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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS8804 | REV. A

Issued 1997-09
Cancelled 2001-07

Deicing System, Pneumatic Boot, Aircraft, General Specification For

CANCELLATION NOTICE

This document has been declared "CANCELLED" as of July 2001. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index.

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NOTICE

This document has been taken directly from U.S. Military Specification MIL-D-8804B and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, (b) the use of the existing government specification or standard format, and (c) the exclusion of any qualified product list (QPL) sections.

1. SCOPE:

1.1 Scope:

This specification covers the general requirements for pneumatic deicing systems for wings, empennages, radomes, radio masts, air induction system entrance cones, and ducts of aircraft. Deicing boots shall be of one type, operating at 15 to 22 psig pressure.

2. APPLICABLE DOCUMENTS:

2.1 Government documents:

2.1.1 Specifications, standards, and handbooks: The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issue of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-B-585	Boxes, Wood, Wirebound
PPP-B-591	Boxes, Shipping, Fiberboard, Wood Cleated
PPP-B-601	Boxes, wood, Cleated Plywood
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
PPP-B-636	Boxes, Shipping, Fiberboard

MILITARY

MIL-C-104	Crates, Wood, Lumber and Plywood Sheathed, Nailed and Bolted
MIL-P-116	Preservation, Methods of
MIL-W-5088	Wiring, Aerospace Vehicle
MIL-P-5518	Pneumatic Systems, Aircraft, Design and Installation General Specification For
MIL-T-5842	Transparent Areas, Anti-Icing, Defrosting, and Defogging Systems, General Specification For
MIL-E-6051	Electromagnetic Compatibility Requirements, Systems
MIL-P-8564	Pneumatic System Components, Aeronautical, General Specification For
MIL-S-8879	Screw Threads, Controlled Radius Root With Increased Minor Diameter, General Specification For
MIL-L-10547	Liners, Case, and Sheet, Overwraps, Water Vaporproof or Waterproof, Flexible
MIL-B-18927	Environmental Control Systems, Aircraft, General Requirements For
MIL-B-81365	Bleed Air Systems, General Specification For

2.1.1 (Continued):

STANDARDS

MILITARY

MIL-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-280	Definitions Of Item Levels, Item Exchangeability, Models and Related Terms
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements For the Control of Electromagnetic Interference
MIL-STD-470	Maintainability Program Requirements (For Systems and Equipment)
MIL-STD-471	Maintainability Demonstration
MIL-STD-704	Aircraft Electric Power Characteristics
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-1186	Packaging and Packing for Overseas Shipment General Specification
MIL-STD-2069	Requirements For Aircraft Nonnuclear Survivability Program
MIL-STD-2073-1	DOD Material Procedures For Development And Application Of Packaging Requirements
MIL-STD-2089	Aircraft Nonnuclear Survivability Terms

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the DODSSP-Customer Service, Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

PUBLICATIONS

Navy Department Specification

SD-8706	Data And Tests, Engineering Contract Requirements For Aircraft Weapon Systems

(Copies of documents are available from the Navy Aviation Supply Office, Code 03443, 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents, drawings, and publications: The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

UNITED STATES GOVERNMENT PRINTING OFFICE

GPO Style Manual

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402-0001.)

PUBLICATIONS

DEPARTMENT OF TRANSPORTATION/FEDERAL AVIATION ADMINISTRATION HANDBOOKS

DOT/FAA/CT-88/8-1 Aircraft Icing Handbook Volume 1
DOT/FAA/CT-88/8-2 Aircraft Icing Handbook Volume 2

(Unless otherwise indicated, copies of the above handbooks are available from U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.)

2.2 Non-Government publication:

The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D3951 Packaging, Commercial

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence:

In the event of conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS:

3.1 First article:

When specified (see 6.2) a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.4.2.

3.2 Component design:

All pneumatic components used in the system shall conform to the design and operating requirements as specified in MIL-P-8564.

3.3 Material:

Materials for deicing components shall be in accordance with the aircraft detailed specification. For any material used which is not covered in the aircraft detailed specification, the manufacturer may use his material with the approval of the contracting activity.

3.4 Icing conditions:

The atmospheric conditions for icing occurrence shall be those as specified in MIL-T-5842.

