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AEROSPACE RECOMMENDED PRACTICE

SAE ARP1971 REV. A

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Submitted for recognition as an American National Standard

Aircraft Deicing Vehicle - Self-Propelled, Large Capacity

1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) covers requirements for a self-propelled, boom type aerial device, equipped with an aircraft deicing fluid spraying system. The unit shall be highly maneuverable for deicing all exterior surfaces of wide-body and smaller commercial jet aircraft, e.g., B-747 to Fokker F28 and BAC-111. The vehicle will also be used for aircraft maintenance and inspection. The vehicle shall be suitable for day and night operations.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP1247	General Requirements for Aerospace Powered Mobile Ground Support Equipment
ARP1328	Aircraft Ground Support Equipment Vehicle Stability Analysis
ARP1838	Pictograms for Ground Support Equipment
ARP4737	Aircraft Deicing/Anti-Icing Methods with Fluids, for Large Transport Aircraft
ARP5058	Enclosed Operator's Cabin for Aircraft Ground Deicing Equipment
AMS 1424	Aircraft Deicing/Anti-Icing Fluids, Newtonian, Type I
AMS 1428	Aircraft Deicing/Anti-Icing Fluids, Non-Newtonian, Type II, III, and IV

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2.2 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI A92.2 For Vehicle-Mounted Elevating and Rotating Aerial Device

2.3 OSHA Publications:

Available from OSHA, 200 Constitution Avenue, NW, Washington, DC 20210.

Safety and Health Standards 29 CFR 1910

2.4 ISO Publications:

Available from International Organization for Standardization, Case Postale 56. CH-1211 Geneve 20, Switzerland

ISO 11075 Aerospace - Aircraft de-icing/anti-icing Newtonian fluids, ISO type I
ISO 11076 Aerospace - Aircraft de-icing/anti-icing methods with fluids
ISO 11077 Aerospace - Self-propelled de-icing/anit-icing vehicle - Functional requirements
ISO 11078 Aerospace - Aircraft de-icing/anti-icing non-Newtonian fluids, ISO type II (III, IV will be added)

2.5 Other Publications:

CSA (Canadian Standard Association) CSA C-225 Vehicle-Mounted Aerial Devices

NFPA 70 - National Fire Protection Association Electrical Code

prEN 1915-1 Aircraft Ground Support Equipment General Requirements, Part 1: Basic Safety Requirements

prEN 1915-2 Aircraft Ground Support Equipment General Requirements, Part 2: Stability and Strength Requirements, Calculations and Test Methods

prEN 280 Mobile elevating work platforms - Design calculations - Stability criteria - Construction - Safety - Examinations and Tests

IATA AHM 975 Functional Specifications for an Aircraft de-icing/anti-icing vehicle

ATA. 101 Specification for Ground Equipment Technical Data

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3. TECHNICAL REQUIREMENTS:

3.1 General Description:

The unit shall consist of a suitable self-propelled chassis, an aerial device with personnel basket constructed and mounted in accordance with national safety standards, fluid supply tanks, a fluid pumping system, and an enclosed flame combustion heater(s) for applying heated water or heated deicing fluid to all necessary aircraft surfaces. An auxiliary engine will power the spraying system, the aerial device and the heater(s), or these systems shall be driven by the propulsion engine directly or through one or more power takeoff (PTO) devices which provide power from the chassis propulsion engine. All major items shall be enclosed in a compartmentalized body meeting recognized appearance and functional standards of the truck body industry.

3.2 Basic Performance Features:

3.2.1 The primary function of the vehicle shall be to apply heated water and/or deicing fluid mixtures from a variable height boom to the surfaces of stationary aircraft while traversing their perimeter. A hose stored in a compartment shall also be fitted for ground use. The vehicle shall be acceptable for use around terminal gate areas, airport service roads, and aircraft service ramps.

