

MIL-T-18607(Aer)
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MILITARY SPECIFICATION

THERMAL ANTI-ICING EQUIPMENT, WING AND EMPENNAGE

This specification has been approved by the
 Bureau of Aeronautics, Department of the Navy

1. SCOPE

1.1 Scope. -This specification covers the general requirements for the design, installation, and performance of thermal anti-icing equipment for the wings and empennage surfaces in aircraft.

1.2 Classification. -There shall be no restriction as to the type of thermal anti-icing equipment used. It is considered that either a system using the exhaust heat of the engine, or combustion heaters will be acceptable for use as the prime source of heat. For clarity, thermal anti-icing systems shall be designated-as:

Exhaust Heat Exchanger Anti-Icing System
 Combustion Heater Anti-Icing System
 Compressor Bleed Air Anti-Icing System

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications of the issue in effect on date of invitation for bids, form a part of this specification.

SPECIFICATIONS

FEDERAL

L-T-101	Tape, Shielding and Identification; Pressure Sensitive
QQ-P-416	Plating, Cadmium (Electrodeposited]
WW-T-787	Tubing, Aluminum Alloy 52S, Round Seamless, Drawn

MILITARY

JAN-A-669	Compound; Anti-seize; White' Lead Base, General Purpose (for Threaded Fittings)
MIL-C-5015	Connectors; Electrical, "AN" Type
MIL-B-5087	Bonding; Electrical (for Aircraft)
MIL-W-5088	Wiring, Aircraft, Installation
MIL-E-5272	Environmental Testing, Aeronautical Equipment, General Specification
MIL-H-5484	Heaters; Aircraft, Combustion Type

MIL-T-18607(Aer)

MIL-F-5509	Fittings, Fluid Connection
MIL-E-5557	Enamel; Heat Resisting, Glycerol Phthalete, Black
MIL-F-5572.	Fuel; Aircraft Reciprocating Engine Grades 80, 91/96, 100/130, 115/145
MIL-I-6051	Interference Limits and Methods of Measurement; Aircraft Radio and Electronic Installations
MIL-P-6889	Primer, Zinc Chromate, for Aircraft Use
MIL-E-7080	Electrical Equipment; Installation of Aircraft, General Specification
MIL-P-7105	pipe Threads, Taper, Aeronautical National Form, Symbol ANTP
MIL-S-7742	Screw threads, Standard, Aeronautical
MIL-A-8625(ASG)	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-F-17874(Aer)	Fuel Systems; Aircraft, Installation and Test of
MIL-C-18591(Aer)	Carbon Monoxide Elimination; Requirement for
MIL-E-18609(Aer)	Heating and Ventilating Equipment, Aircraft; Installation of
MIL-E-25109(ASG)	Engines, Aircraft, Reciprocating, General Specification for

NAVY DEPARTMENT

General Specifications for Inspection of' Material

STANDARDS

AIR FORCE - NAVY AERONAUTICAL

AND-10375 colors; Fluid Line Identification

PUBLICATIONS

AIR FORCE - NAVY AERONAUTICAL (BULLETIN)

ANA-143 Specifications and Standards, Use of

(When requesting specifications, standards, drawings, and publications refer to both title and number. Copies of this specification and applicable specifications may be obtained upon application to the Commanding officer, U.S. Naval Air Station, Johnsville, Pennsylvania, Attention Technical Records Divisions)

2.2 Other Publication.-The following documents forms a part or this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

NACA T.N. No. 1472 "The Calculation of the Heat Required for

MIL-T-18607(Aer)

Wing Thermal Ice Prevention in Specified Icing Conditions.

Carr B. Neal, Jr., Norman R. Bergum, David Sukoff, and Bernard A. Schloff, December 1947 1

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

3. REQUIREMENTS

3.1 Surfaces to be protected.-The anti-icing system shall protect the surfaces of the aircraft against the accumulation of ice as outlined in the following paragraphs.

3.1.2 All portions of the wing(s) and stabilizing surfaces which are exposed to ice accumulations during flight under the conditions specified in 3.2, 3.3, 3.3.1, 3.3.2 and 3.3.3 shall be protected by the anti-icing system.

