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MILITARY SPECIFICATION

ENVIRONMENTAL CONTROL, ENVIRONMENTAL PROTECTION, AND ENGINE BLEED AIR SYSTEMS, AIRCRAFT, GENERAL SPECIFICATION FOR

1. SCOPE

1.1 Scope. This specification covers performance, design, and testing requirements for the environmental control, the environmental protection, and the engine bleed air systems of aircraft.

1.2 Functions. The following functions when required in a particular aircraft and when performed by or associated with the environmental control, the environmental protection, and the engine bleed air systems shall be accomplished in accordance with the requirements of this specification.

(a) Pressurization, cooling, heating, ventilation, contamination control, and moisture control of occupied compartments (see 6.3.1), equipment compartments, and electronic equipment

(b) Pressurization of inflatable pressure seals, subsystem reservoirs, and miscellaneous equipment

(c) Distribution of engine compressor bleed air between the engines and the components and the subsystems that require bleed air

(d) Removal of rain, snow, dust, insects, salt, frost, fog, and ice from transparent surfaces and sensor windows

(e) Anti-icing or deicing of flight surfaces, radomes, antenna, and ram air scoops

(f) Pressurization and temperature control of air for anti-g suits, pressure suits, and ventilation suits.

2 APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-B-5087	Bonding, Electrical, and Lighting Protection, for Aerospace Systems
MIL-E-5400	Electronic Equipment, Aircraft, General Specification for
MIL-H-5484	Heater; Aircraft, Combustion Type
MIL-T-5842	Transparent Areas, Anti-Icing, Defrosting and Defogging Systems, General Specification for
MIL-W-7233	Windshield Wiper System, Electric, Aircraft, General Requirements for
MIL-D-7890	Design and Installation of Anti-g Suit Pressure Systems in Jet Propelled Aircraft
MIL-T-8207	Test Procedure for Aircraft Pressurized Compartments
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aircraft and Missiles
MIL-R-8573	Reservoirs, Air, Nonshatterable Steel
MIL-F-8615	Fuel System Components: General Specification for
MIL-H-8796	Hose, Air Duct, Flexible, Aircraft
MIL-D-8804	Deicing System, Pneumatic Boot, Aircraft, General Specification for
MIL-A-8806	Acoustical Noise Level in Aircraft, General Specification for
MIL-P-9024	Packaging, Materials Handling, and Transportability, System and System Segments, General Specification for
MIL-A-9482	Anti-Icing Equipment for Aircraft, Heated Surface Type, General Specification for
MIL-M-25047	Markings and Exterior Finish Colors for Airplanes, Airplane Parts, and Missiles (Ballistic Missiles Excluded)
MIL-R-25054	Regulator, Temperature, Aircraft-Cabin, General Specification for
MIL-C-25969	Capsule Emergency Escape Systems, General Requirements for
MIL-C-26500	Connectors, General Purpose, Electrical Miniature, Circular, Environment Resisting, General Specification for
MIL-F-38363	Fuel System, Aircraft, Design, Performance, Installation, Testing, and Data Requirements, General Specification for
MIL-C-38373	Cap, Fluid Tank Filler
MIL-H-46855	Human Engineering Requirements for Military Systems, Equipment and Facilities
MIL-R-83055	Rain Repellent Dispensing Systems, Aircraft Windshield, General Specification for
MIL-R-83056	Rain Repellents, In-Flight Applied, Aircraft Windshield
MIL-A-83116	Air Conditioning Subsystems, Air Cycle, Aircraft and Aircraft Launched Missiles, General Specification for
MIL-E-83210	Equipment, Electronic, Criteria for the Utilization of Micro/Molecular Electronic Technology

STANDARDS

Military

MIL-STD-130	Identification Marking of US Military Property
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-210	Climatic Extremes for Military Equipment
MIL-STD-461	Electromagnetic Interference Characteristics Requirements for Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-470	Maintainability Program Requirements (for Systems and Equipments)
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-800	Procedure for Carbon Monoxide Detection and Control in Aircraft
MIL-STD-810	Environmental Test Methods
MIL-STD-838	Lubrication of Military Equipment
MIL-STD-882	System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for
MIL-STD-890	Environmental Control, Environmental Protection, and Engine Air Bleed Subsystem Performance and Design Requirements Analyses
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MS33561	Connection, Aircraft Ground Air Conditioning, 5 Inch, Minimum Requirements
MS33562	Connection, Aircraft Ground Air Conditioning, 8 Inch, Minimum Requirements
MS33565	Connections, Ground Leakage Test, Pressurized Cabin, Aircraft
MS33740	Nipple, Pneumatic Starting, 3-Inch ID, Outline Dimensions of

PUBLICATIONS

USAF Specification Bulletin

526	Contaminants, Cabin Air, Maximum Allowable Concentration of

Air Force Systems Command (AFSC) Design Handbooks

DH 1-3	Personnel Subsystems
DH 1-5	Environmental Engineering
DH 1-6	System Safety
DH 2-2	Crew Stations and Passenger Accommodations
DH 2-3	Propulsion and Power

Air Force Pamphlet

161-2-1	Threshold Limit Values for Toxic Chemicals and Certain Electromagnetic Radiations

Air Force Regulation (AFR)

80-18	DOD Engineering for Transportability

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publication. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Society of Automotive Engineers (SAE), Inc. Aerospace Recommended Practice

ARP699C	High Temperature Pneumatic Duct Systems for Aircraft

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001).

2.3 Precedence of documents. In case of conflict between the requirements in this specification and the requirements in the documents referenced in this specification, the requirements in this specification shall govern.

3. REQUIREMENTS

3.1 Performance

3.1.1 Environmental control system performance. The environmental control system shall provide in accordance with the following paragraphs pressurization, cooling, heating, ventilation, moisture control, and contamination control for occupied compartments and as applicable for equipment and equipment compartments, inflatable pressure seals, and subsystem reservoirs. The above functions shall be accomplished with minimum attention and manipulation by the pilot or other crewmembers.

3.1.1.1 Pressurization

3.1.1.1.1 Occupied compartments. Aircraft that have operating altitudes greater than 20,000 feet shall be equipped with pressurized compartments for all crewmembers and passengers.

3.1.1.1.1.1 Pressure schedule. Pressurization for occupied compartments shall be maintained at the nominal cabin pressure schedule within ±0.4 inch Hg in the pressurized range and within 0 to +1 inch Hg of ambient pressure in the unpressurized range. The following pressure schedules shall be maintained at the various flight altitudes.

(a) Except for the occupied compartments of aircraft specified in 3.1.1.1.1.1(b), the occupied compartments of all aircraft shall be unpressurized from sea level to 8,000 feet and then maintained at an 8,000-foot, isobaric pressure altitude to the operational ceiling of the aircraft. For aircraft where mission operation at high altitudes (above 40,000 feet) is for a relatively short time period (1 hour or less) and a substantital weight increase is incurred by maintaining an 8,000-foot pressure altitude to the operational ceiling of the aircraft, it is acceptable to provide as a minimum a 5 pound per square inch (psi) differential pressure schedule above 23,000 feet.

(b) The occupied compartments of cargo and personnel transports, navigational trainers, and early warning aircraft shall be pressurized so that any cabin altitude between -1,000 and +10,000 feet may be selected by the crewmembers and may be maintained up to a maximum pressure differential equivalent to that between an 8,000-foot cabin altitude and the maximum operating cruise altitude (see 6.3.2) of the aircraft.

(c) When an emergency escape capsule system is installed in an aircraft, the aircraft pressurization system shall be designed to maintain pressure on the crewmembers during normal aircraft operation as given in 3.1.1.1.1.1(a). During the escape sequence and during periods of failures of the aircraft pressurization system, capsule pressurization shall be provided in accordance with MIL-C-25969 and shall permit periodic system performance verification.

3.1.1.1.1.2 Pressure regulation. Pressurization in the occupied compartments shall be regulated automatically, within the tolerances specified in 3.1.1.1.1.1, as follows:

(a) The occupied compartments shall be protected from excessive positive differential pressures by a separate outflow valve, a safety valve, or a combination of valves that shall be capable of passing the entire air input to the cabin at a pressure not in excess of 110 percent of normal maximum operational differential pressure but shall not relieve at a pressure less than 0.15 psi above the upper tolerance limit of the maximum normal operational differential pressure. The value for maximum positive pressure differential shall be specified in the contractor's detail specification.

(b) The occupied compartments shall be protected against excessive negative differential pressures for all possible operational conditions including rapid descent from maximum altitude with the pressurizing source shut off. The value for maximum negative differential pressure shall be determined by structural considerations and shall be specified in the contractor's detail specification.

(c) The maximum rate of pressure change within the occupied compartments of all aircraft, except the aircraft specified in 3.1.1.1.1.1(b), shall be 1 psi per second for decreasing pressure and 0.5 psi for increasing pressure. The rate of pressure change within the occupied compartments of the aircraft specified in 3.1.1.1.1.1(b) shall be controlled by an automatic controller that will allow for selection and control anywhere in the range of 100 to 2,000 feet per minute.

(d) Provisions to assure that detrimental residual occupied compartment pressure differentials (positive or negative) will not exist when opening of canopies, hatches, or doors is required under any normal or emergency operational conditions shall be incorporated.

(e) Following pressure schedule changes during transient conditions, overshoot shall not exceed 1 psi; the resulting fluctuations shall not have a frequency greater than 0.15 cycle per second; the fluctuations shall dampen out with a minimum of cycles. Variations in pressure shall not exceed 0.2 psi at any altitude up to the flight ceiling of the aircraft when engine speed is changed by maximum throttle rate change between the limits of 100 percent rated revolutions per minute (rpm) and the minimum rpm setting at which level flight can be maintained.

3.1.1.1.1.3 Pressure release. Both normal and emergency provisions for pressure release shall be provided for the occupied compartments. Where possible, the normal and the emergency provisions for pressure release shall be an additional function of the safety valve. The normal pressure release provisions shall be capable of dumping (see 6.3.3) cabin pressure without shutting off the pressurizing air source. The emergency pressure release provisions shall be capable of dumping cabin pressure rapidly with the pressurizing air source shut off automatically at initation of dump. All emergency release provisions shall be activated by a single control. The time required to accomplish pressure release, after the initation of the emergency pressure release provisions, shall be as follows:

(a) The release time to dump from maximum cabin pressure differential to within 1 psi of ambient pressure on aircraft with emergency escape systems for all occupants shall be such that the overall average rate of pressure change will be within the range of 0.5 to 1.0 psi per second.

(b) Unless the aircraft have emergency escape systems for all occupants, the maximum release time shall be 15 seconds for the aircraft specified in 3.1.1.1.1.1(a) and 60 seconds for the aircraft specified in 3.1.1.1.1.1(b). The rate of pressure decrease during depressurization shall not exceed 1 psi per second.

3.1.1.1.1.4 Pressure source. The pressure source for the occupied compartments, whether it is controlled air from the air conditioning system or a stored gas system or a combination of both, shall provide sufficient flow to maintain the pressure schedule given in 3.1.1.1.1.1(a) or 3.1.1.1.1.1(b) while overcoming uncontrolled in-service allowable air leakage per 3.1.1.1.1.5. This flow rate shall be compatible with the minimum ventilation requirements of 3.1.1.2.1.5 and the allowable contamination levels of 3.1.1.2.1.7. For the portions of flight in which the aircraft occupied compartment is pressurized by a stored gas supply, the partial pressure of the oxygen in the compartment shall be equivalent to the partial pressure of oxygen at 8,000-foot altitude. When emergency enclosed escape systems are installed, a separate pressurization source for use during the escape sequence and descent to earth and during periods of failure of the aircraft pressurization system shall be provided in accordance with MIL-C-25969.

3.1.1.1.1.5 In-service and production leakage rate. The maximum allowable in-service leakage rate of occupied compartments shall be 1.6 times the maximum allowable production leakage rate corrected to sea level standard conditions. The in-service leakage rate shall be the leakage rate included in field maintenance manuals. The maximum allowable production leakage rate of the occupied compartments shall be the maximum allowable rate following completion of the Air Force acceptance flight tests just prior to delivery to the using command. The maximum allowable production leakage rate of the occupied compartments shall be the lesser rate that will result from the following:

(a) The maximum allowable production leakage rate for all aircraft except aircraft using a 5 psi differential pressure schedule shall not exceed one-half the rate that will assure the compartment pressure altitude will not exceed 30,000 feet during a maximum rate of descent from maximum operating ceiling with the compartment initially pressurized at 10 pounds per square inch absolute (psia). The maximum allowable production leakage rate for aircraft using a 5 psi differential pressure schedule shall not exceed one-half the rate that will assure the compartment pressure altitude will not exceed 42,000 feet during a maximum rate of descent from maximum operating ceiling with the compartment initially pressurized at a 35,000 foot pressure altitude.

(b) The maximum allowable production leakage rate under the most adverse flight condition of pressure and temperature shall not exceed $0.07V^{0.667} + 0.5$ pounds per minute, where V is the volume of the pressurized enclosure in cubic feet. This value for leakage includes the leakage from outflow valves and air conditioning units.

(c) The maximum allowable production leakage rate shall not exceed one-half the rate that will assure that the required pressure schedule can be maintained during descent with engines at idle speed.

(d) The maximum allowable production leakage rate for aircraft that have more than one air conditioning unit supplying air to the pressurized compartment shall not exceed one-half the rate that will assure that the required pressure schedule can be maintained with one air conditioning unit inoperative.

3.1.1.1.2 Equipment pressurization. Equipment requiring individual unit pressurization from an external source shall be supplied flows at pressures, temperatures, humidity, and contamination levels that are compatible with the equipment specification and MIL-E-5400. When two or more units are pressurized by the same source, loss of pressurization by one shall not cause loss of pressurization to the other units. Pressure relief provisions to prevent over-pressurization of the equipment shall be incorporated. When radar units are pressurized by individual pressurizing sets, the AN/ASQ-14, the AN/ASQ-15, or the AN/ASQ-70 pressurization set (Government-furnished aeronautical equipment) shall be used wherever compatible with the radar pressurization requirements.

3.1.1.1.3 Equipment compartment pressurization. Pressurization of equipment compartments that are separate from the occupied compartments shall be regulated automatically and maintained at a pressure compatible with the most critical unit contained within the compartment. When the compartment pressurization is accomplished by controlling the outflow of air conditioning air or stored gases from the compartment, a second outflow valve or safety valve to prevent excessive positive and negative pressures shall be provided. The valve settings shall be determined by structural considerations. The compartment pressurization medium shall be supplied at pressure, temperature, moisture, and contamination levels compatible with the equipment specifications. The criteria of 3.1.1.1.1.5, except for 3.1.1.1.1.5(a), shall apply for the allowable production and in-service leakage rates for pressurized equipment compartments.

3.1.1.1.4 Inflatable seal pressurization. Inflatable seals shall be sufficiently pressurized to provide effective sealing of closures when the compartment pressure is at a maximum, the aircraft is at maximum operational ceiling, and the pressurizing source is at a minimum pressure. The pressurization medium shall be supplied at pressure, temperature, moisture, and contamination levels compatible with each inflatable seal requirement.

3.1.1.1.5 Subsystem reservoir pressurization. When the reservoirs of subsystems such as fuel, oil, hydraulic fluid, coolant fluid, and water are pressurized with air, the pressurization airflows shall be provided at pressure, temperature, moisture, and contamination levels compatible with the applicable subsystem specification requirements. Fail-safe provisions to prevent the entrance of hazardous fumes and fluids into environmental control, the environmental protection, and the engine bleed air systems shall be provided. The supply airflow rate and temperature shall be controlled to prevent autoignition.

