

AIR CONDITIONING EQUIPMENT, AIRPLANE GENERAL REQUIREMENTS FOR

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1. PURPOSE:

- 1.1 "ARP - This recommended practice is based on sound engineering principles and intended as guides for future standard engineering practices for aircraft industry."
- 1.2 This recommended practice is to be considered as being currently applicable and necessarily subject to revision from time to time, due to rapid development of the aircraft industry.
- 1.3 The following recommendations are based on practical engineering requirements for the design and testing of such types of heating and ventilating equipment as are now used on airplanes and for such as may be developed to meet the demand imposed in the field of service.

2. SCOPE:

- 2.1 Air Conditioning System - General - Dealing with Design Features
- 2.2 Air Conditioning Equipment - Commercial Passenger - Dealing with features. Applicable only to commercial passenger carrying aircraft.
- 2.3 Desirable Design Features - General information for use of those concerned in meeting requirements contained herein.

3. AIR CONDITIONING SYSTEM - GENERAL:

3.1 Definition:

3.1.1 An aircraft air conditioning system should consist of the following:

- a. A source of heat.
- b. A source of fresh air. (If a cabin supercharger is used, a second source of fresh air should be employed, second source to be completely independent of the supercharger.)
- c. A cooling unit.
  1. Air cycle machine with intercoolers or aftercoolers.
  2. Vapor cycle machine with evaporators and condensers.
- d. Distribution system.
- e. Exhaust system.
- f. Temperature control.
- g. Cabin pressure indicator.
- h. Cabin low pressure warning device.

3.1.2 The system may also include one or more of the following:

- a. Filters
  1. Dust.
  2. Smoke.
  3. Odor (or counter agents).
  4. Oil.
  5. Gases.
  6. Vapors.

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- b. Recirculating fans.
- c. Dehumidifier.
- d. Humidifier.
- e. Germicidal lamps.
- f. Germicidal Aerosols.
- g. Automatic temperature control.
- h. Automatic humidity control.
- i. Cabin pressure regulating valves.
- j. Cabin pressure altitude selector.
- k. Cabin pressure rate of change selector.
- l. Cabin emergency pressure relief valve.
- m. Cabin vacuum relief valve.
- n. Cabin pressure dump valve.
- o. A means for controlling mass flow of supply air to pressurized cabins.
- p. Cabin temperature indicator.
- q. Cabin humidity indicator.

### 3.2 General Recommendations:

- 3.2.1 The design of the air conditioning system should be such as to preclude the possibility of introduction of harmful concentrations of any toxic, combustible or objectionable fluids or gases from the aircraft or engine such as exhaust gases, de-icer fluids, gasoline or the fumes therefrom.
- 3.2.2 The air conditioning system should provide adequate ventilation to avoid an objectionable odor level and smoke concentration for all normal flight conditions.
- 3.2.3 The duct distribution system including the air inlets to the occupied space should be such as to provide for a minimum of temperature variation and air movement in accordance with values hereinafter recommended, within the air conditioned space.
- 3.2.4 An adequate exhaust system should be provided for removal of vitiated air. Emergency provisions should be made to remove smoke or other contaminants resulting from equipment malfunction or fire.
- 3.2.5 A temperature control system, either manual or automatic, should be provided which will provide a means for regulating the temperature within the air conditioned space independent of engine or airplane operation.
- 3.2.6 The airplane heating requirement should be met at all speeds and altitudes of the airplane.
- 3.2.7 The heating system and the airplane insulation should be so designed that a stable average temperature condition of 75°F can be achieved within 30 minutes with an ambient temperature of -40°F during all normal conditions of flight.
- 3.2.8 The airplane heating requirements should be met at all altitudes from sea level to the maximum design cruising altitude of the airplane.