3.2.1.1 Wing areas adjacent to fuel cells.-Wing areas adjacent to integral fuel cells need not be heated.

3.1.2 Stabilizing surfaces.-All parts of the aircraft stabilizing surfaces which are exposed to ice accumulation during flight shall be protected by the anti-icing system.

3.1.3 The entrance to each air scoop which must function during icing conditions shall be protected against ice accumulations. Protection shall also be provided for the guide vanes or at abrupt changes in direction of ducts leading from these scoops to permit unrestricted airflow in these ducts.

3.1.4 Protection of antenna masts, hinge fairings, spoilers, dive brakes, struts, and other miscellaneous ice accreting parts shall depend upon the effects of: (1) ice accumulation on the normal functioning of the individual part, and (2) increased drag on aircraft performance.

3.2 Icing conditions.- The thermal anti-icing system shall be designed to preclude the forming of ice on the protected surfaces of the aircraft in atmospheric conditions at least as severe as to those in which the free air temperature is not over 15 degrees Fahrenheit, the moisture content is at least 0.5 grams per cubic meter, and the average size of the water droplets is at least 25 microns in diameter.

3.3 Flight Conditions.- The thermal anti-icing system shall be designed to preclude the forming of ice on the protected surfaces of the aircraft during the following conditions:

3.3.1 Altitude.- The anti-icing system shall function satisfactorily from sea level to 20,000 feet or to the ceiling of the airplane, whichever is lower.

3.3.2 Attitude.- The anti-icing system shall function satisfactorily with the aircraft in any permissible flight attitude.

3.3.3 Speed.- The anti-icing system shall function satisfactorily at any speed between design stalling and the design level flight speeds of the aircraft.

3.3.4 Vibration and acceleration.- The functioning of the anti-icing system shall not be adversely affected by acceleration or vibration of the aircraft.

3.4 Thermal requirements

3.4.1 Flight temperatures.- The anti-icing system shall be capable of maintaining the skin of the protected surface as outlined herein.

3.4.1.1 Conditions.- Readings shall be made under the following conditions:

MIL-T-18607(Aer)

3.4.1.1.1 Normal rated power. - The aircraft shall be in a level flight in clear air with the engines operating at normal rated power.

3.4.1.1.2 Ambient temperature.- The ambient air temperature shall be 15 degrees Fahrenheit*

3.4.1.1.3 Solar radiation.- The specified temperatures shall be obtained independently of the effect of solar radiation.

3.4.1.2 Spar at 20 percent chord point. - When the spar is located immediately aft of the 20 percent chord point, temperature of the leading edge skin forward of the spar shall be not less than 50 degrees Fahrenheit.

3.4.1.3 Spar at 15 percent chord point. - When the spar is located immediately aft of 15 percent chord point, the temperature of the leading edge skin forward of the spar shall be not less than 85 degrees Fahrenheit.

3.4.1.4 Spar at 10 percent chord point. - When the spar is located immediately aft of the 10 percent chord point, the temperature of the leading edge skin forward of the spar shall be not less than 120 degrees Fahrenheit.

3.4.2 Temperature Distribution.-The maximum variation in skin temperature between any two points along the surface span at a given percentage of chord shall not exceed 20 degrees Fahrenheit.

3.4.3 Fuel temperature. - Operating of the anti-icing system under any flight condition shall not raise the temperature of the fuel in any portion of the fuel system more than 10 degrees Fahrenheit.

3.4.4 Temperature of structure.-Operation of the anti-icing system shall not result in raising the temperature of any structural member of the aircraft to a value in excess of 250 degrees Fahrenheit.

3.5 General requirements.

3.5.1 Weight. - The airplane weight empty shall not be increased more than one percent (1.0 percent) due to installation of the thermal anti-icing system. The weight of the anti-icing system shall be included in the weight empty of the airplane.

3.5.2 Accessibility.- All operating components of the anti-icing installation shall be readily accessible for inspection, adjustment and repair.

3.5.3 Removability.

3.5.3.1 heaters, heat exchangers and accessories. - All heaters, heat exchangers and accessories used there with shall be readily removable. It shall not require more than 8 man-hours to remove and replace each heat exchanger or heaters

3.5.3.2 Ducts. - It is desired that major components of the anti-icing system such as ducts be removed for flight operations where anti-icing equipment will not be required. Provisions shall be made in the aircraft for securing cables, etc., which will "be loose when equipment is removed.