3.1.1.2 Air conditioning. All aircraft whether pressurized or unpressurized shall be provided with cooling, heating, and ventilating provisions.

3.1.1.2.1 Occupied compartment. Aircraft heating, cooling, and ventilating equipment shall meet the requirements specified in 3.1.1.2.1.1 through 3.1.1.2.1.8.

3.1.1.2.1.1 Cooling. The cooling equipment shall have sufficient capacity to maintain the average compartment air temperature (see 6.3.4) at 70°F for all flight conditions, throughout the range of minimum to maximum engine power setting, except transients of 30 minutes or less such as climb, idle descent, and high speed burst. For transient flight conditions of 30-minute duration or less the cooling equipment shall have sufficient capacity to prevent the average compartment temperature from exceeding 80°F. During ground operation in ambient temperatures up to 125°F, when using either the aircraft propulsion engines operating at idle or an on-board auxiliary power unit (APU), the cooling equipment shall be capable of preventing the average compartment temperature from exceeding 80°F. The preceding flight performance shall be met or exceeded throughout the ambient temperature and humidity range specified in MIL-STD-210. The preceding system ground operating performance shall be met or exceeded at all temperature and humidity conditions of figure 1. Transient cool down times of compartments following high temperature soaks shall be as specified in the weapon system specifications or held to a minimum if not specified. The temperature of all surfaces, except small local areas such as diffusers, structural attachment fittings, and circuit breakers, which enter into radiant heat exchange with occupants, shall be prevented from exceeding levels that adversely affect human comfort. The temperature of these surfaces shall not exceed 105°F, except during transient periods of 30 minutes or less at which time they shall not exceed 160°F. All surfaces in occupied compartments, which can be touched by personnel, shall be maintained at levels that will not cause discomfort if touched with the unprotected parts of the human body.

3.1.1.2.1.2 Heating. The aircraft heating equipment shall be capable of maintaining an average compartment air temperature of at least 80°F for all ground and flight conditions when operating in cold day ambient conditions specified in MIL-STD-210. The floor areas of all aircraft, which the crewmembers and the passengers will be in contact with for extended time periods, shall be maintained at or above 60°F during all flight conditions. The floor areas of all aircraft, which the crewmembers and the passengers will not be in contact with for extended time periods, shall be maintained, during all flight conditions, at an average floor temperature of at least 60°F with no areas colder than 40°F. The maximum floor temperature during all heating conditions shall not exceed a level that is hazardous or uncomfortable to the crewmembers or the passengers. Minimum temperature of radiant surfaces, except small local areas, to which occupants may be exposed during flight for periods longer than 30 minutes shall be 50°F.

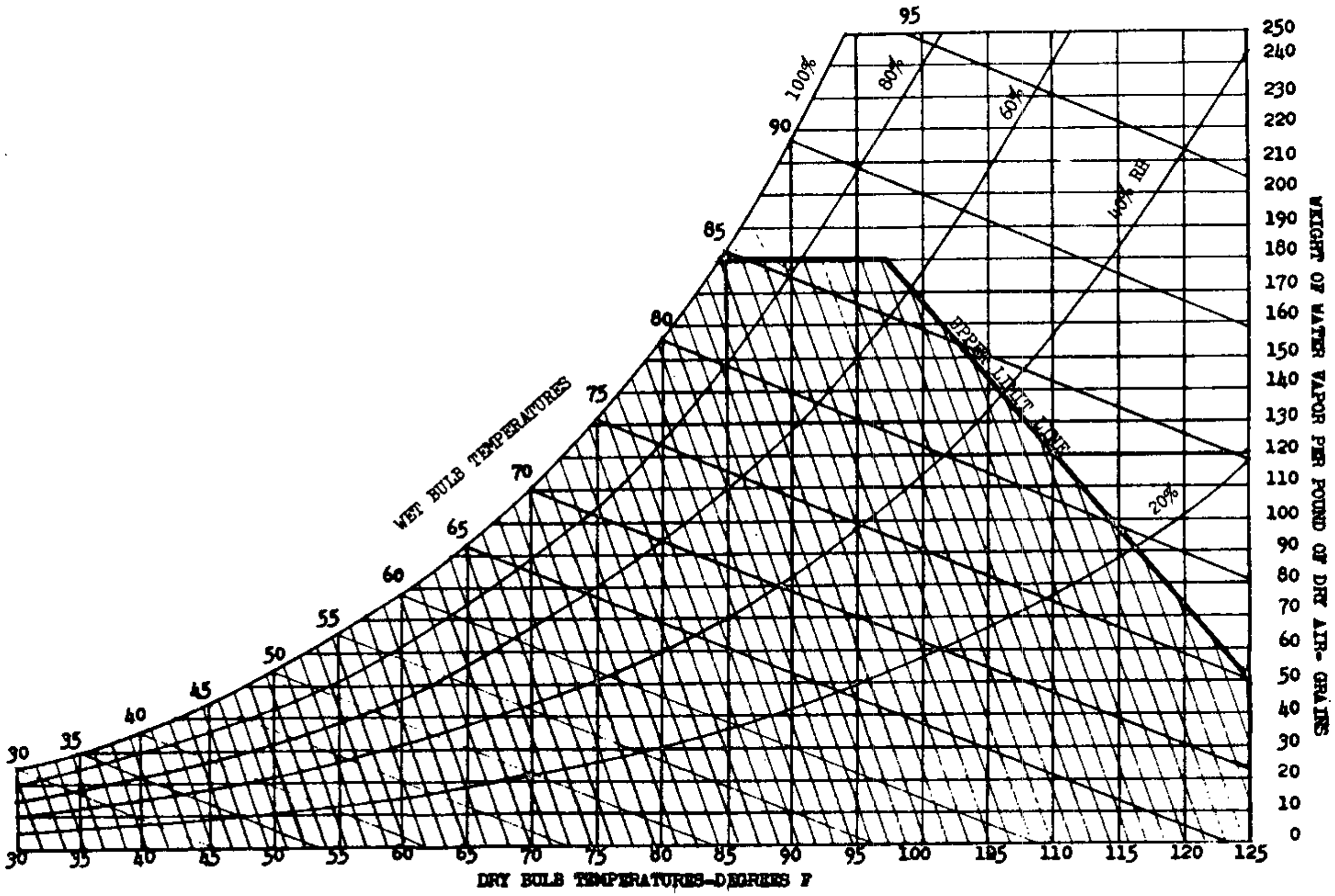

FIGURE 1. Ground Level Design Humidity Range

3.1.1.2.1.3 Temperature control. The following requirements for automatic temperature controls shall be applicable to all aircraft.

(a) Steady state: The controls shall hold the average compartment air temperature to within ±3°F of the setting selected by the crew.

(b) Transient: The time required for the average compartment air temperature to stabilize within ±3°F of the setting selected by the crew after encountering extreme temperature transients caused by engine power changes, aircraft maneuvers, or change of selected temperature shall be held to a minimum and in no instance shall exceed the time specified in the airframe contractor's detail procurement specification.

(c) Manual: An electrical or mechanical means of overriding the automatic controller shall be provided.

3.1.1.2.1.4 Distribution. The air supplied to occupied compartments shall be uniformly distributed to prevent excessive temperature differences. Temperature variation between any two points in the envelope occupied by seated personnel shall not deviate more than 5°F from the average compartment temperature. Temperature differences in the areas outside the envelope of seated personnel in which movement of personnel is possible shall not vary more than 10°F from the average compartment temperature. The velocity of the air moving past crewmembers or passengers shall not exceed 300 feet per minute.

3.1.1.2.1.5 Ventilation. A fresh air ventilation rate of at least 20 cubic feet per minute per person shall be provided for the full complement of crewmembers and passengers during all flight and ground conditions, except that the minimum ventilation rate for passengers on high density personnel transports may be 13 cubic feet per minute per person. In addition, the minimum airflow rate into the compartments of pressurized aircraft for all flight conditions shall be at least 1.8 times greater than the maximum allowable production leakage rate. A breathable atmosphere for all personnel during ejection and descent and during periods of failure of the aircraft pressurization system shall be provided on aircraft in which an emergency escape capsule system will be used. Capsule ventilation after landing on land or water shall be provided in accordance with MIL-C-25969. An air supply of at least 13.25 cubic feet per minute to each ventilated suit assembly at a suit disconnect pressure given by the formula $P = 0.5 + 88\rho$ where P is pressure in inches of water above cabin pressure and ρ is density of air in pounds per cubic foot, shall be provided in aircraft in which ventilating suits will be used. The temperature of the air supplied to the ventilated suit under normal cruise flight conditions shall be in the range between 50°F and 90°F. The temperature of air supplied to the ventilated suit during transient flight and ground conditions shall be between 50°F and 130°F.

3.1.1.2.1.6 Ram air ventilation. An emergency ram air ventilation system that will provide uncontaminated air in accordance with the requirements of 3.1.1.2.1.5 during periods of failure of the normal aircraft cooling provisions shall be incorporated in all aircraft that do not use ram air as the normal means of ventilation.

3.1.1.2.1.7 Contamination. Air supplied to occupied compartments, regardless of origin, shall not cause compartment contamination levels in excess of the maximum allowed by MIL-STD-800 and Bulletin 526. Vapors resulting from auxiliary engine exhaust systems, aircraft fuel system, gunfire exhausts, combustion heater exhaust, cartridge actuated devices, propellant actuated devices, hydraulic fluid, oil, overheated electrical insulation, coolant fluids, fire extinguisher agents, motor vehicles, fuel tanks, dry ice, and any other cargo or equipment shall be prevented from entering the occupied compartments wherever possible. When prevention of entry of these vapors is not possible, sufficient ventilation shall be provided to prevent concentrations in excess of the concentrations specified in Air Force Pamphlet 161-2-1 or concentrations that will create an explosion hazard during pressurized, unpressurized, and depressurized periods. An aircraft installed system shall provide adequate ventilation for cargo compartments during ground operations to assure that aircraft exhaust product concentrations from a full aircraft load will not exceed human tolerance levels during normal loading and offloading operation. Satisfactory air filtration of radioactive particles and chemical and biological warfare agents shall be provided in accordance with the aircraft requirements.

3.1.1.2.1.8 Moisture control. All air delivered to occupied compartments shall be free of entrained moisture (see 6.3.5). Consideration to maintaining a minimum ambient relative humidity of 30 percent for all the crewmembers and the passengers should be given for all aircraft that have mission times in excess of 12 hours at high altitude.

3.1.1.2.2 Equipment and equipment compartments. Air conditioning as required by the equipment specifications and the results of analyses and evaluations accomplished in accordance with MIL-STD-890 and MIL-E-83210 shall be provided for equipment and equipment compartments.

3.1.1.2.2.1 Electronic equipment cooling. The cooling provisions for electronic equipment, excluding the means for distribution of the coolant media, shall provide cooling for an electronic heat dissipation load 25 percent greater than the on-board electronic equipment heat load of the first production aircraft. This excess capacity is intended for future equipment that may be added to the aircraft during service usage; therefore, an additional allowance in excess capacity for equipment that might be added during the development phase prior to production and for possible increases in heat dissipation of equipment over that assumed for the equipment at the start of the program shall be made in establishing the total system cooling capacity at the start of an aircraft development program. The appropriate environment for both operating and nonoperating equipment shall be maintained during all flight conditions and all aircraft ground operational conditions with ground ambient temperatures up to 125°F and ground humidity levels within the range defined by figure 1, including engines at idle speed. The ram air cooling systems for electronic equipment shall have provisions to assure that the equipment will not be adversely affected during flight in rain with rain fall rates up to 6 inches per hour.

3.1.1.2.2.1.1 Free convection air cooling. Compartments containing electronic equipment in accordance with MIL-E-5400, which are cooled by ambient free convection, shall be supplied with sufficient conditioned air to maintain the ambient temperatures, throughout the conditions of 3.1.1.2.2.1, within the specified maximum and minimum temperature and altitude limits for the particular class of equipment as defined in MIL-E-5400. Free convection cooled equipment shall be limited to the operating environment for which the equipment was designed and tested.

3.1.1.2.2.1.2 Internally forced air cooling. Forced air cooled equipment shall be provided with the cooling air temperature and weight flow specified in the equipment specification. Temperature and pressure ambients compatible with the environment to which the equipment was designed and tested shall be provided. In instances where it is proposed to install equipment in compartments with ambient temperature that is more severe than the temperature to which the equipment has been tested, a thermal analysis that will show satisfactory functional and reliability performance may be acceptable in lieu of a retest. Cooling air forced directly over the surface of miniaturized or basic electronic components shall be totally void of entrained moisture.

3.1.1.2.2.1.3 Cold plate forced convection air cooled. Air supplied to cold-plate (see 6.3.6) forced convection cooled units shall meet the temperature and weight flow or heat rejection requirements of each equipment specification.

3.1.1.2.2.1.4 Forced convection liquid cooled. Liquid coolant supplied to forced convection liquid cooled equipment shall be at flows, temperatures, and pressures specified by the equipment detail specifications. All line replaceable units of the liquid cooling loops shall have self-sealing disconnects. Liquid coolant connections to the equipment being cooled shall be a self-sealing and a quick-disconnect type.

3.1.1.2.2.2 Temperature control. The range and rate of fluctuation between minimum and maximum electronic equipment operating temperatures shall be minimized and should not exceed that necessary to provide the specified equipment reliability except during emergency ram air operations. The inlet cooling air temperature and flow rate to forced and ambient cooled electronic equipment should be controlled to prevent overcooling and assure no problems due to moisture.

3.1.1.2.2.3 Distribution. The cooling air shall be distributed to each unit of equipment in accordance with the cooling requirements determined as specified in 3.1.1.2.2 and 3.1.1.2.2.1. When plenum chambers (integrated equipment racks and distribution system) are used to supply cooling air to several units, the effects of temperature rise and pressure loss shall be taken into account in determining cooling requirements. Allowances for improper flow balancing and system leakage shall also be included in the cooling requirements. Cooling air ducts routed through compartments in which high ambient temperatures or humidity can exist shall be insulated to prevent excessive heat gain or condensation. When equipment is cooled by exhaust air from occupied compartments, sufficient redundancy shall be incorporated to insure that no single failure in the occupied compartment cooling circuit will result in equipment overheat. Flexible ducts shall be in accordance with MIL-H-8796. All other ducting shall meet the flame resistance requirements of MIL-H-8796.

3.1.1.2.2.4 Contamination. Air delivered to the interior portions of internally forced convection air cooled electronic equipment shall not contain more than 0.1 gram of solid contaminants per pound of air, and 95 percent of the particles shall be less than 20 micron in size, and no particle shall be greater than 50 micron.

3.1.1.2.2.5 Emergency cooling. In the event of failure of the normal mode of cooling, an alternate cooling mode through the use of ram air or another cooling unit if available shall be provided for all mission essential electrical and electronic equipment, weapons, and any other applicable compartments, which are not normally cooled by ram air, to enable sufficient cooling of the equipment for mission completion as long as ram air temperatures are below 120°F. The emergency ram air controls shall be designed so that the normal supply of cooling air to the equipment and equipment compartment is shut off and compartment pressure is released when emergency ram air is selected. Reverse flow through the emergency ram air circuit shall be prevented unless it is configured to act as a dump function.

3.1.2 Environmental protection system performance

3.1.2.1 Defrosting and defogging. Frosting or fogging of the interior surfaces of all transparencies and sensor windows essential for completion of the mission shall be prevented or eliminated in accordance with the requirements of MIL-T-5842. Efforts should be made to reduce the overheating effect in the occupied compartment when the defogging or defrosting system is on. Closing of the air conditioning package shutoff valve shall not prevent use of the defogging and defrosting provisions to enable a safe return (see 6.3.7) and landing.