3.5 Threads:

Threads used on the deicing components shall be in accordance with MIL-S-8879. Pipe threads shall not be used.

3.6 Environment:

All components used in the system shall operate without system failure or performance degradation in all the environments for which the aircraft is designed. Any equipment installed in locations where explosive vapors may exist shall be safe for operation in this location.

3.7 Design and construction:

3.7.1 Deicing boots: The deicing boots shall be designed with pneumatically inflated tubes which, when fully expanded, shall not distort the outer surface of the wing such that excessive transient aerodynamic degradation is incurred or cause the formation of an unstable turbulent boundary layer (see Figure 1). Inflatable boots shall be designed to operate at extremes of design pressure ± 10 percent and shall be able to extend chordwise or spanwise along the leading edges and fillets of the wings, fins, stabilizers, radio masts, radomes, and scoops. Typical installation of deicing boots are shown in Figure 2, and Figure 3 for fixed wing and rotary wing aircraft.

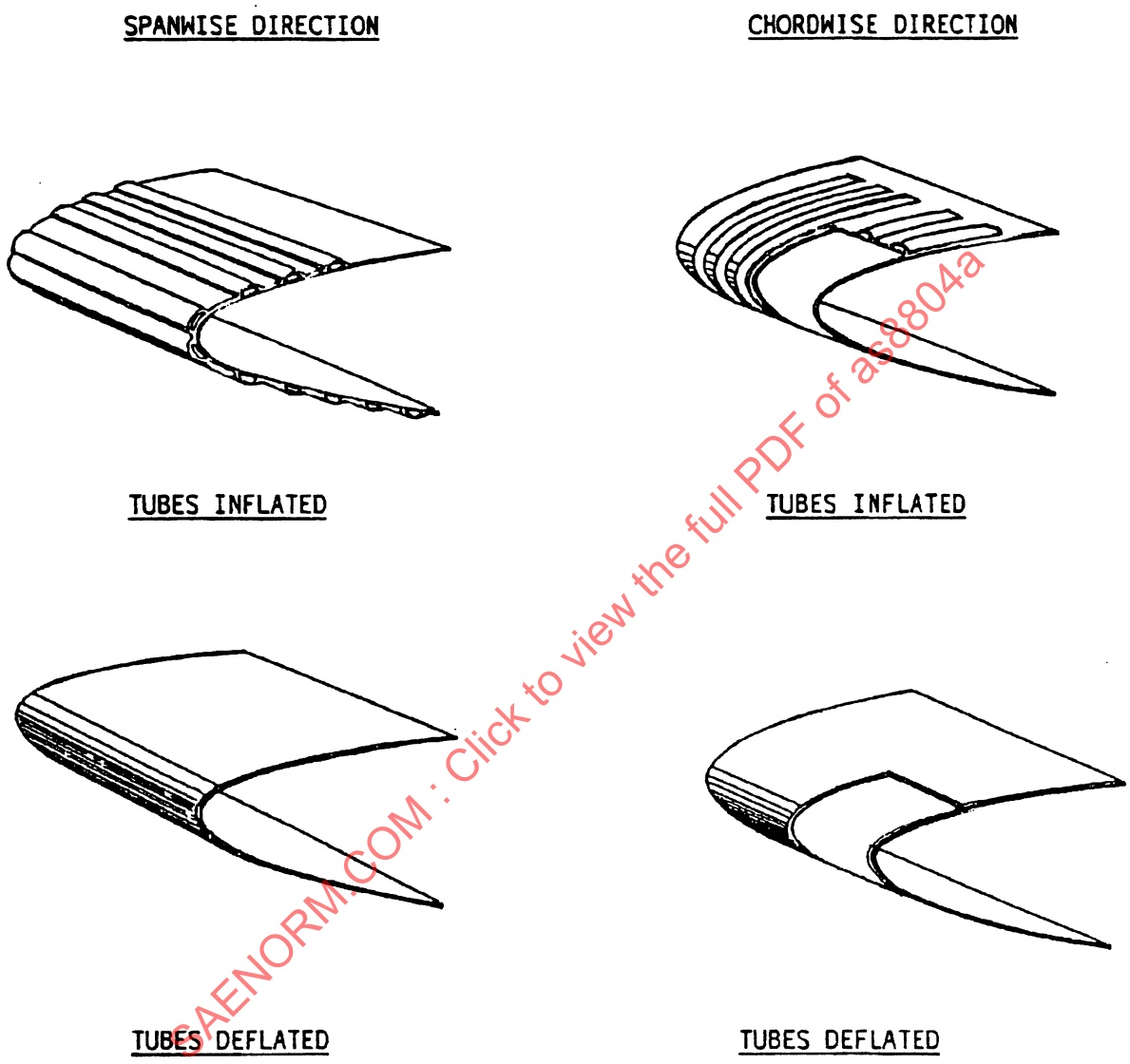

FIGURE 1. Inflatable deicing tubes.

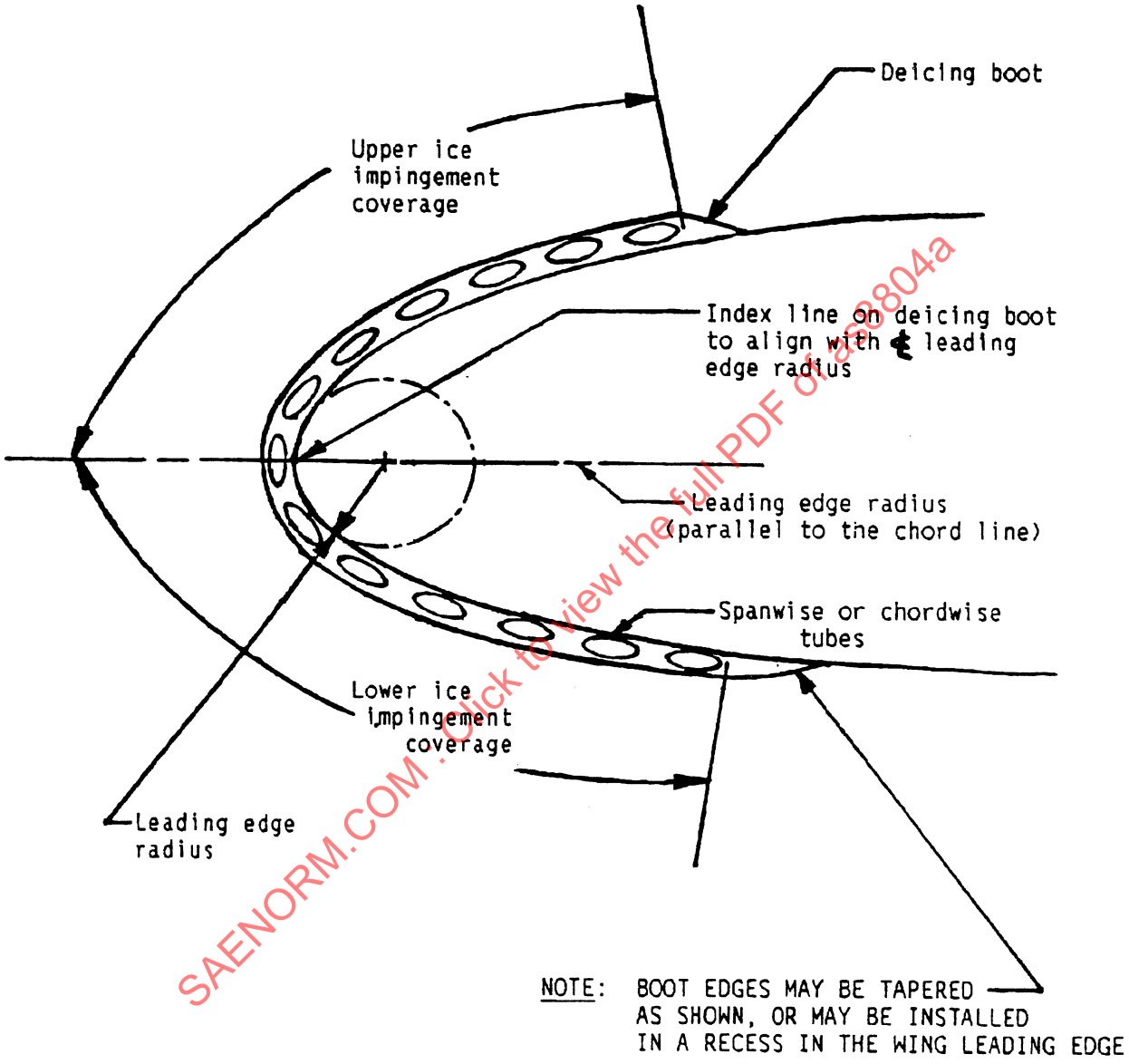

FIGURE 2. Typical deicing boot installation fixed wing aircraft.