3.5.4 Operation of anti-icing system.

3.5.4.1 Cockpit.-The following items shall be grouped together in a position convenient to the pilot, copilot or flight engineer.

3.5.4.1 Control. -For normal operation, the anti-icing system shall be operated by a single control.

3.5.4.1.2 Temperature indicator. -A temperature indicator shall be provided which indicates in degrees Fahrenheit the temperature of one typical point on each protected semi-span wing panel and on each protected stabilizing surface (semi-stabilizer and fin), that is most responsive to icing condition.

3.5.4.1.3 Warning signal.-A suitable warning signal shall be provided to indicate when actuation of any safety device has stopped the operation of the anti-icing system.

3.5.4.1.4 Operating instructions.-A suitable instruction plate shall be provided containing necessary instructions for the operation of the anti-icing system.

3.5.4.2 Temperature control.-The temperature of the hot air being supplied to the protected surfaces shall be automatically controlled to prevent overheating of the surfaces.

3.6 Hot air distribution system.

3.6.1 Distribution.-The hot air shall be distributed to the leading edges of the protected surfaces by means of suitable ducts. The system shall be designed so that the hot air, after leaving the heat source, may be directed through the system or it may be dumped overboard.

3.6.2 Exhaust gases. - Whenever the anti-icing system contains gases from the engine exhaust, or the combustion heaters, the system shall be designed to preclude the possibility of toxic gases escaping into occupied compartments in the event of leaks in the heater or heat exchanger, or of corroding any part of the aircraft structure.

3.6.3 Water drains. - Provision shall be made to insure the free drainage of any water that may enter the system.

3.7 Heat sources.

3.7.1 Heat exchangers.-When heat is to be obtained from engine exhaust, it shall be extracted by one or more heat exchangers.

3.7.1.1 Exhaust back pressure. - With heat exchangers installed, the exhaust back pressure shall conform to the requirements of Specification AN-9500.

3.7.2 Combustion heaters. - Combustion heaters shall conform with the requirements of Specification MIL-H-5484.

3.7.2.1 Fuel supply.-Fuel for the combustion heaters may be obtained from the engine fuel pumps or pumped directly from the aircraft fuel system by electrically-driven pumps.

3.7.2.2 Shut-off valves.-Positive Shut-off valves shall be incorporated as near as practicable to the fuel sources (engine-driven pumps or fuel tanks).

3.7.2.3 Fuel lines. - All lines carrying fuel to the heaters shall be either AN-6264 hose assemblies or aluminum alloy tubing in conformity with the requirements of Specification WW-T-787. Fuel lines shall be marked in accordance with Standard AND-20375.

3.7.2.4 Drain lines. - Each heater shall be provided with drain lines to insure that in the event of nonignition, all fuel pumped to the heater will be drained overboard.

3.7.3 Bleed air.-In turbo prop and jet aircraft, bleed air from the compressor may be utilized.

3.8 Electrical equipment.

3.8.1 Installation. - The electrical installation shall conform to Specification MIL-W-5088 and Specification MIL-E-7080.

3.8.1.1 Quick disconnect connectors.-Where equipment is subjected to removal for inspection and servicing, quick disconnect electrical connectors in conformance with Specification MIL-C-5015 shall be provided.

MIL-T-18607(Aer)

3.8.1.2 Bonding. -Electrical bonding shall be in accordance with MIL-B-5087 with special allowance made for flexibility in the bonds to provide for thermal expansion.

3.8.2 Voltage. -The equipment shall be designed to operate from the primary electrical power system of the aircraft.

3.8.3 Power. - Electrical power consumption of any single heating unit in continuous operation shall not exceed 100 watts.

3.9 Reports and Engineering data.

3.9.1 Anti-icing system data. - The airplane manufacturer shall submit to the procuring activity for approval a report on the design of the system showing a complete schematic drawing of the proposed system and complete data on heat requirements and heat available and weight. These data shall be sufficiently detailed to permit evaluation of the accuracy of the methods used and shall contain complete sample calculations for at least one condition. The report shall also contain a word description of system operation. Submission and approval of this report is a prerequisite for any other approvals on the system or equipment.