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4. AIR CONDITIONING EQUIPMENT:

- 4.1 Component parts of the air conditioning equipment should be constructed of materials throughout which are considered acceptable for the particular use, and should be made and furnished with the degree, uniformity and grade of workmanship generally accepted in the aircraft industry.
- 4.1.2 Component equipment should be designed to start and operate satisfactorily at design atmospheric temperatures of  $-65^{\circ}\text{F}$  to  $+160^{\circ}\text{F}$  local environmental conditions and  $-65^{\circ}\text{F}$  to  $120^{\circ}\text{F}$  ambient temperatures. Specific installations may require consideration of a broader range of temperatures. This broader range should be stipulated in the detailed specification.
- 4.1.3 Cabin and crew station temperatures should not be less than  $68^{\circ}\text{F}$  at  $-65^{\circ}\text{F}$  outside ambient temperatures.
- 4.1.4 Maximum desirable warm air temperature entering occupied space  $200^{\circ}\text{F}$ .
- 4.1.5 Cargo compartment temperatures should be above freezing unless otherwise specified.
- 4.1.6 The following equipment temperatures should be maintained during flight:
- a. Air driven instruments should be maintained at minimum of  $40^{\circ}\text{F}$ .
  - b. Batteries should be maintained between  $40^{\circ}\text{F}$  and  $110^{\circ}\text{F}$ .
- 4.1.7 The distribution of heat within any crew station and all spaces normally occupied by passengers should be adequate to prevent air temperature variations in excess of  $10^{\circ}\text{F}$  from floor to ceiling and the forward and aft portion of the space.

4.2 Ventilating Requirements:

4.2.1 Air Quantities:

- 4.2.1.1 Ventilation requirements for odor control varies upward from 1.0 #/min per passenger, depending on the volume of cabin per occupant, and degree of recirculation used. If the ventilation is accomplished in part by recirculation, the recirculated air should be purified by adequate filters and/or air washers. In the absence of adequate filters and/or air washers, a minimum of 1.0 #/min per passenger of outside air is required for odor control.

Note: These ventilation requirements have been found satisfactory with volumes of cabins per occupant between 40 and 60 cubic feet.

- 4.2.1.2 In addition to the minimum quantity of fresh air stipulated an additional quantity of cabin air may be recirculated in order to provide proper temperature distribution and lower air inlet temperatures during heating.

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- 4.2.1.3 A minimum quantity of fresh air during warm weather unpressurized (when no mechanical cooling is available) of 40 CFM per minute per occupant should be provided.
- 4.2.1.4 Sources of outside air should be capable of supplying a minimum of 30 CFM of fresh air per occupant in the crew compartment. The air should not be recirculated, but when exhausted, can be used for windshield heat, equipment cooling, etc.
- 4.2.1.5 If the air conditioning system is used for defogging and defrosting cockpit transparencies, then the system should be capable of maintaining adequate visibility for all conditions of aircraft operation.
- 4.2.1.6 Toilets and galleys should be provided with an exhaust system, the capacity of which will exceed the air supply in order to preclude the possibility of any air supplied to such spaces moving into any other occupied portion of the airplane, either through doors or recirculating systems.
- 4.2.1.7 Air Velocity in Occupied Spaces:
- 4.2.1.7.1 During heating velocity over occupants should not exceed 75' per minute.
- 4.2.1.7.2 During cooling (when mechanical means of cooling the ventilating air are provided) velocity over occupant should not exceed 200' per minute, except for individual seat air outlets.
- 4.2.1.8 Air Inlets:
- 4.2.1.8.1 General air supply to occupied spaces should be through inlets which are adjustable only for purpose of balancing the system but are not to be controllable by occupants.
- 4.2.1.8.2 All crew stations or points of localized heating should have inlets controllable as to quantity or temperature. Such adjustment should not affect the overall balance of the distribution system.
- 4.2.1.8.3 Sleeper airplanes with enclosed berths should be provided with an inlet to each berth partially controllable by the occupant.
- 4.3 Pressurizing: See SAE Aeronautical Recommended Practice entitled "Airplane Cabin Pressurization."
- 4.4 Cooling:
- 4.4.1 Design Conditions:
- 4.4.1.1 Ambient Conditions - The average maximum temperature coincident with the average maximum humidity values for the four warmest months of the year in the territory where the airplane is to be operated should be used. For operation within the continental United States, values of 100°F dry bulb and 33% relative humidity at sea level are considered satisfactory.