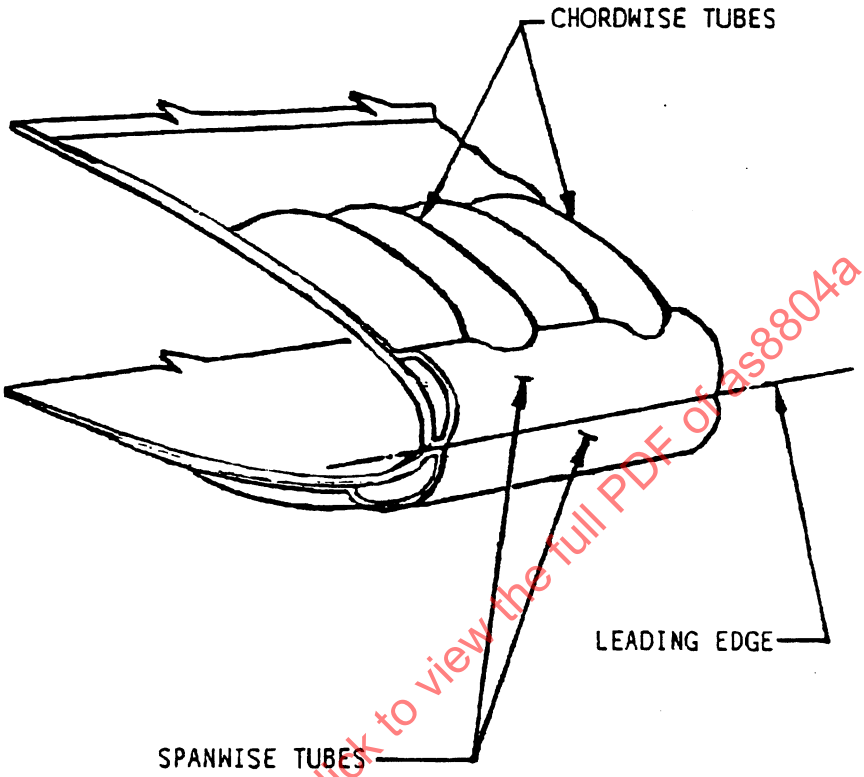

FIGURE 3. Rotorcraft blade pneumatic boot rotary wing aircraft.

3.7.2 Air and vacuum source: An air, and if required, a vacuum source shall be provided which will meet the pressure and vacuum requirements of the deicing boot on the aircraft. When a separate air pump is used, it shall operate the boot deicing system at the design pressure from sea level to 25,000 feet. In turbo-propeller or turbojet aircraft, the engine compressor air may be used as the pressure source and air from the same pressure source used in an ejector to provide the required vacuum. A heat exchanger consisting of the pressure manifold itself, shall be provided when required to prevent allowable boot inlet air temperature being exceeded above the maximum operating temperature. The air source system shall be in accordance with MIL-E-18927 for air distribution and MIL-B-81365 for compressor bleed air.

3.7.3 Electrical power: Electrical power required in the operation of the deicing system shall be in accordance with the aircraft electrical system specification.

3.7.3.1 Electromagnetic compatibility: The electromagnetic emission and susceptibility requirements for electronic equipment and components installed in deicing systems aboard aircraft and aircraft ground interface equipment shall be in accordance with the aircraft specification. Electromagnetic emission and susceptibility requirements shall be in accordance with MIL-STD-461 part 2, category A1b and A1c respectively.

3.7.3.2 Electrical wiring: All electrical wiring for deicing equipment shall be in accordance with the aircraft specification.