3.1.2.2 Rain removal. Provisions shall be installed on all aircraft to clear to the degree necessary the area of the pilot and co-pilot's windshield required for an adequate field of vision in heavy rain (0.59 inch per hour, 1,500-micron-median-droplet diameter) during the following conditions:

(a) Ground taxi

(b) Takeoff

(c) Landing approach

(d) Landing

(e) In-flight refueling on aircraft where this will be accomplished at altitudes below 20,000 feet

(f) Level flight at 1.6 times the stall speed at maximum weight with flaps and gear retracted for fixed wing aircraft

(g) Maximum cruise speed for rotary wing aircraft.

In addition, the rain clearance system shall provide sufficient clearance to enable safe landing during excessive rain (1.6 inches per hour, 2,300-micron-median-droplet diameter). The area requiring clearance and the degree of clearance necessary for each of these ground and flight conditions shall be established early in the aircraft development program through the use of a cockpit mockup and rain tunnel testing. The area and degree of clearance shall be as specified in the aircraft detail specification. In addition to the required clearance capability, the rain removal provisions shall not be damaged by flight at the maximum speed of the aircraft. Rain removal provisions, which will provide the necessary clearance for proper sensor operation during heavy rain for all in-flight conditions in which sensor operation is required, shall be incorporated for the sensor windows.

3.1.2.3 Snow removal. Provisions that will adequately remove snow from the pilot and co-pilot's windshield and sensor windows during the same ground and flight conditions as specified in 3.1.2.2 shall be installed.

3.1.2.4 Salt removal. When aircraft missions require low level flights over the oceans or along the coast, a salt removal subsystem for the pilot and co-pilot's windshield and the sensor windows shall be provided with the capability of maintaining adequate vision throughout the period of maximum over the water low level flight during one mission.

3.1.2.5 Insect and dust removal. For aircraft having a low level mission over land, an insect removal system for the pilot and co-pilot's windshield and the sensor windows shall be provided, if required, with the capability of maintaining adequate vision throughout the period of maximum over the land low level flight during one mission. The system performance shall be based on encountering insects of honeybee size (120 milligrams) at a concentration of one per 20,000 cubic feet. Vertical takeoff and landing aircraft shall have a washing system for maintaining the pilot and co-pilot's windshield free of dust.

3.1.2.6 Ice protection

3.1.2.6.1 Transparent areas and sensor windows. All critical crew sighting and camera windows shall be anti-iced in accordance with the requirements of MIL-T-5842. Anti-icing (see 6.3.8) for sensor windows, if required to accomplish the mission in meteorological conditions defined by figures 2 and 3, shall be provided.

(1. ALTITUDE; SEA LEVEL TO 22,000 FEET
(2) MAXIMUM VERTICAL EXTENT; 6,500 FEET
(3) HORIZONTAL EXTENT; 20 STATUTE MILES

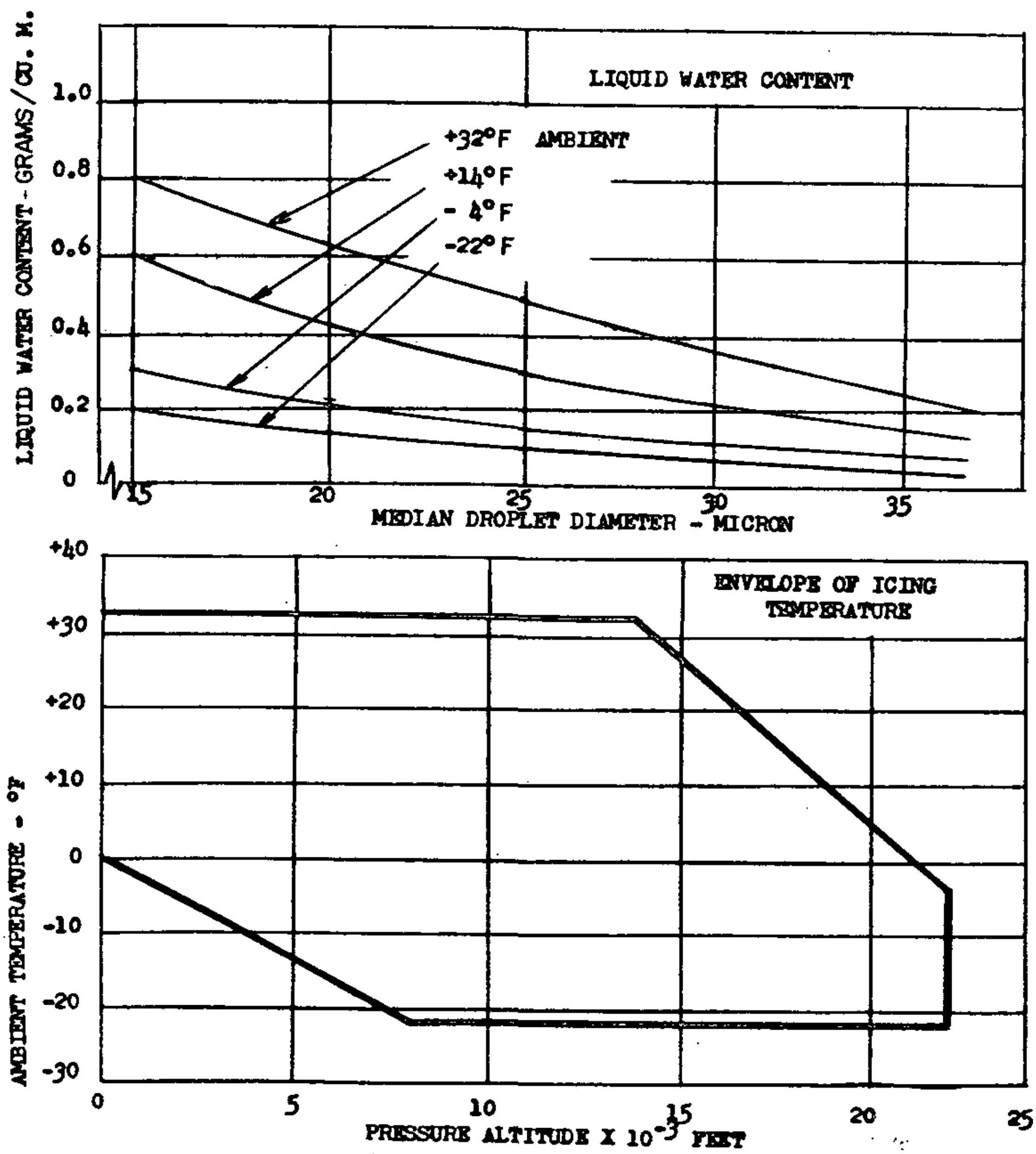

FIGURE 2. Continuous Maximum Icing Conditions

(1) ALTITUDE; 4,000 TO 22,000 FEET
(2) HORIZONTAL EXTENT; 3 STATUTE MILES

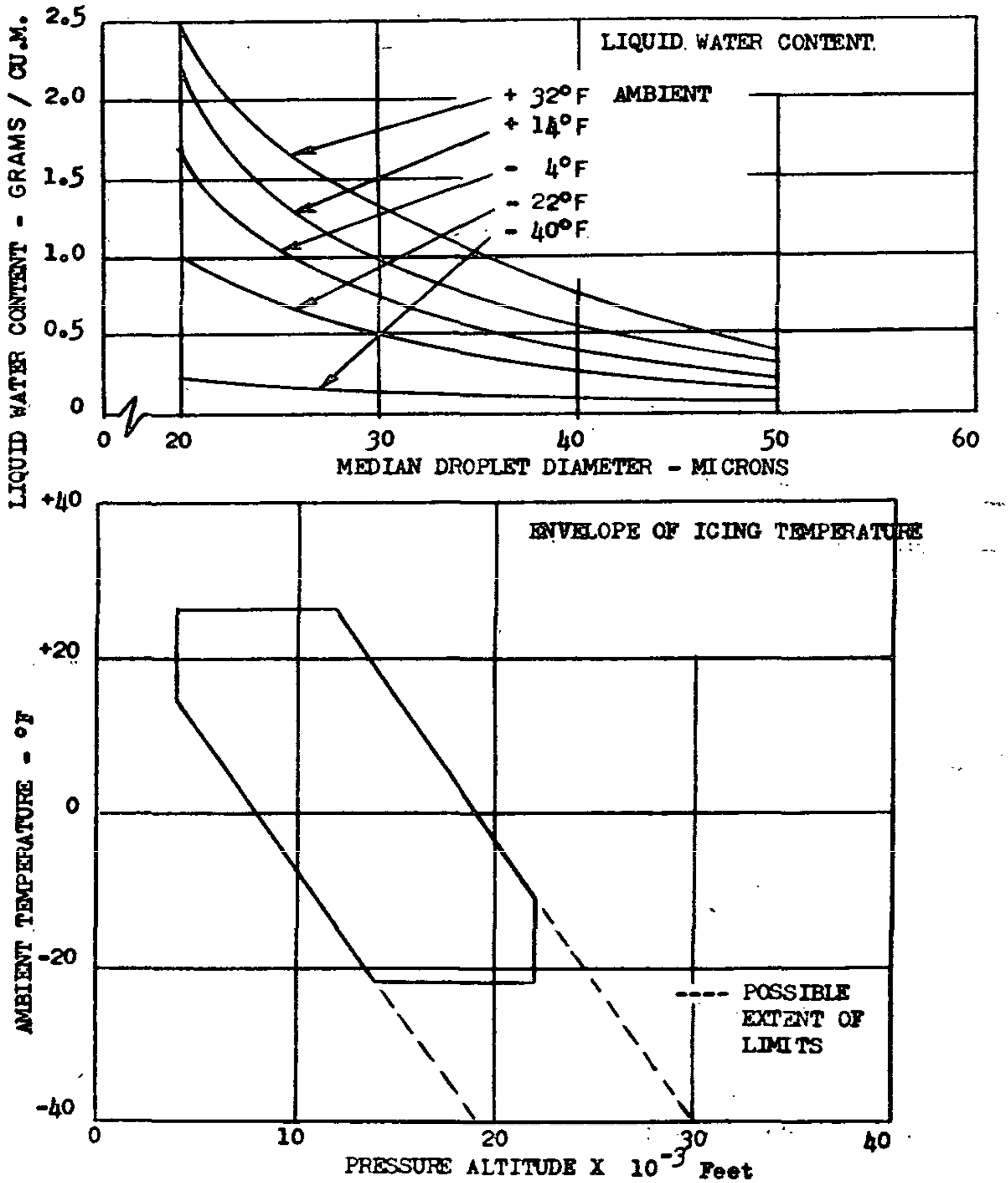

FIGURE 3. Intermittent Maximum Icing Conditions

3.1.2.6.2 Radomes and antennas. Anti-icing or deicing (see 6.3.9) of radome and antenna surfaces, if required to maintain radar or communications efficiency in meteorological conditions defined by figures 2 and 3, shall be provided.

3.1.2.6.3 Flight surfaces, pylons, and external stores. All flight surfaces, pylons, and external stores on which ice buildup or shedding would cause flight hazard, engine damage, or significant deterioration in performance when subjected to the icing conditions of figures 2 and 3 shall be protected.

3.1.2.6.4 Ram air inlets. Ram air inlets and emergency ram air inlets for supplying cooling to air conditioning pack(s), electronic equipment, and compartments shall be anti-iced unless it can be demonstrated that operation during the icing conditions of figures 2 and 3 is possible without detrimental ice build-up that could seriously impair air conditioning performance or equipment cooling or damage system components.

3.1.2.7 Anti-g suit air supply. Pressurization air at pressure, moisture, and contamination levels compatible with anti-g suit equipment shall be provided to each anti-g suit on aircraft in which the anti-g suits will be used. The temperature of the anti-g suit air supply shall be controlled between 50°F and 130°F.

3.1.2.8 Pressure suit air supply. A supply of air at pressure, moisture, and contamination levels compatible with the pressure suit equipment shall be provided for each pressure suit on aircraft in which pressure suits will be used. The temperature of the pressure suit air supply shall be controlled between 55°F and 90°F.

3.1.3 Engine bleed air system performance. The engine bleed air system as covered in this specification shall consist of the ducting and components that pass high or low pressure bleed air from the engine ports or other compressed air sources to the various subsystems that use compressed air such as air conditioning, jet blast rain removal, anti-icing, defrosting, defogging, fuel tank pressurization, anti-g suit pressurization, air turbine motor, and boundary layer control.

3.1.3.1 Distribution. The bleed air distribution system shall provide air to all components requiring bleed air at a specified pressure, temperature, and weight flow and shall minimize energy losses from the bleed air. External leakage at any one joint shall not exceed 0.01 cubic foot per minute of standard air per inch of duct diameter, and the total external leakage from the bleed air distribution system shall be held to a minimum. In the case of duct or component failure resulting in an open line, the bleed air from the engine shall not be extracted at a flow rate greater than the flow rate allowed by the engine manufacturer. The distribution system shall be sized so that bleed flows in the necessary quantities can be routed to all equipment requiring operation simultaneously. The distribution system including the duct mounting components shall be able to withstand the following without failure or degradation of fatigue life:

(a) Aircraft structural deflection resulting from maximum gravity maneuvers

(b) Maximum thermal expansion normally resulting from aircraft structure being at -65°F and the ducting being heated by airflow to maximum operating temperature

(c) Internal duct airflows at maximum operating conditions

(d) In some installations, external airflow disturbance due to duct exposure when bomb bays and wheel wells are opened.

3.1.3.2 Ducting. The ducting shall require minimum maintenance and provide maximum possible reliability. The ducting shall induce minimum loads on equipment and vice versa. The ducting shall withstand handling fabrication and maintenance without incurring dents and bulges causing degradation in duct strength.

3.1.3.3 Components. Components such as shutoff valves and pressure regulators of the engine bleed air system shall be corrosion resistant and shall resist freezing of moisture condensed on the item either internally or externally.

3.1.3.4 Insulation. Insulation shall offer maximum protection against heat transfer to structure, maximum resistance to combustible fluid wicking, maximum protection against impingement of combustible fluids upon hot air ducting and components, and protection of surrounding components from direct hot air impingement when small duct or coupling leaks occur. Shields shall be provided around any ducting with surface temperatures greater than 200°F that are routed in occupied compartments in which loose items in the compartment can come in contact with the duct.

3.1.3.5 Controls. A normally open shutoff valve, which fails in the open position, shall be provided at each source of bleed air. Manifold bleed ports on a single engine shall be considered to be a single source. Controls shall be provided so that the valve may be actuated from the crew station and combined or alternate sources may be selected when there is a multiple source of supply.

3.2 Design requirements

3.2.1 General design requirements

3.2.1.1 Component interchangeability and selection. The components of the environmental control, the environmental protection, and the engine bleed air systems that are obtained from two or more manufacturers shall be interchangeable in accordance with MIL-I-8500. The contractor where practicable shall establish alternate sources for the components of these systems. Every effort shall be made to select components that will function in more than one location within the aircraft to minimize the number of components with different part numbers. Previously developed equipment, preferably in the Government inventory, shall be used wherever possible.

3.2.1.2 Atmospheric conditions. The design ambient temperature conditions for meeting the heating and cooling requirements of this specification during flight conditions shall be based on the standard cold and hot atmospheres presented in MIL-STD-210. The heating and cooling requirements of this specification shall be met during operation in the worldwide ground hot and cold extremes defined by MIL-STD-210. The design maximum specific humidity for the standard hot atmosphere shall be as given in MIL-STD-210. The design specific humidity for ground conditions shall be as defined by the upper limit line of figure 1. The atmospheric conditions specified in MIL-T-5842 shall govern the design of defogging and defrosting systems for all transparencies. Ice protection system, except for transparent areas, shall be designed to operate under meteorological conditions of figures 2 and 3. The design range of ambient temperatures for rain removal operation shall be 32°F to 90°F. The value for solar radiation intensity versus altitude as shown by figure 4 shall be used in determining cooling requirements. The effects of solar radiation shall be neglected in determining heating requirements.