3.9.2 System test report. -Prior to conducting ground or flight tests of the system, the contractor shall submit a test program for approval by the procuring activity.

3.9.3 Evaluation and extrapolation. - At the completion of the flight testing of the system, a complete report on the testing shall be submitted. This report shall include an evaluation and extrapolation of the data to design icing conditions. Final approval of the anti-icing system is contingent on satisfactory submission on this data.

3.10 Workmanship. -The anti-icing system, including all parts and accessories, shall be fabricated and finished in a thoroughly workmanlike manner. Particular attention shall be given to freedom from defects, accuracy of dimensions, and marking of parts and assemblies.

4. QUALITY ASSURANCE PROVISIONS

4.1 Preproduction tests:

4.1.1 A representative item of each item of equipment used in the system shall be tested to indicate suitability of the design for the use intended. These tests shall be in accordance with the manufacturer-approved equipment specifications and shall include life and performance tests, plus the applicable environmental tests in accordance with Specification MIL-E-5272A.

4.2 Prototype tests:

4.2.1 The ground and flight tests specified below shall be conducted on an airplane to demonstrate compliance of the anti-icing equipment with the requirements of this specification. Wherever possible, it is desirable to conduct these tests on ground mock-ups, if his facilities permit, to preclude damage to the airplane in case of system malfunction and to ensure early detection of deficiencies. Details of testing shall be in accordance with the manufacturer-approved testing specification and shall include the tests listed in 4.2.2 and 4.2.3.

4.2.2 Ground test. - Ground tests shall be conducted to demonstrate control system operation, temperature indication system operation, operation of overheat warning or control, general security and safety of the system for flight testing, distribution of available airflow, and freedom from overheating and detrimental effects of differential expansion.

4.2.3 Flight tests. -Flight tests shall be conducted to demonstrate control system operation, temperature indication operation, operation of overheat warning or control, freedom from overheating and detrimental effects of differential expansion.

MIL-T-18607(Aer)

Flight conditions shall include at least the following:

- (1) Normal Takeoff and climb to operating altitude
- (2) Normal descent and landing
- (3) Level flight at speed for maximum endurance, maximum speed, and an intermediate speed approximately halfway between these speeds at 5,000, 12,000 and 20,000 feet altitudes

4.2.3.1 Instrumentation shall be installed to determine the quantity and temperature of air from each heat source and the temperature and quantity of airflow in all main distribution ducts. least 3 wing stations on one side of the airplane and 2 stations on one horizontal and one vertical tail surface shall be instrumented to provide a chordwise profile of exterior and inner skin temperatures as well as temperature drop and airflow through the double skin passages. Sufficient structural temperatures shall be measured to ensure that structural overheating does not occur. Shielded thermocouples shall be used for measuring air temperatures in locations where there is a substantial difference between air temperature and the surrounding metal. If there are discontinuities in the heated areas, sufficient temperature measurements shall be made to determine the effect of the heat flow from the heated to the unheated area.

4.3 Individual tests.

4.3.1 Each anti-icing "system installation shall be inspected and tested to determine that the air distribution and system leakage is within allowable limits as specified in the design analysis. In addition each installation shall be inspected to meet the requirements of paragraph 3.10.

5. PREPARATION FOR DELIVERY

(Not applicable.)

6 . N O T E S

6.1 Intended use. - The equipment outlined in this specification is intended for use in naval aircraft for preventing the formation of ice on the wing and empennage surfaces during flight, and for removing frost from these surfaces prior to take-off.

6.2 Windshield anti-icing. - The provision of windshield anti-icing, a necessary item on any airplane equipped for operation in icing conditions, is not covered in this specification, but will be included in the detail specification of the airplane. If practical, windsheild anti-icing may be an integral part of surface anti-icing as herein specified.

6.3 Cabin heating. - Cabin heating is covered in Specification MIL-H-18609(Aer) and as in the case with windshield anti-icing, may be an integral part of the surface anti-icing system as herein specified.

6.4 Publication. - NACA technical note No. 1472, "The Calculation of the heat required for Thermal Anti-ice Prevention in Specified Icing Conditions" should be studied thoroughly by the designer of the equipment herein specified.

PATENT NOTICE. - When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government

MIL-T-18607(Aer)

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