3.7.4 Valve safety: A safety valve, or valves, shall be installed to prevent damage to the deicing system in the event of failure of the pressure regulating valve. The safety valves shall be set to relieve pressure no more than 10 percent above normal operating pressure of the deicing system.

3.7.5 Valve check: On multiengine aircraft, check valves shall be installed in the manifolds or compressor bleed lines to ensure the operation of the deicing system in the event of engine failure.

3.7.6 Valve regulating and unloading: The predetermined pressure shall be regulated to vary not more than 1 percent of the operating pressure. The capacity of the unloading valve shall be sufficient to dump overboard the output of the pump when the engine is operating at takeoff rpm. The pressure regulating valve in a turbo-compressor bleed-type system shall not incorporate dump provisions.

3.7.7 Valve distribution: The distributor valve, or valves in the case of a manifold-type system, shall operate instantaneously and shall be able to operate at the operating pressure with a minimum of pressure drop.

3.7.8 Valve vacuum relief: On a system which uses the intake side of the air pump compressor as the vacuum source, a vacuum relief valve shall be provided with sufficient capacity to regulate the vacuum pressure to 1.5 percent of the design value when the engine is operating at takeoff rpm. When the vacuum is provided by an ejector, a vacuum relief valve is not required.

3.7.9 Valve selection and installation: All valves used in the deicing system shall be selected and installed in accordance with MIL-P-5518.

3.7.10 Timer: The timer shall be installed in the deicing system to automatically control of the deicing boot (see 3.11). The time required to inflate and deflate the pneumatic tubes shall be as rapid as possible in order to minimize the effects on the aerodynamic performance.

3.7.11 Oil separator primary and secondary: The pneumatic boot deicing systems shall have a primary and secondary oil separator. The primary oil separator shall remove 75 percent of the oil from the air and shall return the oil to the engine sump. The secondary oil separator shall remove the remaining oil from the system. The requirement for an oil separator in a turbo-compressor bleed system shall be individually determined for each application.

3.7.12 Test connection: A test connection, or connections, shall be provided in the deicing system for ground checking.

3.7.13 Instruments: A pressure and vacuum indicator (multifunctional displays) for the deicing system shall be provided in aircraft for the pilot and crew members. When these indicators are mounted in a pressurized compartment, the indicator (functional display) shall measure the difference between system pressure and ambient.

3.8 Component coverage:

Deicing boot coverage shall extend along the leading edge of the components to be deiced including root and fairing areas. The entire empennage leading edge surface shall be protected by deicing boots. In cruise condition, fixed wing chordwise coverage shall be not less than 15 percent on lower surfaces and 5 percent on upper surfaces except in locations where it is impracticable because of leading edge cutouts or other interfering structure. For propellers and rotors, the deicing boot coverage ranges 10 percent upper and 24 percent lower of the surface areas of propellers. Detailed airfoil coverage for a specific shape component shall be calculated by a droplet trajectory and impingement analysis.

3.9 Attachment:

Deicing boots shall be attached to the surfaces of the aircraft by an adhesion system. The adhesion material used shall permit the removal of the deicing boots without damage to the aircraft.

3.10 Boot thickness:

The thickness of the boot shall be designed such that design complexity and interference is minimal. The boot and deicing component leading edge surface interface shall be a smooth transition and shall be less than or equal to 60 percent of aerodynamic displacement thickness at that chordwise and spanwise location. Deicing boots shall be designed to withstand an internally applied pressure of 25 percent above the normal design pressure without distortion, blowout, or any damage.

3.11 Controls:

The pneumatic boot system shall inflate and deflate rapidly in order to function effectively and minimize deicing system performance degradation. The system shall be controlled by a three position switch with "OFF", "MANUAL", and "AUTO CYCLE" modes of operation. When the switch is in the manual position, all boots shall inflate and shall remain inflated until the switch is released. When the "AUTO CYCLE" position is selected, an electronic timer shall be installed to control the inflation, deflation, timing and sequence of the system. For fixed wing aircraft, the time to reach full pressure shall be 6 seconds. During moderate icing a 60 second cycle shall be used, while for light icing, longer accretion times of 3 to 4 minutes shall be used. For rotorcraft the boot inflation time shall be 2 seconds.