3.2.1.3 Operating conditions. The environmental control, the environmental protection, and the engine bleed air systems shall be capable of satisfactory operation during all flight altitudes and attitudes, rapidly changing altitudes and air speeds, extremes of engine operation, extremes of temperature, and accelerations that can be encountered during takeoff, flight, landing, or servicing of the aircraft and during ground operations when engines are running.

3.2.1.4 Acoustical noise level. Noise levels resulting from operation of the environmental control and the environmental protection systems shall be as follows:

(a) The levels of noise measured at head level in the occupied compartments of multi-crew and personnel carriers shall not exceed the levels specified in table IVA of MIL-A-8806.

(b) The levels of noise measured at head level in the occupied compartments of single-place aircraft shall not exceed the values given by curves 1 and 2 of figure 5. If pure tones are generated within the compartments by the environmental control system for a period longer than 5 minutes, the levels of figure 5 shall be reduced by 5 decibels.

3.2.1.5 Crew station controls. Crew station controls for the environmental control, the environmental protection, and the engine bleed air systems shall be compatible with design requirements for crew stations specified in the applicable aircraft specification.

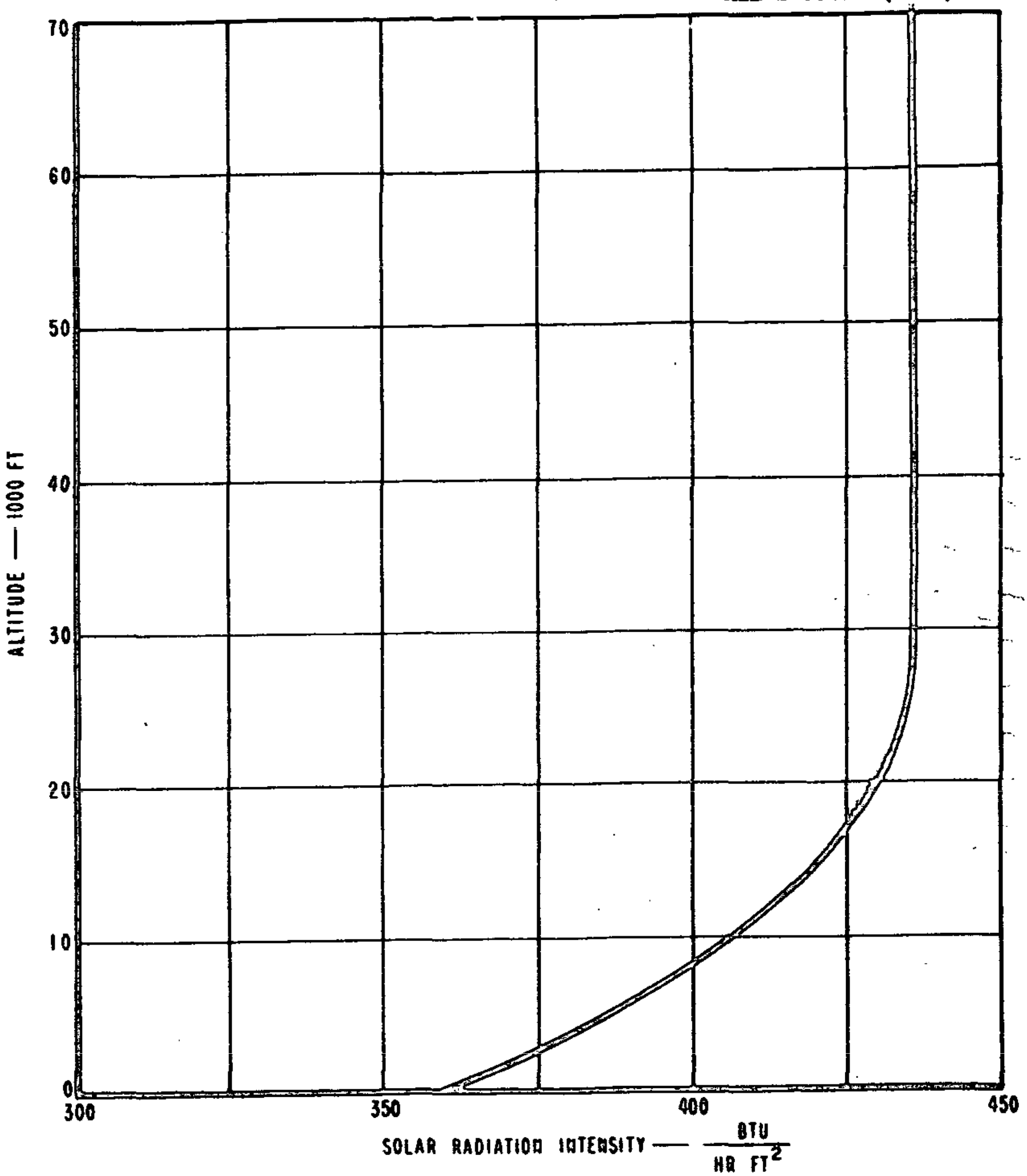

FIGURE 4. Solar Radiation Intensity Versus Altitude

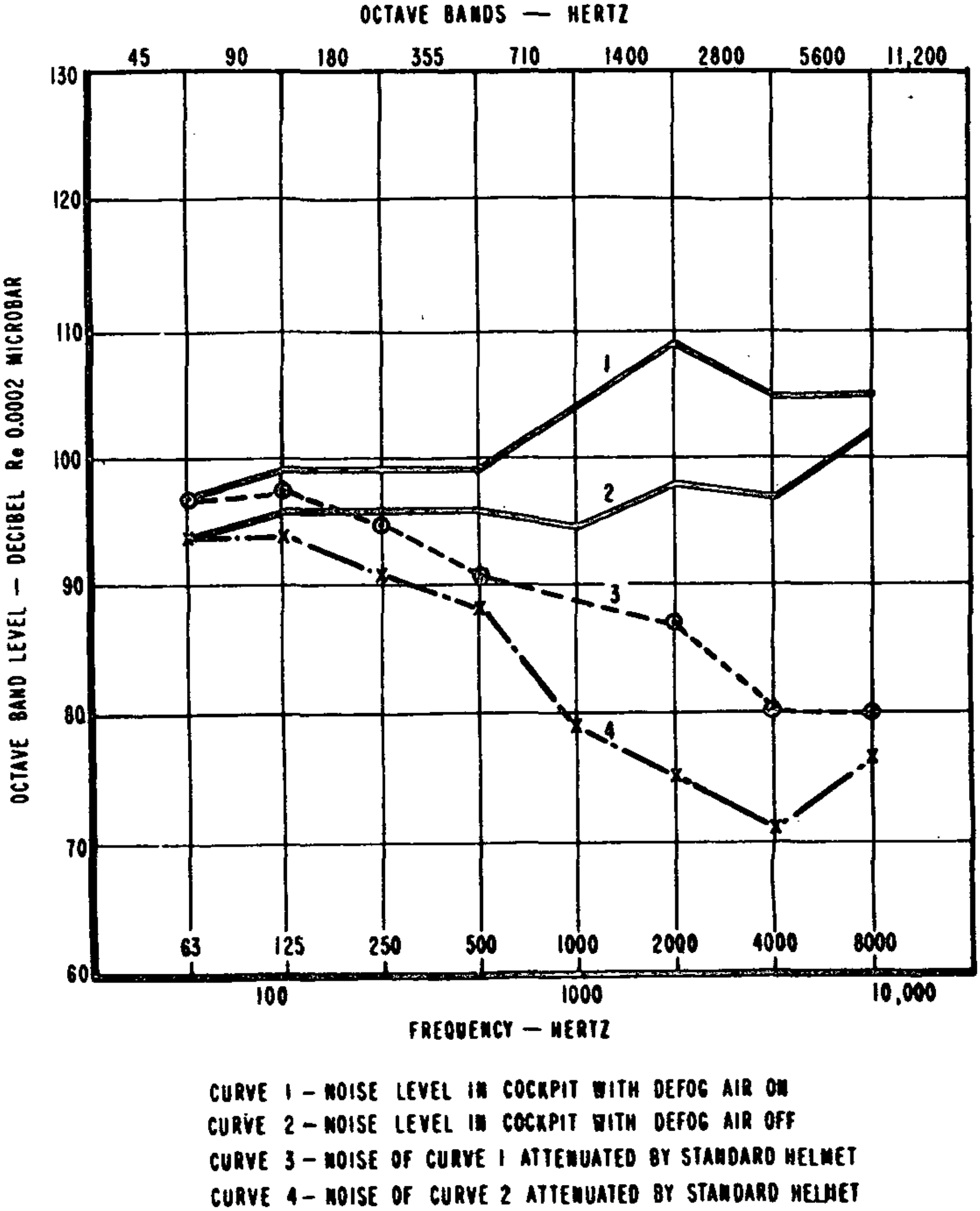

FIGURE 5. Allowable Cockpit Noise Levels Due to the Environmental Control System

3.2.1.6 Electrical requirements

3.2.1.6.1 Power. All electrical power shall conform to the requirements of MIL-STD-704.

3.2.1.6.2 Bonding and grounding. All electrical equipment and all electronic equipment shall be bonded in accordance with the requirements of MIL-B-5087. The bonding shall not be degraded by corrosion-preventive measures or by any other finish or process.

3.2.1.6.3 Connectors. Electrical connectors shall be selected in accordance with MIL-C-26500.

3.2.1.7 Materials. Materials used in the manufacture of the environmental control, the environmental protection, and the engine bleed air systems shall be high quality, shall be suitable for the purpose, and shall conform to applicable Government specifications. Materials conforming to contractor specifications may be used, provided it can be clearly demonstrated that these materials are at least equivalent to materials conforming to Government specifications with respect to operating characteristics and that a saving in weight or cost can be accomplished thereby. The contractor specifications shall be satisfactory to the Government and contain provisions for adequate tests. The use of contractor specifications shall not constitute waiver of Government inspection. The use of magnesium shall require prior approval of the procuring activity. Cadmium plated bolts shall not be used in installations where the temperature of the bolt can exceed 450°F. The use of 19-9DL stainless steel is prohibited in installations where the temperature of the components can exceed 700°F. Where fusion welding is used to join components manufactured from 19-9DL stainless steel the assembly shall be heat treated to assure sensitization is not present.

3.2.1.8 Selection of specifications and standards. Specifications or standards for necessary materials, processes, parts, and equipment not specifically identified herein shall be selected by the contractor in accordance with MIL-STD-143. Except for contractor specifications and standards, the applicable issue of specifications and standards selected in accordance with MIL-STD-143 shall be the issue in effect on date of contract award. Contractor specifications and standards selected in accordance with MIL-STD-143 shall be subject to review and approval by the procuring activity.

3.2.1.9 Proof pressure. All components of the environmental control, the environmental protection, and the engine bleed air systems that are exposed to either positive or negative pressure or both shall withstand without permanent deformation a proof pressure equal to the greater, from the standpoint of the more adverse effect upon the structural integrity of the components, of the following:

(a) Proof pressure 1.5 times the gage pressure, with the component at the associated temperature for the most adverse pressure and temperature condition that occurs during normal operation

(b) Proof pressure 1.1 times the gage pressure, with the component at the associated temperature for the most adverse pressure and temperature condition that occurs in the event of failure of an upstream pressure or temperature control device.

3.2.1.10 Burst pressure. All components of the environmental control, the environmental protection, and the engine bleed air systems that are exposed to either positive or negative pressures or both shall withstand without rupture a burst pressure equal to the greater, from the standpoint of more adverse effect upon the structural integrity of the component, of the following:

(a) Burst pressure 2.5 times the gage pressure, with the component at the associated temperature for the most adverse pressure and temperature condition that occurs during normal operation

(b) Burst pressure 1.5 times the gage pressure, with the component at the associated temperature for the most adverse pressure and temperature condition that occurs in the event of failure of an upstream pressure or temperature control device.

3.2.1.11 Containment. The housing and scrolls of all rotating machinery shall completely contain the fragments from rotating blades and wheel bursts (tri-hub failure) at the greater speed condition either of the maximum speed resulting from any failure inducing condition or of 135 percent of the maximum normal operating speed with the unit at the pressure and temperature associated with these speeds. Fragments may penetrate the containing housing but shall not pass through the housing. Particles or parts resulting from a failure and passing through inlet or outlet ports of the assembly shall be contained by the adjoining ducting. Rotating equipment such as electrical motor operated fans, which cannot exceed a certain design maximum speed, shall contain all fragments from blade and wheel bursts (tri-hub failure) at the maximum possible operating speed.

3.2.1.12 Reliability. Reliability shall be a basic consideration in the design of all components used in the environmental control, the environmental protection and the engine bleed air systems. The required mean time between failures (MTBF) for these systems and the components thereof shall be determined by analysis and shall be the MTBF necessary to achieve the overall weapon system reliability. This analysis shall be submitted to the procuring activity for approval.

3.2.1.13 Air discharge. Discharge air from the environmental control, the environmental protection, and the engine bleed air systems shall not be exhausted into engine air inlets.

3.2.1.14 Pneumatic actuated components. All components that utilize pneumatic actuating control mechanisms shall be protected by a filter or filters that will allow only filtered fluid to enter the control mechanisms. The number of filters shall be minimized. The porosity of the filters shall be such that the screen will prevent the entry of particles, into the control mechanism, that would adversely affect the operation of the control mechanism. The filters shall be readily accessible for inspection and maintenance and shall have a minimum of 600 hours of service life without maintenance. All bleed and sensing lines and all their fittings used in pneumatic actuated systems shall have an outside diameter of at least 3/16 inch. Continuous drainage shall be provided in pneumatic actuating control mechanisms so that accumulation of condensate, ice, and corrosion will not occur. All pneumatic actuated components shall be made of corrosion-resistant materials. Provisions to prevent entrained moisture from entering the control mechanisms of all pneumatic actuated components shall be incorporated.

3.2.1.15 Lubrication. Lubrication for all components shall be in accordance with MIL-STD-838.

3.2.1.16 System safety. The system safety design principles of MIL-STD-882 and AFSC Design Handbook DH 1-6 shall be applied to the environmental control, the environmental protection, and the engine bleed air systems to the extent specified by the procuring activity.

3.2.1.17 Human performance. The principles and the procedures of human engineering defined in MIL-H-46855 shall be systematically applied to the design of the environmental control, the environmental protection, and the engine bleed air systems to permit optimum performance by maintenance personnel. The design details of the environmental control, the environmental protection, and the engine bleed air systems shall comply with the design standards of MIL-STD-1472 and AFSC Design Handbook DH 1-3. In particular, the system configuration shall be compatible with service and repair requirements while the systems are installed in the aircraft.

3.2.1.18 Transportability. The transportability design criteria for the environmental control, the environmental protection, and the engine bleed air system shall be in accordance with MIL-P-9024 and AFR 80-18.

3.2.1.19 Identification of product. Each component of the environmental control, the environmental protection, and the engine bleed air systems shall be marked for identification in accordance with MIL-STD-130.

3.2.2 Environmental control system design

3.2.2.1 Pressurization. The following design requirements shall be met by the pressurization provisions for occupied compartments, equipment, equipment compartments, inflatable seals, and fuel tanks.