3.2.2 The unit design must provide a safe and stable configuration for maneuvering about the aircraft with the boom in any possible position at speeds up to 6 km/h (4 mph) with fluid and fuel tanks at minimum, one-half, and maximum operating levels. A 40 km/h (25 mph) speed shall be safe and achievable with fluid tanks at maximum levels. A speed of at least 80 km/h (50 mph) (or 72 km/h (45 mph) for a diesel chassis) with fluid tank(s) at minimum levels may be specified as an option (see 3.9.29).

3.2.3 The aerial device, when extended, shall provide a basket floor-to-ground height of at least 12.2 m (40 ft) and shall be extendable out to either side of the deicer to at least 8 m (26 ft) as measured from the centerline of rotation to the forward edge of the basket or the nozzle in the case of a turret or boom type of nozzle. The personnel basket capacity shall be at least 204.1 kg (450 lb) (Europe-200 kg) with a 122 cm x 61 cm (48 in x 24 in) (Europe-120 cm x 60 cm) floor area to accommodate two standing persons. Alternatively, an enclosed operator's cabin may be provided.

NOTE: The regulations of some countries may require a basket capacity in excess of 204.1 kg (450 lb).

3.2.4 The deicing fluid system shall provide a delivery rate at the personnel basket spray nozzle of at least 151 Lpm (40 gpm) at minimum pre-nozzle discharging pressure of 690 kPa (100 psi), with the boom fully elevated.

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3.2.5 The deicing fluid supply tank(s) shall be constructed of noncorroding material which is able to withstand temperatures of at least 96 °C (205 °F). The minimum total tank capacity shall be 6810 L (1800 gal). The option of a Type II, III, and IV anti-icing system may be required (see 3.9.1). The option of a 3-way split of the tank(s) allowing for a Type I or Type II, III, and IV/water variable proportioning system in addition to the Type II, III, and IV system may also be required (see 3.9.2 and 3.9.3).

3.2.6 The deicing fluid system shall be designed to withstand fluid temperatures of -40 °C (-40 °F) to 96 °C (205 °F).

3.2.7 An enclosed flame internal combustion type heater(s) with an automatic safety control system(s) shall be capable of raising the temperature of the maximum deicing fluid tank capacity of pure water (for test and demonstration purposes) from 2 °C (35 °F) to 82 °C (180 °F) within 1 h or less. Alternatively, if the heating system is a fast heating design, it should heat pure water from the deicing tank at a minimum rate of 151 Lpm (40 gpm) from 2 °C (35 °F) tank temperature to 82 °C (180 °F) nozzle temperature within 5 min or less from the time of starting the heater. This type of system should be able to supply a sufficient amount of fully heated fluid to complete normal deicing operations.

3.2.8 Power distribution shall be so arranged that vehicle propulsion, fluid spraying, boom positioning, and fluid heating may be accomplished simultaneously with no detrimental effect upon any operation.

3.2.9 A separate engine shall be provided to drive the fluid, blower, and hydraulic pumps on all vehicles using a standard truck chassis. Alternatively, all hydraulic, fluid, heater, and electrical systems should be driven by a PTO(s) or hydraulics on the propulsion engine. In this type of system, the vehicle drive system should be devised so that appropriate engine speeds can be maintained during deicing without regard to vehicle speed (e.g., hydraulic vehicle drive).

3.2.10 Sufficient fuel tank capacity is required for all engines and heater(s) for continuous deicing operation for a minimum of 4 h without refueling, including at least two complete duty cycles of filling, heating fluid as per 3.2.7, deicing, and returning to the fill station. The design shall provide 7.5 to 19 L (2 to 5 gal) of usable fuel for the auxiliary engine after the supply is depleted for heater(s). The design shall provide for the shutdown of the heater(s) first. The propulsion engine should have a separate fuel tank (or stand pipe in a common fuel tank) of sufficient size to allow for 4 h of continuous deicing operations. An option for a larger tank allowing 8 h of continuous deicing operations may be required. The vendor shall supply calculations on the specific fuel consumption at rated output for each engine and the fluid heater(s) on request.