3.12 Reliability:

The deicing system reliability is an integral part of the reliability requirements of the total air vehicle. The overall system reliability program shall be in accordance with MIL-STD-785. Component or subsystem performance reliability is impacted by basic design, material selection, production processing, installed environment, subsystem or component interfaces and maintenance. Therefore, all modes of failure shall be anticipated and analyzed.

3.13 Air filter:

The pneumatic boot deicing system shall include air filter to remove debris for safe operation of the deicing boot without damage. Filter selection and installation shall be in accordance with MIL-P-5518.

3.14 Weight:

The weight of pneumatic components installed in aircraft deicing system shall be as light as the function and design parameters permit. The distribution of system weight shall not significantly affect the aircraft balance and the total weight of the deicing boot shall not cause any design performance degradation of the aircraft.

3.15 Maintainability:

All parts which require periodic inspection or replacement shall be accessible for inspection and readily removable to facilitate maintenance. The deicing system maintainability requirements shall be integrated with the overall system maintainability programs and shall comply with the requirements of MIL-STD-470. Details relating to component and subsystem performance maintainability demonstration shall be in accordance with MIL-STD-471. Deicing system components shall be designed for adjustment and repair at the lowest level of maintenance.

3.16 Survivability:

The deicing system shall be capable of operating and maintenance functions performed in radiological, biological, and chemical environments. External and internal surfaces shall be resistant to chemical reaction and the adherence or absorption of contaminants. General aircraft combat survivability guidelines are provided in MIL-STD-2069 and MIL-STD-2089.

3.17 Performance:

Deicing boot systems when installed in the aircraft shall operate with the aircraft at rest, taxiing, takeoff, landing, or in flight, under the following conditions:

a. When installed in single engine aircraft with the engine operating at 50 percent cruise manifold pressure and with the engine operating at maximum endurance rpm.

b. When installed in twin engine aircraft with one engine operating and the other engine at rest.

c. When installed in aircraft equipped with four or more engines with any of the two engines operating.

d. The operation of the boots, when pulsating, shall not affect the stall characteristics or handling characteristics of the aircraft during takeoff, landing, cruise, or high-speed conditions.

3.18 Identification of product:

The deicing equipment, assemblies and parts shall be marked for identification in accordance with MIL-STD-130. The following special characteristics shall be added:

(a) Model airplane.

(b) Date of manufacture of the model airplane.

3.18.1 Marking method: Marking shall be impressed or embossed in a location where markings shall remain visible after the component is installed.

3.18.2 Markings: All deicing components shall be marked with the manufacturer's name or trademark, the material identification code and complete part number as detailed in the applicable specification sheet. If space permits, the manufacturer's part number and the manufacturer's CAGE code shall be marked to ensure positive identification.

3.19 Part numbering of interchangeable parts:

All parts having the same design activity, Contracting and Government Entity (CAGE) code and part number shall be interchangeable as defined in MIL-STD-280. The item identification and part number requirements of MIL-STD-100 shall govern the design activity part numbers and changes thereto.

3.20 Engineering drawings:

Engineering drawings covering the design and installation of deicing boots including detailed sectional drawings, calculation, weights, and related equipment shall conform to the requirements of MIL-STD-100 (see 6.3).

3.21 Workmanship:

The pneumatic boot used in the deicing system, including all parts and assemblies shall be fabricated and finished with the accuracy of dimensions shown in the detailed applicable specification and drawing. The adhesion surfaces of the boot shall be smooth, clean, and dry and shall be readily available to install in the aircraft.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract, the contractor 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance: All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections:

The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.4).

b. Quality conformance inspection (see 4.5).

4.3 Inspection conditions:

Unless otherwise specified in the contract, all inspections shall be performed in accordance with the test conditions specified in 4.4.3.

4.4 First article inspection:

4.4.1 Sampling instructions: The first article samples shall consist of a representative item of each item of equipment used in the system.

4.4.2 First article tests: The first article tests shall be conducted in accordance with the demonstration tests 4.4.2.1, the system performance tests 4.4.2.2, and the environmental tests 4.4.3.

4.4.2.1 Demonstration tests: The demonstration tests shall be performed to demonstrate ice removal under conditions specified in 3.4. The demonstration tests shall include ground tests and flight tests as specified in 4.6 and 4.7 (see 6.3).