3.2.2.1.1 Occupied compartments

3.2.2.1.1.1 Pressurization source. The air used for the occupied compartment conditioning, when available at compatible weight flows and pressures, shall be used for pressurization. During flight conditions when the conditioned air supply weight flows and pressures are marginal for providing pressurization, a means to supplement pressurization airflow shall be provided. When the compartment conditioning air is not suitable, first consideration should be given to using temperature controlled engine bleed air before using high pressure stored gas as the pressurization source. Reservoirs for storage of high pressure air for environmental control purposes shall be designed and tested in accordance with MIL-R-8573. At least two pressurizing air sources, capable of providing the required pressurization individually, shall be provided on multi-engine aircraft. A means of selecting each source, combinations of sources, or the "off" position shall be provided on aircraft with multiple pressurizing sources. No single failure of any supply or control component shall result in the occupied compartment pressure altitude exceeding 14,000 feet on multi-engine, passenger-carrying aircraft that do not fly above 50,000 feet. No single failure shall result in conditions where crew or passenger safety is jeopardized with the use of available oxygen provisions on aircraft flying in excess of 42,000 feet. No single failure shall result in failure of any other component either directly or indirectly. Pressurization system sources other than the aircraft engine, such as compressors or storage tanks, shall provide nontoxic and odorless breathable air in compliance with the contamination limits of MIL-STD-800 and Bulletin 526. Check valves or other suitable automatic means for sealing all pressurization supply inlet openings into pressurized occupied compartments to prevent rapid loss of compartment pressure in the event of air source failures shall be provided. When two or more sources will be supplying pressurizing air to the compartment through common ducting, a check valve or other suitable automatic devices shall be included in the inlet line from each source of pressurizing air. When stored gas or APU sources will be used, manual, electrical, or mechanical means shall provide for "on-off."

3.2.2.1.1.2 <u>Pressure regulation.</u> Pressure regulation of occupied compartments, except high pressure storage systems, shall be acomplished by providing compartment pressure regulator outflow valves, safety valve, and crew station controls.

3.2.2.1.1.2.1 <u>Pressure regulators.</u> The occupied compartment pressure regulator shall maintain the pressure schedule of 3.1.1.1.1.1. Pressure regulator outflow valves shall be designed so that they will remain in their last position or close in case of failure. Pressure regulator outflow valves with thrust recovery features shall be provided when analyses show that the performance gains exceed the added weight penalty. Means whereby the regulator can be made inoperative in closed position shall be incorporated to enable occupied compartment pressure and leakage tests to be accomplished on the ground. Means to prevent leaving the valve in the closed position shall be provided. Escape capsule pressurization system shall be designed in accordance with MIL-C-25969.

3.2.2.1.1.2.2 <u>Safety valve.</u> Protection of occupied compartments from excessive positive and negative pressures shall be provided. Safety valves shall be designed so that they will remain in the last position or close in case of failure. If compartment volume is so large that the negative relief function dictates the valve size, separate positive and negative relief valves may be used. Blow-out panels or sufficient flow areas between compartments to prevent personnel injury and structural failure in the event of sudden decompression shall be provided.

3.2.2.1.1.2.3 Pressurization instruments and controls. A caution indicator to show loss of compartment pressure below 10 psia shall be provided in the crew station of all aircraft having occupied pressurized compartment, except for aircraft that are designed to operate a 5 psig pressure schedule. A warning light to warn occupants that compartment pressure has dropped below 3 psia for combat aircraft and 8 psia for passenger-carrying aircraft shall be provided, in accordance with crew station requirements, in the crew station in all combat aircraft that operate above 42,000 feet and passenger-carrying aircraft that fly above 25,000 feet, respectively. Crew station controls for accomplishing pressure release as specified in 3.1.1.1.1.3 shall be provided. Crew station controls for selecting cabin rate of climb and descent and variable isobaric altitude in aircraft that maintain the pressure schedule specified in 3.1.1.1.1.1(b) shall be provided. A guard shall be installed over toggle-type switches used for dumping compartment pressure. Cabin air pressure altitude indicators shall be provided in accordance with AFSC Design Handbook DH 2-2. Instruments to show cabin rate of climb and descent in feet per minute and the cabin pressure differential in psi shall be provided in the crew compartment in aircraft that maintain the pressure schedule of 3.1.1.1.1.1(b).

3.2.2.1.1.3 Installation. At least one pressure regulator shall be installed in each portion of the aircraft where occupied compartment pressure can be maintained independently or in each portion of an occupied compartment where segregation of the compartment is possible. Pressure regulators and safety valve or outflow portions of each shall be adequately protected against damage and shall be sealed to prevent tampering. Discharge ports shall be located in an ambient pressure area not subject to exposure to adverse weather conditions such as icing or rain or not subject to physical interference from structures, insulation, or any other installed items. Simultaneous failures of both the occupied compartment pressure regulator and the safety valve shall not occur as a result of single component failure, sensor or control line failure, or sensor or control line leaks.

3.2.2.1.2 Equipment pressurization. A pressurizing medium shall be provided to each unit that requires pressurization. Pressure relief shall be provided as protection against excessive pressure. Moisture levels of the pressurization medium shall not exceed the limits of the equipment specification. A pressure regulator shall be provided when necessary to insure pressures compatible with the equipment. Provisions that allow ground checkout of the pressure regulator, relief provisions, and system leakage shall be incorporated. Providing a means for indicating loss of equipment pressurization to the crewmembers shall be given consideration.

3.2.2.1.3 Equipment compartment pressurization. The air used for equipment compartment cooling, when available at weight flows and pressure sufficient to provide pressurization, shall be used. If the cooling air is not suitable, the equipment compartment pressurization shall be provided from a high pressure stored gas system, use of temperature controlled bleed air, or other suitable means. When using equipment compartment cooling air or temperature controlled engine bleed air, the pressure shall be maintained by contolling outflow of air from the compartment by means of a pressure regulator. A safety valve shall provide positive pressure relief and negative pressure relief. The regulator shall be provided with means for holding the outflow portion in the closed position to accomplish equipment compartment ground pressure and leakage tests. Means to prevent leaving the valve in the closed position shall be provided. Moisture levels shall be compatible with the moisture levels specified in the equipment specification(s). Providing a means for indicating loss of equipment compartment pressurization to the crewmembers shall be given consideration.

3.2.2.1.4 Inflatable seal pressurization. The inflatable seal system shall include pressure regulator, check valve, filter, and ground pressurizing and checkout connections in accordance with MS33565 and shall be located to be easily accessible during ground maintenance. The inflatable seal system shall include provisions for deflation when on the ground. The seals shall remain inflated in the event of aircraft electrical system failure.

3.2.2.1.5 Fuel tank pressurization. When the source of air for fuel tank pressurization is the same as the source of air for the air conditioning and environmental protection system, the possibility of contamination of the compartment air supply with fuel shall be eliminated. Fuel or fuel vapors shall be prevented from backing up into the engine bleed air system as a result of fuel expansion, even with the failure of a single component. The entrance of fuel fumes into the engine bleed air system shall be prevented by fail-safe provisions consisting of two check valves or two similar redundancy means. Means for enabling ground test of fail-safe provisions for proper operation shall be incorporated. Where single failure can create the possibility of excessive fuel tank air temperatures, means for indicating excessive temperature to the crewmembers shall be provided.

3.2.2.2 Air conditioning system. In establishing the air conditioning design, an accurate trade-off study that thoroughly considers all possible approaches shall be made in relation to the overall integrated environmental control and environmental protection systems for the particular aircraft. The design selected shall be the design that is determined to be the overall best from the trade-off study. The following design requirements, where applicable, shall be met by the air conditioning system.

3.2.2.2.1 Cooling. Cooling may be accomplished by air cycle refrigeration, vapor cycle refrigeration, ram air, compartment air, expendable coolants, heat storage materials, thermoelectric refrigeration, or similar techniques. The number of different refrigeration package configurations and components on an aircraft shall be minimized. Crossover capability between cooling units on aircraft that have two or more refrigeration units should be given consideration to give greater flexibility and increased possibility for mission completion.

3.2.2.2.1.1 Air cycle subsystem. Air cycle subsystems when installed shall meet all requirements of MIL-A-83116. If two or more air cycle units provide air to a pressurized compartment, the compartment pressurization shall be maintained with one air cycle unit failed.

3.2.2.2.1.2 Vapor cycle subsystem. The vapor cycle subsystem when installed shall include but not be limited to evaporator, compressor, condenser, refrigerant receiver, expansion valve, refrigerant filter-drier, liquid line sight glass, condenser cooling provisions, high pressure cutout switch, and high pressure blowout plug. When cooling of occupied compartments and pressurized equipment compartments is accomplished by recirculating compartment air through the evaporator, make-up air shall be ducted to the compartment to maintain pressurization and ventilating requirements. Heating may be accomplished by mixing hot air at controlled amounts into the recirculation system. Wherever possible, the vapor cycle subsystem components shall be assembled as a package, with no breaks in package refrigerant piping required during installation or removal from the aircraft. Wherever possible, the ducting and piping required to make up the package shall be permanently fastened together rather than coupled. Means shall be provided so that the refrigerant can be discharged and a new charge added without removing the package from the aircraft. The filter-drier shall absorb moisture and remove foreign matter, acid, and sludge and shall be easily accessible. The liquid line sight glass shall be installed in the refrigerant line directly upstream from the expansion valve and shall be positioned so that it can be easily viewed by maintenance personnel when the system is installed in the aircraft. The high pressure cutoff switch shall shut off the compressor in the event of excessive refrigerant vapor pressure to protect the system against operational overloads. An elapsed time meter to indicate total system operating time shall be provided and located to be easily readable. The high pressure blowout plug shall relieve refrigerant pressure below the system proof pressure limit. Provisions that will permit purging the system of air and moisture prior to and during filling of the system shall be incorporated. Provisions that will prevent frosting of the evaporator during low cooling load conditions shall be incorporated. Provisions for collecting and draining overboard the moisture condensed out of the air in the evaporator shall be incorporated. The evaporator moisture removal provisions shall assure that no entrained moisture is in the air leaving the evaporator. The use of copper tubing shall be avoided. The refrigerant shall be noncorrosive, nonflammable, and essentially nontoxic. The system shall not require the addition of oil at intervals of less than 500 hours of operation. Assemblies requiring lubrication at intervals between overhaul shall have readily accessible oil fill ports and a means for readily determining oil level. The vapor cycle package shall be designed to require no regular service, repair, or replacement of system components for a minimum of 1,000 hours of operation, except for checking the refrigerant and oil level, addition of oil and refrigerant, and service or replacement of filters.

3.2.2.2.2 Ventilation. Provisions for admission and circulation of fresh outside air for ventilation shall be incorporated in pressurized and unpressurized aircraft. Ventilation provisions may be combined with the heating and cooling system and may utilize common air inlets and distribution system. Fresh air shall be supplied in controlled amounts to each crew position and to the cabin. Directional adjustable air outlets for comfort heating and cooling shall be provided for each active crew station or bunk. Directional and quantity adjustable air outlets shall be provided at each passenger position. Galley and toilet areas shall be well vented and provided with direct overboard exhaust outlets sufficient to eliminate odors from the areas.

3.2.2.2.3 Auxiliary air

3.2.2.2.3.1 Occupied compartment. A means shall be incorporated to supply outside air to the occupied compartments during intervals when the air conditioning system is inoperative and at flight conditions that will not result in excessive ram air temperatures. A ram air scoop, when used, shall be designed and located to minimize susceptibility to icing. The inlet area of the scoop shall be sized so that the expected amount of ice buildup will not reduce the inlet area below the inlet area required at minimum speed to provide the minimum required airflow; otherwise, the scoop shall be provided an ice protection system. The controls shall be designed so that the systems supplying air to the occupied compartments will shut off and compartment pressure will be released when auxiliary ram air is selected. Means to prevent reverse flow throughout the auxiliary ram air provisions shall be incorporated. The defrosting-defogging capability shall not be shut off automatically when ram air is selected. It is desirable to control the volume of the ram air entering the compartment. A guard shall be installed over toggle-type switches used for selecting auxiliary ram air.

3.2.2.2.3.2 Equipment and equipment compartment. An auxiliary air system that will adequately cool the necessary equipment when the normal air conditioning system is inoperative shall be provided. If a ram air system is used, the ram air scoop shall be designed and located or protected to minimize its susceptibility to icing. The inlet area of the scoop shall be sized so that the expected amount of ice buildup will not reduce the inlet area below the inlet area required at minimum speed to provide the minimum required airflow; otherwise, the scoop shall be provided an ice protection system. The controls shall be designed so that the system supplying air to the equipment and equipment compartment shall be shut off and the compartment pressure shall be released when auxiliary ram air is selected. Means to prevent reverse flow through the auxiliary ram air provisions shall be incorporated.

3.2.2.2.4 Heating. Heating may be accomplished by the use of compressor bleed air from the main propulsion engines, APU compressor bleed air, engine or APU exhaust heat exchangers, electric or combustion heaters, and compressed ram air. When the source of heat is the engine exhaust, the heat shall be extracted from the exhaust gases by a secondary heat exchanger or by a muff around the exhaust pipe. These provisions for extracting heat shall be designed to assure that no single failure will result in contamination of the cabin air supply by exhaust gases. The heated air conveyed to the cabin shall be within the contamination levels of 3.1.1.2.1.7. Electrical resistance heaters shall incorporate an overheat protection device. A pressure or flow sensitive switch shall be used to prevent operation of the heater below a predetermined minimum airflow rate.

3.2.2.2.5 Temperature controls

3.2.2.2.5.1 Occupied compartments. Means for controlling the degree of heating and cooling independently for each occupied compartment shall be provided. The controls shall be readily accessible to the crew. All aircraft shall have automatic temperature control(s) with manual override provisions. The temperature regulator shall comply with MIL-R-25054. Solid state electronic devices shall be designed for satisfactory operation within the limits specified in MIL-STD-704 and to compensate for any changes in performance resulting from changes in ambient conditions surrounding the device. Except for passenger-carrying aircraft, the temperature selector for automatic cabin temperature control shall be designed for a range of +40°F to +90°F. The temperature selector for automatic cabin temperature control in passenger-carrying aircraft shall be designed for the range of +65°F to +85°F. The relation between movement of the selector and the change in compartment temperature shall be essentially linear. The movement of the control shall be designed so that each degree change in compartment temperature will be at least a 4-degree angular movement or 0.05-inch linear movement. The compartment temperature sensor shall be located in an area that is representative of the average compartment air temperature and shall be exposed to an air velocity of approximately 500 feet per minute. Provisions shall be incorporated to assure, during normal operation and with single component failure, that the air temperature entering occupied compartments will not exceed 200°F when air above this temperature is considered detrimental to structure, transparent enclosure, or personnel. The compartment inlet air temperature shall not exceed 350°F in any case.

3.2.2.2.5.2 Equipment and equipment compartment. Temperature control for equipment and equipment compartments shall be automatic. An indication of overtemperature conditions shall be provided to the crewmembers.

3.2.2.2.6 Distribution

3.2.2.2.6.1 Occupied compartments. The cooling, heating, and ventilating air shall be distributed to occupied compartments so that the crew's exhalation is prevented from coming in contact with transparencies, so that the velocities of air in contact with personnel and the temperature gradients will not exceed the requirements specified in 3.1.1.2.1.4, and so that the airflow direction is not fixedly directed into the crewman's eyes or onto the crewman's arms or shoulders. Distribution ducting and outlets shall be designed for low noise levels. Insulation to prevent excessive heat losses or gains shall be installed around the occupied compartment distribution ducts when ducting is routed through areas of very high or low ambient temperatures. Flexible ducts shall be in accordance with MIL-H-8796.

