to 90°F by the vent suit gaseous heater. The heater is of the electric-tubular type and is controlled from the cockpit. Pressure and ventilation to the pressure suit are maintained automatically up to the vent suit flow control valve, when the air conditioning and pressurization system is in operation, by either the carrier airplane or the X-15 nitrogen system. The pressure suit is equipped with a pressure regulator that is used for suit ventilation, and an antiblackout pressure regulator that operates from the breathing oxygen supply. In addition to these provisions, the suit back pan also contains a demand-type oxygen regulator for normal and emergency use and a stored supply of oxygen to be used during emergency ejection. An integrated parachute harness and restraint assembly also forms a part of the pressure suit.

Pressure Suit Ventilation Knob.

A knob (2, figure 1-3), on the left console, controls the flow of gaseous nitrogen to the pressure suit. This knob, marked "PRESS. SUIT VENT," has an arrow to indicate the direction the knob should be turned (counterclockwise) to increase the volume and flow of the nitrogen to the suit. The knob has direct mechanical linkage to the flow control valve. Nitrogen flow is restricted to 7 cfm by a stop on the knob. This is to prevent excess nitrogen flow which could override the capabilities of the vent suit heater in addition to causing suit overpressurization. The 7 cfm provides sufficient ventilating gas flow for normal conditions. When initiating suit ventilation, the knob should be opened about one turn and then the vent suit heater switch should be moved to either HIGH or LOW, as required. If additional ventilation is required, the knob can be opened further.

Vent Suit Heater Switch.

The vent suit heater switch (3, figure 1-3), on the left console, is a three-position switch. With the switch in the HIGH position, the gaseous nitrogen to the vent suit is heated to a temperature of approximately 75°F to approximately 90°F and is maintained within that range by a thermoswitch. With the switch in the LOW position, another thermoswitch maintains a temperature of approximately 55°F to approximately 70°F. With the switch in the OFF position, the heater is inoperative, and the temperature of the gaseous nitrogen is that of the system temperature. The heater switch is powered by the primary dc bus. The heater is powered by the primary ac busses.

CAUTION

- When the augmented cooling system liquid nitrogen supply is being used during captive flight, the vent suit heater switch should be at HIGH or LOW, as necessary, to prevent liquid nitrogen from entering the area between the inner and outer windshield panels and consequently obscuring vision.
- When either the augmented cooling system or the X-15 liquid nitrogen system is supplying gaseous nitrogen to the pilot's ventilated suit, the vent suit heater switch should be at HIGH or LOW, as necessary, to ensure that the liquid nitrogen is converted to gaseous nitrogen.
- When there is no nitrogen flow (augmented cooling and X-15 liquid nitrogen systems turned off), the heater switch should be turned off to prevent damaging the heaters and equipment adjacent to the heaters.

Face Mask Heater Switch.

Primary dc bus power for the helmet visor heat elements is controlled by a four-position switch (4, figure 1-3), on the left console. The switch is labeled "FACE MASK HTR." The face mask heater is energized when the switch is moved from OFF. Heat is increased as the switch is moved from the LO to the MED and HI positions.