4.4.2.2 System performance tests: The contractor shall develop a detailed test plan and the performance of deicing system component shall be tested prior to installation in aircraft. Air flows, pressures, and temperatures shall be recorded under simulated flight conditions (see 6.3). The system test data shall be compared to the system design analysis. All discrepancies shall be resolved to the extent that the analytical system performance and laboratory test data are in reasonable agreement and demonstrate the performance requirements have been achieved.

Tests (per DOT/FAA/CT-88/8-2	Test methods (reference tables)
Fixed wing aircraft	4.1
Engine induction system	4.2
Turbojet jet engine	4.3
Model icing test	4.4
All weather systems	4.6
Airframe icing test	4.7
Engine inlet icing test	4.8
Aircraft and engine icing test	4.10
Engine nacelle icing tests	4.12
Wind boot certification (pneumatic boot system	4.14

4.4.3 Environmental tests: The following environmental tests shall be performed in accordance with MIL-STD-810 (see 6.3):

a. High temperature, Procedure I, Method 501.3.

b. Low temperature, Procedure I, Method 502.3.

c. Humidity, Procedure I, Method 507.3.

d. Altitude, Method 500.3.

e. Salt spray, Procedure I, Method 509.3.

f. Vibration, Procedure I, Method 514.4.

g. Fungus resistance, Procedure I, Method 508.4.

h. Sunshine, Procedure I, Method 505.3 (applicable only to boots).

i. Explosive atmosphere, Procedure I, Method 511.1.

j. Gunfire, Procedure I, Method 519.2.

k. Shock, Procedure I, Method 516.2.

l. Leakage, Procedure I, Method 512.2.

m. Rain, Procedure I, Method 517.1.

4.5 Quality conformance inspection:

The quality conformance inspection shall be conducted on each deicing boot system component in accordance with the system performance tests (see 4.4.2.2) and the environmental tests (see 4.4.3). In addition, component installation shall be visually inspected to ensure fabrication and assembly are constructed in accordance with approved engineering design and meet the requirements of this specification.

4.6 Ground tests:

Ground tests of the deicing system shall be conducted with the airplane at rest, using the design pressure and a suction of at least 4 in. Hg to demonstrate safe operation of the deicing system for flight test as specified in 4.7 and control system operation as specified in 3.11. The systems shall also be checked for leaks by inflating deicing tubes to the design pressure. The pressure shall not decrease by more than 30 percent of the design pressure in 1 minute with the pressure source disconnected and the system sealed (see 6.3).

4.7 Flight tests:

Tests shall be conducted as part of the flight test program of the aircraft on which the boots are installed, to evaluate the effect of the boot system operation on performance and handling characteristics of the aircraft. The handling characteristics of the aircraft at various gross weights (including maximum gross weight) during takeoff, landings, cruise, and at high speed conditions shall be demonstrated. Operation of the boots shall not cause adverse effect on the performance of the aircraft. The stall speed of the aircraft shall be substantially the same with or without the boots pulsating. The deicing boot system shall be observed during flight in regard to the rate of cycling and uniformity of tube inflation under the conditions specified in 3.17 (see 6.3).

4.8 Inspection of marking and packaging:

Except when commercial packaging is specified, the sampling and inspection of preservation and interior package marking shall be in accordance with groups A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing for shipment and storage shall be in accordance with the quality assurance provisions of the applicator container specification shown in section 5. The inspection of marking for shipment and storage shall be in accordance with MIL-STD-129 (see 6.2).

5. PACKAGING:

5.1 Preservation:

Preservation shall be Level A or Commercial as specified in MIL-STD-2073-1 (see 6.2).

5.1.1 Level A:

5.1.1.1 Cleaning: All parts shall be free from grease, oil, dirt or any other foreign material. Any process or combination of processes that will accomplish thorough cleaning without damage to the parts shall be acceptable.

5.1.1.2 Preservative: Preservation for deicing boots shall be in accordance with MIL-P-116, basic method II, submethod IIb.

5.1.1.3 Drying: Deicing boot shall be dried in accordance with MIL-P-116.

5.1.2 Commercial preservation: Commercial preservation shall be in accordance with ASTM D3951.