3.2.2.2.6.2 Equipment and equipment compartment. The cooling air shall be proportioned to the equipment in accordance with the cooling requirements of the applicable specification. Insulation to prevent excessive heat gains shall be installed around the equipment and equipment compartment distribution ducts when ducting is routed through compartments capable of high ambients. When cooling of equipment is accomplished with the air exhausted from occupied compartments, sufficient redundancy shall be incorporated in the provisions that induce flow to the equipment to insure that no single failure will result in equipment overheat. Flexible ducts shall be in accordance with MIL-H-8796.

3.2.2.2.7 Moisture control. Moisture control provisions that will assure the performance requirements of 3.1.1.2.1.8 and 3.1.1.2.2.1.2 are met for all ground and flight conditions shall be incorporated.

3.2.2.2.8 Contamination control. Contamination control provisions that will assure the performance requirements of 3.1.1.2.1.7 and 3.1.1.2.2.4 are met for all flight and ground operating conditions shall be incorporated. When filters are used for contamination control, the quantity and type of filters shall be minimized. The filters shall be located for easy accessibility for inspection, cleaning, and replacement. The filters on aircraft that may be exposed to nuclear particulate matter and chemical and biological warfare agents shall be designed with a remote handling capability.

3.2.2.2.9 Air conditioning components

3.2.2.2.9.1 Heat exchanger and airflow control system. Heat exchanger and airflow control system shall be designed in accordance with MIL-A-83116. When analyses show that the performance gains exceed the added weight penalty, area modulating devices that will automatically vary the cross-sectional area of each ram air cooling duct to provide only the ram airflow required for proper cooling shall be used.

3.2.2.2.9.2 Water boilers and water storage tanks. All water boilers and water storage tanks in the environmental control system shall be in accordance with MIL-A-83116.

3.2.2.2.9.3 Water separator. Water separators shall be provided in accordance with MIL-A-83116. Any entrained moisture not removed by the water separator or re-evaporated in the downstream distribution ducting shall be trapped and drained overboard before reaching any outlet or critical component.

3.2.2.2.9.4 Combustion heater. Combustion heaters shall conform to MIL-H-5484. Fuel shall be obtained from the main engine fuel supply either by the engine boost pumps or heater fuel pumps. Fuel lines or heater accessories containing fuel shall be separated as far as possible from electrical wiring or hot exhaust ducts and in any case shall not be installed above heater exhaust or electric wiring. The combustion heater fuel system design, performance, testing, and installations shall be in accordance with MIL-F-38363 and MIL-F-8615. The heater fuel system shall incorporate a normally closed, electrically operated solenoid shutoff valve located near the takeoff from the aircraft fuel system. A normally closed, electrically operated solenoid cycling valve shall be provided at or near the heater. The heater fuel system shall have a strainer capable of removing all particles from the fuel that would fail to pass through the minimum diameter passage in the heater fuel system. Combustion heaters and enclosed fuel controls shall be provided with adequate drains so that fuel or explosive vapors will not be trapped within the heater, combustion air ducting, or fuel control enclosure. All fuel drains shall discharge at a point of neutral or negative static pressure and extend beyond the skin line of the aircraft to make certain that all drainage will clear the skin and fuel or explosive vapors will not re-enter the aircraft. Drains shall be located where the discharge is unlikely to impinge on hot surfaces or external ground equipment capable of causing ignition. Drain lines that may carry exhaust gases shall not be connected with other drain lines. When ground operation is required by the aircraft specification or when used in rotary wing or vertical takeoff and landing aircraft, combustion air and ventilating air shall be supplied by blowers. Pressure on the ventilating side shall always exceed pressure on the combustion side. Combustion air and ventilating air shall be sufficiently separated to insure that malfunctions in the combustion process shall not damage the heating system or contaminate the ventilating air. Provisions shall be made so that ventilating airflow through the heater is automatically maintained for sufficient time after the heater has been turned off to prevent overheating. Air scoops shall be provided with water traps and drains to minimize the entry of water. The inlet shall be anti-iced if the aircraft is intended for flight in icing conditions and the air scoop is susceptible to blockage by ice. Heater exhausts shall terminate in exits displaced sufficiently from the aircraft skin so that exhaust gases will not directly contact and corrode the skin. Exhaust shall not pass over fuel drains. If heater exhausts will be installed in any compartment that also will contain combustible fluid lines under pressure, the exhaust shall be covered with a metallic shroud, and sufficient air shall be passed between the exhaust and the shroud to keep the exposed surfaces at least 100°F below the autogenous ignition temperature of the combustible fluid. The heater shall be accessible for observation during flight or adequately protected by fire detection and extinguishing devices. Heater and accessory equipment shall be located or adequately drained to eliminate the collection of condensed or entrained moisture.

3.2.2.2.9.5 Liquid cooling loops. Liquid cooling loops shall have reservoir, fill and drain provisions, pressure relief, liquid level indication, filtration, circulation pump(s), heater, and necessary controls. If pump failure could prevent mission completion, i..cor·oration of a standby redundant circulation pump in the liquid cooling loops shall be given consideration. If gravity fill provisions are used, the fill port shall have a minimum 1-1/2-inch-diameter opening. The reservoir shall allow for full liquid expansion throughout the complete range of possible operating and nonoperating temperatures and pressures. In addition the reservoir shall have an allowance for a reserve capacity of liquid. This reserve capacity shall be as specified in the contractor's detail specification. The liquid cooling loops shall have no external leakage. There shall be no leakage from the self-sealing, quick-disconnects when components are removed from the system. The liquid level indication provisions shall indicate system fill level over the entire operating and nonoperating temperature and pressure range.

3.2.3 Environmental protection system design

3.2.3.1 Defrosting and defogging. The defogging and defrosting provisions shall be designed in accordance with MIL-T-5842. If defogging and defrosting are accomplished with hot air, measures shall be taken to minimize the overheating effect in the occupied compartment. When hot air defogging and defrosting provisions for occupied compartments will be controlled by a power operated shutoff valve, manual backup provisions shall enable the crewmembers to turn off the defogging hot air in the event of a failure of the power operated valve.

3.2.3.2 Rain removal. Windshield wipers, jet blast systems, and rain repellent systems shall be designed in accordance with the applicable requirements specified herein.

3.2.3.2.1 Windshield wipers. Electrically operated windshield wiper installations shall conform to the requirements of MIL-W-7233 and shall be adapted for proper fit and operation to the particular application. Hydraulically operated windshield wipers shall not be used if the installation will involve routing high pressure hyrdaulic supply lines through the cockpit, unless adequate shrouding is provided with overboard drainage, the lines are well anchored, and the flow control valve is located outside of the crew compartment. A completely separate wiper system for eac.. windshield shall be provided in side by side cockpit ai·craft.

3.2.3.2.2 Jet blast system. Where engine bleed air conditions are suitable, a jet blast system may be used for windshield rain removal. Adequate flow and pressure shall be available for all ground and flight conditions including the minimum engine power settings normally associated with descent, flareout, touchdown, and taxi. It is recommended that a flow rate of at least 7 pounds per minute per inch of nozzle length and sonic flow through nozzles should be maintained at all conditions where rain removal is required. Temperature shall be controlled by design and orientation of the nozzle or any other means necessary so that the temperature limits of windshield materials and supporting structure will not be exceeded. Excessive temperatures shall be sensed and indicated by a caution light to warn the crewmembers of impending windshield overheat. A normally closed shutoff valve that will fail closed shall be provided in the jet blast air supply line to each cleared windshield. Airflows to both windshields in side by side cockpit aircraft shall not be lost due to failure of a flow control or pressure regulating device. The jet blast system shall be designed to prevent possible damage to the windshield or aircraft through inadvertent operation of the jet blast system during dry weather.

3.2.3.2.3 In-flight applied rain repellent (see 6.3.10). Rain repellent systems shall be in accordance with MIL-R-83055. Rain repellent fluids shall be in accordance with MIL-R-83056.

3.2.3.3 Snow removal. A jet blast rain removal system or windshield wipers, when installed, may be used for snow removal.

3.2.3.4 Windshield washers. Washer systems for removing dirt, salt, or insects from windshields and sensor windows shall include a refillable reservoir with drainage provisions, a means for determining fluid level, and a bleed purging line or a nozzle drain. The washing fluid shall be nontoxic, nonflammable, and noncorrosive and shall not have any adverse effects on the windshield or any other aircraft materials. If freezing of the washing fluid can occur throughout the range of environmental extremes that will be encountered, the following design requirements shall apply to the washing systems.

(a) The fluid storage and the supply equipment that will normally contain fluid shall not fail as a result of repeated freeze and thaw cycles.

(b) The fluid shall be provided when required, to the transparency, in sufficient quantity to meet the system washing performance requirements.

3.2.3.5 Ice protection

3.2.3.5.1 Transparent areas. A hot air jet blast system may be used for windshield anti-icing. Where electrical conductive coated windshields are installed, separate control sensor, overheat sensor, temperature controller, and power source shall be provided for each anti-iced windshield panel. Positive power-off action shall result in the case of a control circuit malfunction or failure that could result in overheat. Solid state electronic controllers shall be protected against voltage spikes in the electrical power supply and designed to compensate for any change in ambient conditions surrounding the controller. Modulating-type controllers shall not induce unacceptable voltage transients in the aircraft electrical power supply.

3.2.3.5.2 Radomes and antennas. Antenna thermal anti-icing systems shall conform to applicable portions of MIL-A-9482. Pneumatic deicing systems shall conform to the applicable portions of MIL-D-8804. Fluid anti-icing or deicing systems shall not be used unless other methods are not feasible. The ice protection provisions shall not cause any significant degradation in radar performance.

3.2.3.5.3 Flight surfaces. Thermal anti-icing systems, when required, shall be designed and installed in accordance with MIL-A-9482. Hot air cyclic or electrical deicing and anti-icing may be used when designed and installed in accordance with an approved contractor specification. Hot air cyclic deicing systems shall also comply with applicable portions of MIL-A-9482. Pneumatic boot deicing systems shall be installed in accordance with MIL-D-8804.

3.2.3.5.4 Ram air inlets. Anti-icing provisions of the ram air inlets, when required, shall be in accordance with MIL-A-9482.

3.2.3.6 Anti-g suit air supply. The compressed air source, when required, shall be in accordance with MIL-D-7890.

3.2.3.7 Pressure suit air supply. Pressure suit provisions, when required, shall be incorporated in accordance with section 5B, chapter 5 of AFSC Design Handbook DH 2-3.

3.2.4 Engine bleed air system design. Each subsystem deriving air from the engine bleed air shall have an individual shutoff valve so that the subsystem can be deactivated without deactivating the engine bleed air system. Operating mode and failure mode of these valves, where not stated by this specification, shall be determined from a failure mode and effect analysis. All parts of the engine bleed air system shall be designed to continuously withstand the simultaneous application of the most critical combination of pressure, temperature, and motion encountered in operation. Adequate space shall be allocated in the airframe to permit directness of routing and proper isolation from other elements, to allow for structural deflections and thermal expansion, and for ease of maintenance and inspection. The bleed air ducting and components shall be well supported. Supports shall be designed to minimize conductive and convective heat losses. Internal air velocities shall ordinarily be limited to Mach 0.25 or less to reduce the effects of air velocity on structural fatigue, noise, and pressure drop. The use of higher air velocities shall require prior approval by the procuring activity. The bleed air installation shall be designed to preclude aerodynamic resonant excitation through the normal range of system airflow conditions. Sufficient joints at accessible locations shall be provided to facilitate installation and replacement and shall be clamped with quick-detachable-type couplings designed to minimize leakage. Quick-detachable, safety-latch-type couplings shall be used in locations where the bleed air temperature normally exceed 450°F. When the bleed air ducting will be routed in a manner that leakage of high temperature and pressure bleed air could cause damage to aircraft structure or adjacent components or present a fire or explosion hazard, either a bleed air leak detection system or provisions to eliminate these hazards shall be incorporated. Where the engine bleed air system design will utilize both high pressure and low pressure bleed air, a single component failure shall not result in engine malfunction. Where failure of the duct systems could cause overpressurization of a compartment, pressure relief provisions shall be provided. When a bleed air leak detection system is provided, it shall comply with the requirements in the paragraph entitled "Bleed Air Overheat and Leak Detection" in Section 5C of AFSC Design Handbook DH 2-3. The bleed air system shall have provisions to permit the use of APU or ground pneumatic carts for ground functional checkout without main engine operation. The recommended duct design and installation practices of SAE Document ARP 699 shall be followed. Means for enabling ground test of each valve of the bleed air system for proper operation shall be incorporated.

3.2.4.1 Ducting. Ducting and duct connectors may be rigid or flexible metallic or nonmetallic, whichever is better suited or consistent with the operational requirements. Sufficient compensation devices shall be provided within the ducting installation to allow for duct deflection, expansion, installation variations, and internal pressure loads. Fixed and sliding brackets shall be used as required to allow freedom of movement due to thermal expansion and deflection of the aircraft. All bleed air ducting shall be adequately protected against corrosion. Corrosion control requirements for the bleed air ducting shall be defined in the contractor's detail specification.

3.2.4.2 Insulation. Ducting routed through areas containing combustible fluid lines shall be insulated as required to prevent the external surface temperature from exceeding 500°F under any operating condition. An external surface temperature up to 700°F will be acceptable if airflow velocities immediately surrounding the bleed duct surface will be shown by data to be greater than 6 feet per second under all conditions of flight or ground operation. All portions including couplings and in-line valves, when insulated, shall be covered, leaving no exposed areas except the low temperature actuator portion. Ducting and components shall be insulated or shrouded as required to prevent overheating of wiring, structure, or any other components. Insulation shall be designed and installed so that entry and retention of combustible fluids under insulation and in pockets especially at seams, mating edges, and cutouts at fittings and supports will be prevented. The use of metallic-foil covering on the inner surface of insulation next to metallic ducts shall be avoided where fretting action may destroy corrosive-preventive films. Materials that in the presence of moisture can produce corrosive substances shall not be used in cover, bonding, or insulation binders.

3.2.4.3 Components. Pneumatic powered components such as shutoff and regulator valves shall be designed to preclude failure or malfunction due to freezing of entrained moisture or corrosion resulting from entrained moisture in the bleed air. All parts including check valve flappers and valve gates shall withstand the shock loading that can result from sudden opening and shutting of bleed air shutoff valves or pneumatic ground carts. A flow limiting device to prevent over bleed in case of duct rupture or failure of a pressure regulating device shall be provided at each engine bleed port. Where multiple engine or multiple stage bleed will occur, a check valve to prevent reverse flow of air into the engine shall be provided near each engine bleed port. A check valve to prevent reverse flow of pressurizing air shall be provided in each supply line to a pressurized compartment. Check valves that are installed at duct joints should be attached to the downstream portion of the duct to maintain pressurization integrity if the joint separates. A shutoff valve for each independent source of bleed air shall be provided as near as possible to the source and remotely controlled from the crew station. The shutoff valve shall be normally open and shall fail open. Provisions shall be made to provide closure of the valve during engine starting. Where multiple sources are manifolded, isolation and crossover means shall be provided to isolate each main supply duct and crossfeed to subsystems from any source. Isolation valves shall be normally open and shall fail open. Crossover valves shall be normally closed and shall fail closed. A readily accessible means for manually opening the crossover valve shall be provided. Provisions to assure that a rupture in the crossover ducting will not result in loss of all compartment pressurization airflow shall be provided. The isolation shutoff valve in each side shall be upstream of any supply line takeoff for compartment cooling or pressurization.