3.2.11 Operation of the spray fluid system shall not be contingent upon operation of the heater(s). Operation of the elevating boom and vehicle propulsion shall not be contingent upon operation of the fluid spray system. Operation of the boom elevation, fluid spray, and heater systems shall not be contingent on operation of the vehicle propulsion engine unless the vehicle engine is the only power source.

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3.3 Chassis Description:

3.3.1 The chassis shall be a standard, current truck model offered by a leading automotive manufacturer or a custom chassis designed for the requirements of a deicing vehicle.

3.3.2 The vehicle driver shall be located at the left side of the chassis and shall have the maximum unobstructed view of the operator and basket under all operating conditions. The left side (looking forward) shall normally be considered as the working side for location nearest to the aircraft being serviced and contain external instruments and controls.

NOTE: The above may be reversed for countries that drive on the left-hand side of the road.

3.3.3 The chassis shall include an enclosed, heated cab for the vehicle driver and a passenger.

3.3.4 The vehicle shall be of minimum overall length and width, consistent with stability requirements. Maximum width shall be limited to 2.44 m (96 in) and maximum height limited to 3.89 m (12 ft 9 in), or as allowed by local regulations.

3.3.5 In addition to standard truck cab equipment (heater/defroster, lights, electric wipers and washer, rear view mirrors, etc.) the roof of the cab shall be fitted with a 91 cm x 46 cm (36 in x 18 in) or larger observation window and electric wiper. This shall be located for overhead viewing from the driver's position.

3.3.6 The vehicle drivetrain shall be equipped with an automatic transmission or a hydraulic drive.

3.3.7 Power steering and power assisted dual braking system shall be provided.

3.3.8 The parking brake shall be applied by an over center operated lever, a foot operated ratchet, or spring set mechanism released by hydraulic or air pressure.

3.3.9 The standard chassis shall be rated to sustain loads imposed by the vehicle at speeds up to 40 km/h (25 mph) with the fluid tanks at minimum and maximum levels. If speed capability is specified (see 3.9.29), the chassis shall be rated to sustain the loads imposed by the higher speed capability.

3.3.10 Tow hooks shall be installed on the chassis structure, or on suitable members attached directly to the chassis; two at front (one on each side of the chassis centerline), and one at rear.

3.3.11 Snow/mud tread tires shall be provided on drive wheels.

3.3.12 Storage batteries shall be of the heavy-duty type. Vehicle electrical system shall be based on 12 V DC or 24 V DC. Fluid heater circuits shall be 120 V AC or 240 V AC, 12 V DC or 24 V DC.

3.3.13 Alternators shall be installed that supply 100% of the maximum vehicle steady electrical load capable of being imposed at engine idle rpm plus a 1 A minimum additional charge capacity.

3.4 Aerial Device Description:

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3.4.1 The aerial device and its installation on the vehicle must conform to all national safety and stability regulations in all respects other than electrical insulation requirements. Boom elevating, telescoping, and basket leveling hydraulic cylinders shall be equipped with pilot operated check (or holding) valves mounted directly to the base of the cylinders to prevent inadvertent boom lowering from a hydraulic system pressure loss. All pivot points shall have easily accessible grease fittings or have self-lubricating type bushings. The personnel basket shall have a self-adjusting mechanism to maintain a vertical attitude for all boom positions. Outriggers or other ground contact devices shall not be required to obtain the specified stability.

3.4.2 The vehicle and boom shall remain stable, on level ground, with the fluid tanks empty, fuel tanks empty, hydraulic and engine oil at minimum safe levels, the boom at any attitude, basket loaded at maximum rated capacity, and a 75 km/h (46 mph) wind from any direction. Spring lock out devices or torsion bar systems may be utilized to maintain stability when boom is elevated, if required. The deicer must also remain stable in the same condition, zero wind and any one tire flat (unless nonpneumatic or foam filled tires are used). See also ARP1247and ARP1328.