3.3 Ground requirements

3.3.1 Maintainability and accessibility. Systems specified herein shall be designed so that, when supported by trained personnel (other than top line maintenance personnel), test equipment, repair facilities, and spare parts, the maintenance manhours per flight hour shall be minimized and, if given, meet the value required by the aircraft specification. Maintainability requirements for the equipment covered by this specification shall be in accordance with MIL-STD-470. Maintainability and accessibility features shall include but not be limited to the following:

(a) All overboard drains shall be located at positions and height levels for easy inspection and insofar as practical so that any ice that may form and break away will not be ingested by the engine or damage aircraft structure.

(b) Access to all components shall be provided to enable expeditious inspection, servicing, fault isolation, testing, and replacement. All access doors shall be marked in accordance with MIL-M-25047.

(c) Fill ports and drains of all fluid reservoirs shall be located to provide easy draining and replenishment.

(d) All dehumidifiers (see 6.3.11) shall be of the self-indicating type with a minimum replacement time of 50 hours and easily accessible for viewing and replacement by maintenance personnel. The minimum replacement time period should be based on encountering maximum ambient humidity conditions during the primary mission flight profile of the aircraft.

(e) All oil servicing and level check points shall be located with sufficient clearance to permit easy filling and oil level checking, especially when oil dip sticks are installed.

(f) All components and fittings used during pressure testing of all pressurized compartments, electronic equipment, inflatable seals, and bleed air ducting shall be accessible and have sufficient clearance area provided to allow expeditious testing without the use of special tools.

(g) Fluid cooling systems shall be provided with quick disconnects, which automatically shut off flow when disconnected, at the inlet and outlet of all components that require removal for checkout.

(h) All meters and gages shall be located to permit reading without the use of a mirror or any other aid.

(i) Handling aid attachment point(s) shall be provided on all assemblies with weight greater than 100 pounds or volume greater than 10 cubic feet. Attachment points for handling aids shall be provided on large and heavy assemblies beyond the hand lifting capability of one man.

(j) Components that require periodic removal for overhaul or replacement shall be installed so that they can be removed without having to remove any other components.

3.3.2 Ground pressurization. Air source fittings and test pressure gage connections to permit ground pressure leakage testing of pressurized compartments and inflatable seals by the "constant pressure flow" method shall be installed and shall be in accordance with MS33565. Where the use of the "constant pressure flow" method would be impractical with presently available ground servicing equipment due to the large pressurized volume, the "time pressure drop" method may be used for leakage testing of the pressurized compartments. Provisions to permit leak testing of the bleed air ducting shall be installed.

3.3.3 Ground cooling, heating, and ventilation. Provisions to permit adequate heating, cooling, and ventilation of occupied compartments by an external air conditioning source shall be incorporated in the environmental control system. Provisions to permit adequate cooling by an external means for all on-board electronic equipment and equipment compartments during flight line maintenance and checkout without the necessity for running the main propulsion engines or on-board APU shall be incorporated in the environmental control system. Checkout of electronic equipment and cooling, heating, and ventilation for the occupied compartments of aircraft that have on-board APU shall be provided, without the use of aerospace ground equipment (AGE), through use of the on-board air conditioning units within the capabilities of the APU. Means to prevent fans used for ground cooling only from windmilling in flight shall be incorporated. The air inlet connection for an external air conditioning source shall conform to either MS33561 or MS33562, depending on the distribution and airflow requirements. A connection that will allow functional checkout of subsystems on the ground when using a ground pneumatic cart shall be incorporated in the engine bleed air system and shall be in accordance with MS33740. The ground connections shall be easily accessible to ground personnel without requiring the use of ladders or stands, except on aircraft where the distance from the ground to the lower part of the fuselage exceeds normal reach capabilities. Any door or cover required for access to the external connection shall be self closing and shall have quick-action locking latches.

3.3.4 AGE. The overall design of all systems covered by this specification shall place minimum reliance on AGE. When AGE is necessary, the contractor shall make maximum use of existing AGE. The use of new or peculiar AGE shall require the prior approval of the procuring activity.

3.3.5 Ground servicing. Reservoirs for water, water-alcohol mixtures, and deicing fluids shall have gravity fill provisions in accordance with MIL-C-38373. Coolant fluid reservoirs shall have at least a 1-1/2-inch-diameter opening for gravity filling.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests. The classification of the tests specified herein to verify the performance and design of components and systems conform to the requirements of this specification is as follows:

(a) Development tests (see 4.4)

(b) Safety-of-flight tests (see 4.5)

(c) Preproduction tests (see 4.6)

(d) Reliability tests and analysis (see 4.7)

(e) Acceptance tests (see 4.8)

(f) Sampling tests (see 4.9)

(g) Ground and flight tests (see 4.10).

4.3 Test conditions

4.3.1 Atmospheric conditions. Unless otherwise specified, tests shall be conducted at local atmospheric pressure and room temperature (approximately 70°F).

4.3.2 Component affecting performance. Any component that could in any way affect the performance of an article that is being subjected to safety-of-flight tests, preproduction tests, and acceptance tests shall be made a part of the test set-up.

4.3.3 Failure criteria. Failure shall be any malfunction of a system or component that prevents meeting the performance and design requirements of this specification.

4.3.4 Similarity of components. No component shall be considered to have met the requirements of the preproduction tests on the basis of similarity to a previously tested component unless both components are similar in size, weight, design, construction, and materials. The operational environment shall not be more severe than the environment in which the previously tested component was tested. Verification of performance shall not be acceptable unless the only differences are nonfunctional such as mounting provisions and flange design. Any required test for a critical component that is planned to be passed on the basis of similarity shall require the approval of the procuring activity prior to the initiation of the preproduction tests. Justification for passage of tests on the basis of similarity shall include the following:

(a) The necessary data for each component to determine the similarity of the components with respect to size, weight, construction, function, pressure and temperature exposure, and materials

(b) The qualification test reports of the previously qualified components.

4.4 Development tests. Development tests are tests that are performed as an aid to design in determining if a component or system will comply with the requirements specified herein prior to any preproduction testing. Development tests should be performed on all components and systems that are new or complex developments to insure the end item will meet the performance requirements of this specification, pass the preproduction tests, and meet the critical lead times. The development tests shall consist of the tests specified in 4.4.1 through 4.4.6. The results of the development tests shall be submitted to the procuring activity.

4.4.1 Rain removal. A rain removal test to verify the adequacy of the installation during all the operational conditions specified in 3.1.2.2 shall be performed. The rain removal test shall simulate actual operational conditions and shall be performed in a wind tunnel. If an in-flight applied rain repellent is utilized, the required repellent characteristics of 3.2.3.2.3 shall be demonstrated during the rain removal test. A rain removal test plan shall be prepared and submitted to the procuring activity prior to the initiation of testing.

4.4.2 Transparent area anti-icing and defogging. Each anti-iced transparency shall be subjected to a laboratory test in accordance with MIL-T-5842. All transparencies shall be evaluated for adequacy of fog prevention under simulated operational conditions.

4.4.3 Flight surface, radome, antenna, and ram air anti-icing or deicing. All surfaces that have provisions installed for anti-icing or deicing shall be subjected to icing tests to demonstrate satisfactory performance when the surfaces are exposed to the icing conditions of figures 2 and 3. The demonstration of the flight surface anti-icing or deicing may be accomplished on a representative portion of the flight surface. Sufficient wind tunnel testing for surfaces that are not intended to have ice protection provisions shall be conducted to prove that satisfactory aircraft performance can be expected while the aircraft is operating in the icing conditions of figures 2 and 3. Wind tunnel tests using simulated ice buildup and shapes may be conducted to aid in determining the need for anti-icing and deicing provisions.

4.4.4 Insect and salt removal. An insect and salt removal test in a wind tunnel or equivalent shall be accomplished to insure the adequacy of the insect and salt removal subsystems. The insect and salt removal test shall adequately prove the performance of the insect and salt removal subsystems throughout the range of minimum to maximum speed during low level flight conditions. An insect and salt removal test plan shall be prepared and submitted to the procuring activity for approval prior to initiation of testing.

4.4.5 Compartment mock-up. A compartment mockup shall be constructed for verifying the adequacy of the proposed environmental control system. The mockup shall consist of the occupied and the equipment compartments of the aircraft; however, a representative section as mutually agreed by the procuring activity and the contractor may be used for large compartments. The occupied compartment of the mockup shall be capable of human occupancy and shall demonstrate compliance with 3.1.1.2.1.4 and 3.2.1.4. The mockup shall provide the capability of accurately simulating all heating and cooling loads, including aerodynamic heating for supersonic aircraft. The testing of the compartment mockup shall adequately prove the performance of the environmental control system and shall demonstrate the function and the capability of the system components for all critical ground and flight conditions during hot and cold day conditions of MIL-STD-210. A compartment mockup test plan shall be prepared and submitted to the procuring activity for approval prior to initiation of testing.

4.4.6 System integration test. The complete system, including all environmental protection, environmental control, and bleed air subsystems, shall be installed in a laboratory setup simulating production aircraft installation. System performance tests shall be conducted to evaluate performance and compatibility, e.g., control system and component interaction and functional operation, of all systems during steady state and transient conditions. Airflows, pressures, and temperatures shall be recorded under simulated flight conditions. A test plan shall be prepared and submitted to the procuring activity for approval prior to the initiation of system integration test.

4.5 Safety-of-flight tests. Safety-of-flight tests are tests that are conducted prior to first flight, as necessary, to assure the systems covered by this specification will not create a safety-of-flight hazard. The safety-of-flight tests shall be performed to substantiate the performance of certain components and systems prior to the first flight of the aircraft. Some of the safety-of-flight tests that shall be accomplished are specified in 4.5.1 through 4.5.4; however, the complete list of the safety-of-flight tests will be defined for the particular system prior to start of the weapon system acquisition phase. A complete environmental or structural test conducted as part of the safety-of-flight tests need not be repeated under the component preproduction tests unless the item has been altered.

4.5.1 Bleed air system. The complete engine bleed air system representative of the production components, including purchased parts and attaching bracketry, shall be installed in a test setup as specified in 4.5.1.1 and shall be subjected to the tests, in the order listed, specified in 4.5.1.2 through 4.5.1.6. An entire bleed air system test plan shall be prepared and submitted to the procuring activity for approval prior to the start of the tests.

4.5.1.1 Test setup. The test setup shall simulate the aircraft installation of the production components. A bleed air source that will provide bleed air at weight flows, pressures, and temperatures that closely simulate the values expected in the actual aircraft installation shall be provided. The test setup shall provide the capability of simulating airframe deflections with normal operating temperature and pressure applied, except for applications that the contractor and the procuring activity mutually agree are not significant to the design. When possible, the test setup shall provide the capability of the simulating aircraft vibration. If the engine bleed air system of the aircraft design is too large to accomplish the simulated aircraft vibrations on the complete system, the simulated vibrations shall be accomplished on several sections of the system as mutually agreed by the contractor and the procuring activity. The size of the sections shall be selected based upon the test equipment campatibility and the approval of the procuring activity. If vibration tests will be conducted in sections, the sections subjected to the vibration tests shall consist of duct system segments between attachment points.

4.5.1.2 Proof pressure at temperature. The engine bleed air system shall be subjected to a proof pressure as specified in 3.2.1.9 to demonstrate the integrity of the engine bleed air system.

4.5.1.3 Air flow resonance. The engine bleed air system shall be subjected to the full range of airflows expected on the aircraft system and also at the rates of change of airflow expected, such as throttle bursts and chops. The effects of airflow and the changes in airflow shall be observed, and any weaknesses of design shall be changed.

4.5.1.4 Pressure and temperature cycling. The engine bleed air system shall be subjected to pressure and temperature cycles for a total number of cycles equivalent to the expected life of the system. The operating pressure and temperature values shall be considered to be the values that will, in combination, result in the highest ratio of stress to yield strength induced in the material. One cycle shall consist of the following:

(a) Introduce hot air to the engine bleed air system until all components have reached the stabilized operating temperature.

(b) Pressurize the complete engine bleed air system to the operating pressure.

(c) Allow the engine bleed air system to decay to 175°F or less and to between zero and 10 percent of the operating pressure.

4.5.1.5 Thermal shock. The engine bleed air system or a representative section as mutually agreed by the contractor and the procuring activity shall be tested for the effect of thermal shock. The thermal shock test shall consist of temperature cycling, for three cycles, the complete ducting system from cold soak at -65°F to the expected maximum cold day operating bleed air temperature. A cycle shall consist of low temperature stabilization, then raising to a high temperature until stabilized, and then lowering to the original temperature simulating the maximum rate of change for increasing and decreasing temperatures expected.

4..1.6 Simulation of aircraft vibration. The engine bleed air system or sections thereof, as specified in 4.5.1.1, shall be subjected to vibrations at realistic frequencies and amplitudes based on the best available vibration data.

4.5.2 Containment. The containment requirements specified in 3.2.1.11 shall be demonstrated for all rotating equipment.

4.5.3 Proof and burst pressure. All components of the environmental control, the environmental protection, and the engine bleed air systems shall be subjected to the proof and burst pressure tests specified in 4.6.2.1.

4.5.4 Ground pressurization. The occupied compartments and the equipment compartments shall be subjected to ground pressurization tests in accordance with MIL-T-8207.

4.6 Preproduction tests. Preproduction tests are laboratory tests that are performed on production configuration component and system samples that are submitted as being capable of meeting the performance and design requirements of this specification. Preproduction samples of all components of the environmental control, the environmental protection, and the engine bleed air systems shall be subjected to preproduction tests that will demonstrate compliance with all the performance and design requirements. Test procedures and requirements for the preproduction tests shall be as required by the applicable documents referenced herein. If no applicable document is referenced herein, the environmental, structural, and performance tests shall be conducted in accordance with an airframe contractor's procurement specification that has been approved by the procuring activity.

4.6.1 Environmental tests. The airframe contractor's procurement specification tions shall include all the environmental tests that are determined to be necessary from an environmental analysis conducted in accordance with the paragraph entitled "Environmental Analysis" in Design Note 1C1, Chapter 1 of AFSC Design Handbook DH 1-5. The environmental analysis shall consider the necessity of all the tests described in MIL-STD-810. The necessary environmental tests shall be conducted in accordance with the applicable procedures of MIL-STD-810.

4.6.2 Structural tests. The airframe contractor's procurement specification shall include but shall not be limited to the structural tests, when applicable, as specified in 4.6.2.1 through 4.6.2.13.

4.6.2.1 Proof and burst pressure. Proof and burst pressure tests shall be accomplished at the conditions defined in 3.2.1.9 and 3.2.1.10.

4.6.2.2 Internal and external leakage. Internal and external leakage shall be determined at maximum normal operating pressure and room temperature to show compliance with the contractor's procurement specification.

4.6.2.3 Endurance. Extended operation that will demonstrate the specified service life shall be conducted under simulated operating conditions.

4.6.2.4 Critical speed. All rotating equipment shall be operated throughout its complete range of rotational speed up to and including the maximum operating rpm in small increments to determine if a critical speed exists. If a critical speed is found, the unit while operating at the critical speed shall not transmit to the structure of the aircraft vibration of an amplitude and gravity load greater than that specified in the airframe contractor's procurement specification.

4.6.2.5 Dielectric strength _ A dielectric strength test shall be performed in accordance with method 301 of MIL-STD-202, using commercial frequency voltages at the potential and for the length of time specified in the detail procurement specifications. The maximum allowable leakage current and retest voltages, if applicable, shall be as specified in the detail procurement specification..

4.6.2.6 Containment. The containment requirements specified in 3.2.1.11 shall be demonstrated for all rotating equipment.

4.6.2.7 Overspeed. Each rotating assembly capable of attaining speeds greater than the normal maximum design operating speed shall be operated for 5 minutes at 120 percent of the normal maximum operating speed without incurring operational or structural damage. The rotating assembly shall then be completely disassembled, and each part of the rotating assembly shall be carefully examined for any dimensional changes, cracks, or any other signs of incipient failure. If such signs are evident in any part, the part shall have failed to pass this test.

4.6.2.8 Attitude. All rotational equipment and units with fluid reservoirs shall be mounted in different attitudes simulating typical aircraft operating attitudes as defined by the weapon system specification. Satisfactory operation shall be demonstrated for the maximum time period associated with each attitude extreme.

4.6.2.9 Electromagnetic interference. All electrical components shall be subjected to electromagnetic interference tests as specified in MIL-STD-461 and MIL-STD-462.

4.6.2.10 Freeze and thaw. Components that utilize freezing liquids shall be tested to demonstrate their capability to withstand the freeze and thaw conditions expected during service life. The component shall be filled with liquid and then exposed to an ambient temperature and for a period of time that will assure complete freezing of the liquid. Thawing shall then be accomplished by applying heat in a manner and at a rate simulating operational modes for the equipment installation. The number of freeze and thaw cycles shall be the number expected throughout the life of the aircraft. If several possible ways of thawing the liquid will occur in the equipment installation, the number of test cycles shall be divided in a realistic manner between each of the possible heating methods.

4.6.2.11 Pressure and temperature cycling. Components that are normally subjected to temperatures and pressures shall be tested to establish the integrity of the components. Each of these components shall be subjected to pressure and temperature cycles for a total number of cycles equivalent to the expected life of the component. The operating pressure and temperature values shall be considered to be the values that, in combination, will result in the highest ratio of stress to yield strength induced in the material. One pressure and temperature cycle shall consist of the following:

(a) Introduce hot air to the component until it reaches the operating temperature.

(b) While the component is at operating temperature, pressurize the component to operating pressure.

(c) Allow the component to decay to 175°F or less and to between zero and 10 percent of the operating pressure.

4.6.2.12 Flow resonance. Each component with internal airflow shall be subjected to the complete range of required operating flows and temperatures to determine resonant conditions. If a resonant condition is found, the component shall be subjected to a 50-hour test using the flow rate and temperature producing the most severe resonance. The component shall not show any structural deterioration at the end of the 50-hour test period and shall successfully pass the specified leakage requirements and proof pressure test.

4.6.2.13 Motion cycling. Each component that is subject to displacement motions during normal operation shall be subjected to motion cycle. The motion cycle shall be the most extreme excursion for the component in direction and range of motions at the temperatures and pressures specified in the component specification. The bending moment and the torsional moment shall be measured periodically throughout this test to insure that neither exceed the values specified in the component specification.

4.6.3 Performance tests. The contractor's procurement specification shall include sufficient tests to verify performance and design requirements.

4.7 Reliability tests and analysis. Reliability tests and analysis are tests and analysis that are performed on components and systems to show compliance with reliability values assigned in accordance with the system reliability requirements. Reliability tests shall be accomplished to the extent necessary to verify adequately that the systems meet the reliability criteria established for the systems in accordance with MIL-STD-785. Reliability tests shall be considered to be a part of the preproduction tests. If approved by the procuring activity, a reliability analysis will be acceptable to show compliance with the reliability criteria.

4.8 Acceptance tests. Acceptance tests are tests that are performed on individual production lots of components or systems prior to acceptance. Each component submitted for acceptance shall successfully complete certain minimum testing to assure its complianc. .'th the procurement specification. As applicable, production acceptance tests shall include but not be limited to the following tests:

(a) Examination of product (see 4.8.1)

(b) Proof pressure (see 4.6.2.1)

(c) Leakage (see 4.6.2.2)

(d) Dielectric strength (see 4.6.2.5)

(e) Minimum functional operation (see 4.8.2)

(f) Rotor overspeed (see 4.6.2.7).

4.8.1 Examination of product. Each component shall be examined to assure compliance with the requirements of this specification and the airframe contractor's procurement specification. This examination shall include but shall not be limited to identification marking, physical measurements, weight, continuity or required wiring, proper wiring, finish, freedom from damage, and maintenance of the required standard of workmanship.

4.8.2 Minimum functional operation. A minimum amount of testing shall be performed on each component to demonstrate satisfactory functional operation, calibration, and capacity of the production component.

4.9 Sampling tests. Sampling tests are tests that are performed periodically on sample quantities of production components and systems to insure high quality. Sampling tests shall be conducted to demonstrate capability of the production item to maintain performance requirements.

4.10 Ground and flight tests. Ground and flight tests are tests that are performed on the systems covered by this specification, when installed on the aircraft, under actual ground and flight conditions having the necessary interrelationships with all aircraft systems to show compliance with the performance requirements of this specification. Ground and flight tests shall be conducted on the environmental control, the environmental protection, and the engine bleed air systems and associated equipment under the following ground and flight conditions to demonstrate compliance with the atmospheric conditions of 3.2.1.2:

(a) Ground operation with the main propulsion engines not operating and conditioned air provided through the use of ground support equipment or aircraft carried ground air conditioning equipment

(b) Ground operation with the main propulsion engines operating and conditioned air provided by the airborne system and in accordance with the conditions of 3.1.1.2.1.1.

(c) Transient flight (climb, dive, landing, and acceleration)

(d) Steady state including minimum and maximum flight speeds at both minimum and maximum operational altitude.

In the event that flights cannot be accomplished under the most critical design atmospheric temperatures, the test data shall be recorded at the actual conditions and accurately extrapolated to the design atmospheric conditions of 3.2.1.2.

4.10.1 Determination of airflows. Sufficient instrumented duct sections throughout the systems shall be calibrated to enable accurate determination of airflows to areas such as occupied compartments, equipment components, and defogging during ground and flight tests.

4.10.2 Pressure and temperature data. Sufficient pressure and temperature data to demonstrate major component performance and permit adequate diagnosis of any component malfunction or inadequacy shall be recorded.

4.10.3 Ventilating, cooling, and heating systems. Flight and ground tests on ventilating and cooling systems shall be accomplished during daylight to determine system performance with effect of the sun and with maximum operating electrical load applied. Flight and ground tests of the ventilation and the cooling systems of passenger-carrying aircraft shall be accomplished with at least 75 percent of the human heat load or equivalent aboard. Flight and ground tests on heating systems shall be conducted at night and with mininum operating electrical load to eliminate heating effects of the sun and electrical loads. Flight and ground tests of the heating system of passenger-carrying aircraft shall be accomplished with less than 10 percent of the human heat load or equivalent aboard.

4.10.4 Equipment. Equipment for the ground and flight tests shall be provided as follows:

(a) Equipment to analyze the contents of the air in occupied and cargo compartments to determine compliance with 3.1.1.2.1.7 and 3.2.2.1.1.1

(b) Equipment to determine air direction and velocities in the occupied compartments during all flight conditions to determine compliance with 3.1.1.2.1.4 and 3.2.2.2.6.1

(c) Equipment to determine the moisture content of air in all occupied compartments of multi-crew and passenger-carrying aircraft.

4.10.5 Instrumentation. Instrumentation for ground and flight tests shall be provided as follows:

(a) All instrumentation installed for flight test purposes shall be located to minimize the effect of the instrumentation on airflows and pressure drop.

(b) All pressure pickups shall be located to minimize the turbulence effects of valves, bends, orifices, et cetera.

(c) All temperature pickups shall be thermocouples, or equivalent sensors, shielded as necessary to include or eliminate the effects of radiation.

(d) Sufficient instrumentation to provide weight flow data, inlet and exit air temperature data, temperature differentials, compartment ambient temperatures, and air supply total pressure differentials to show in detail compliance with the performance requirements of 3.1.1.2 shall be installed in the test aircraft.

(e) Instrumentation and equipment necessary to show compliance with the performance requirements of 3.1.1.1 shall be in accordance with MIL-T-8207.

(f) Instrumentation and equipment necessary to show compliance with the performance requirements of 3.1.2.1 and 3.1.2.6.1 shall be in accordance with MIL-T-5842.

(g) Instrumentation and equipment necessary to show compliance with the performance requirements of 3.1.2.6.3 and 3.1.2.6.4 shall be in accordance with MIL-A-9482. Instrumentation and equipment to show compliance with the performance requirements of 3.1.2.6.2 shall be similar to the instrumentation and equipment specified in MIL-A-9482.

(h) Instrumentation used during all rain removal testing specified in 4.1[illegible].7.8 shall include a device for measuring the rainfall rate (if rain is simulated), camera coverage to give photographic representation of the clearance observed by the pilot, and an external target adequate to present the extent and quality of clearance observed by the pilot. Aircraft flight speed should be recorded. When jet blast rain removal is utilized, instrumentation shall also be included for the measurement of the jet blast nozzle inlet temperature, pressure, and air weight flow.

4.10.6 Ground tests

4.10.6.1 Safety tests

4.10.6.1.1 Air inlet. The aircraft shall be inspected to insure that all occupied compartment air inlets are located so that no drainage or exhaust of flammable or noxious fluid or gases can enter the inlets during flight or on the ground at any heading relative to the wind. All air inlets, especially ram cooling air to the heat exchanger, shall be inspected to insure that there is no blockage. All inflatable compartment opening seals shall be pressurized and checked for proper pressurization and fit.

4.10.6.1.2 Combustion heater installations. Combustion heater installations shall be tested for proper operation as specified in 3.2.2.2.9.4.

4.10.6.2 Performance tests

4.10.6.2.1 Temperatures and airflows (with engines not operating). With the engines not operating and conditioned air being supplied by ground support equipment or aircraft carried ground air conditioning equipment, ground tests shall be conducted to verify that required temperatures and airflow rates are provided for occupied compartments, equipment compartments, and individually cooled equipment. The data specified in 4.10.5(d) shall be recorded.

4.10.6.2.2 Temperatures and airflows (with engines operating). With the engines operating and the conditioned air being supplied by the airborne air conditioning system, ground tests shall be conducted to verify that required temperatures and airflows are provided for occupied compartments, equipment compartments, and individually cooled equipment. In addition, compliance with the contamination levels of 3.1.1.2.1.7 and the ducting surface temperature requirements of 3.2.4.2 shall be verified.

4.10.6.2.3 Ground pressurization. Ground testing of the pressurization provisions shall be accomplished in accordance with MIL-T-8207.

4.10.7 Flight tests

4.10.7.1 Pressurization. Flight testing of pressurization provisions for the occupied compartments and the equipment compartments to show compliance with 3.1.1.1 shall be accomplished in accordance with MIL-T-8207.

4.10.7.2 Air conditioning. Flight testing of the air conditioning subsystems to show compliance with the requirements of 3.1.1.2 and 3.2.2.2 shall be accomplished at the conditions specified in 4.10(c) and 4.10(d). The equipment specified in 4.10.4 and the instrumentation to record data of 4.10.5 shall be used to collect detail data in sufficient quantities to provide a thorough analysis of the environmental control system performance.

4.10.7.3 Contamination. Sa..ple of a'r from occupied compartments shall be collected, analyzed, and recorded to show compliance to allowable contaminations in accordance with 3.1.1.2.1.7 and 3.2.2.1.1.1 at the following conditions:

(a) At sea level and maximum operational ceiling (see 6.3.12) of the aircraft under minimum and maximum compartment cooling and heating airflows

(b) Immediately following a maximum normal rate of descent to 12,000 feet from the maximum operational ceiling.

4.10.7.4 Humidity. Humidity measurements shall be taken and recorded in the occupied compartments at the following conditions: low level flight at maximum and cruise power settings with all equipment operating and all moisture sources that would add to the compartment moisture level present or simulated.

4.10.7.5 Defogging and defrosting provisions. Flight testing of the defogging and defrosting provisions shall be accomplished in accordance with MIL-T-5842.

4.10.7.6 Windshield anti-icing. Flight testing of the windshield anti-icing provisions shall be accomplished in accordance with MIL-T-5842 and demonstrated by flight in natural or simulated icing conditions.

4.10.7.7 Flight surface, inlet, and radome anti-icing. Flight testing of flight surface and inlet anti-icing provisions shall be accomplished in accordance with MIL-A-9482 and demonstrated by flight in natural or simulated icing conditions. Flight testing of radome anti-icing provisions shall be accomplished, with procedures given in MIL-A-9482 for flight surfaces, and demonstrated by flight in natural or simulated icing conditions. When flight surface or inlet anti-icing provisions are not provided, flights shall be made with simulated ice build-up shapes installed to demonstrate that performance is not degraded below a minimum acceptable level.

4.10.7.8 Rain removal. Flight testing of the rain removal system to demonstrate the adequacy of the cleared area during flight and ground conditions of 3.1.2.2(a) through 3 1.2.2(g) shall be accomplished in actual or simulated rain. The rainfall rate during this testing shall be equal to or greater than 0.59 inch per hour. If this flight testing will be accomplished by use of a spray tanker aircraft for simulating rain conditions, the testing shall be accomplished at flight speeds and angles of attack that will simulate low level flight (low speeds), approach and landing flare.

5. PREPARATION FOR DELIVERY

5.1 This section is not applicable to this specification.

6. NOTES

6.1 Intended use. The environmental control, the environmental protection, and the engine bleed air systems covered by this specification are intended to be used in aircraft.

6.2 Data requirements. Data submittal requirements for the environmental control, the environmental protection, and the engine bleed air systems shall be in accordance with the contractual requirements for the particular aircraft.

6.3 Definitions

6.3.1 Occupied compartments. Occupied compartments are compartments in which crewmembers or passengers are expected to perform their functions even for short periods of time. Examples of occupied compartments are crew compartments, rest areas, passenger areas, and cargo compartments where in-flight entry is necessary.

6.3.2 Maximum operating cruise altitude. The maximum operating cruise altitude is the maximum altitude obtainable while operating the engines at the most economical cruise power setting for the minimum gross weight.

6.3.3 Dumping. Dumping refers to the opening of the normal outflow valves or the emergency exhaust openings, thereby equalizing cabin and ambient pressure in a minimum time.

6.3.4 Average compartment air temperature. The average compartment air temperature is the resulting dry bulb temperature obtained by taking the average of numerous dry bulb temperature measurements at the same instant of time, either throughout the complete pressurized compartment in the aircraft where crew movement throughout the cockpit is possible or throughout the volume immediately surrounding the crewmember(s).

6.3.5 Entrained moisture. Entrained moisture is moisture that is carried along in the air as free water.

6.3.6 Cold plate. Cold plate refers to electronic equipment constructed so that heat dissipating components transfer heat directly to a common plate. The cooling medium is passed across the plate to dissipate the heat load of the electronic equipment so that the components will not be exposed directly to the cooling medium.

6.3.7 Safe return. Safe return refers to the ability of the aircraft to return safely to the nearest base, when the normal mission has been terminated, with capabilities for radio transmissions and rendezvousing with the refueling tanker (where applicable), and with normal landing provisions.

6.3.8 Anti-icing. Anti-icing is the prevention of ice buildup on the protected surface by the process of either evaporating the impinging water or allowing it to run off or run back and freeze on the noncritical area.

6.3.9 Deicing. Deicing is the periodic shedding, either by mechanical or thermal means, of small ice buildup by destroying the bond between the ice and the protected surface.

6.3.10 In-flight applied rain repellent. In-flight applied rain repellent is a liquid repellent with such a viscosity that it can be applied during flight to an aircraft transparency by a spray system with application characteristics as required in this specification.

6.3.11 Dehumidifier. A dehumidifier is a component used in a line to remove the moisture from air. It is sometimes a molecular sieve material in a case with fittings on each end for connection in the line.

6.3.12 Maximum operational ceiling. Maximum operational ceiling is the maximum altitude at which an aircraft can sustain level flight.

6.4 Annotation of changes. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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