3.4.3 Boom rotation shall be achieved by a turret, mounted on the chassis, which swings through a 180° arc in either direction. The turret shall be mounted on a circulating ball turntable bearing, with accessible grease points. Alternatively, a fixed boom may be employed with a highly maneuverable vehicle which provides similar operational flexibility.

3.4.4 The aerial basket shall be designed to position an operator to effectively apply fluid to the upper areas of aircraft control surfaces, wings, empennage, and fuselage.

3.4.5 Stability and safety shall be paramount in the boom and basket design. Operation of the boom and its controls shall be smooth and positive.

3.4.6 Aerial Device Safety Factor Design Requirements: Manufacturers may use Method A and/or Method B

Aerial Device Safety Factor Design Requirements-Method A:

Design requirements for the aerial device shall be in accordance with ANSI 92.2. The design requirement shall include a minimum dynamic safety factor of 2:1 (based on yield strength for ductile materials). The following dynamic loading conditions shall apply:

- Vehicle driving over a test fixture (defined below) at a speed of 6 km/h (4 mph) with any axle in forward and reverse directions.

- Vehicle driving at a speed of 6 km/h (4 mph) in forward and reverse directions and suddenly applying brakes to simulate emergency (panic) stops.

The dynamic loading conditions shall incorporate boom orientation and fluid tank level which generates maximum stress on the structural boom components. The basket shall be loaded at maximum rated capacity.

3.4.6 (Continued):

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Definition of test fixture:

The test fixture is defined as a device used to simulate obstacles that may be encountered on an airport ramp (e.g., wheel chocks, storm drains, fuel pit lids, snow and ice ruts, etc.). The test fixture shall be made out of wood measuring 10.2 cm (4 in) high x 15.2 cm (6 in) wide x 60.96 cm (24 in) long. The top corners shall be symmetrically cut at 45° angles along the longitudinal length of the member providing a top flat surface measuring 5.1 cm (2 in) in width. The test fixture shall be secured in such a manner that prevents sliding or overturning as the vehicle is driven over it during dynamic load testing.

Aerial Device Safety Factor Design Requirements-Method B:

The dynamic safety factor of 2:1 in Method A can be substituted with the minimum stress factor S as specified in Table 1 below.

Design calculations for the aerial device shall as a minimum include the following loads:

a. Deadweight: Weight of individual parts of the structure.
b. Payload: Weight of persons and equipment in the basket or enclosed cabin.
c. Local loads: Where specified.
d. Snow load: Weight of snow or ice on the structural parts depending on geographical area in question.
e. Dynamic forces
    1. Secondary dynamic forces: Forces caused by persons in the basket or enclosed cabin.
    2. Horizontal dynamic forces: Centripetal forces caused by driving the chassis.
    3. Vertical dynamic forces: Forces caused by the movement of the aerial device and by persons in the basket or enclosed cabin.
    4. Wind load: A windspeed of 20.58 m/s (40 knots) shall be taken into account.

The established stress resulting from the multiplication of the calculated stress by the stress factor S shall not exceed the yield stress of the respective material. The stress factor S shall be as specified in Table 1.

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TABLE 1 - Stress Factors S

	Structural Members Equiv. Stress	Structural Members Normal Stress	Structural Members Shear Stress	Welds Butt Welds	Welds Fillet Welds
S	1.25	1.33	2.22	1.5	1.7

3.4.6 (Continued):

A verification of fatigue strength in respect of safety against failure under frequently repeated stresses variable with time shall be carried out for structure members experiencing numbers of stress cycles of 2×10^4 or greater.

In case of stress cycles of 2×10^4 or higher, the stress factor S as per Table 1 has to be multiplied by the fatigue strength factor D as per Table 2.

TABLE 2 - Fatigue Strength Factors D

Stress cycles	Fatigue strength factor D
$<2 \times 10^4$	1.00
5×10^4	1.10
10^5	1.20
2×10^5	1.30
5×10^5	1.45
10^6	1.55
$>10^6$	1.6

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The design verification shall include a dynamic loading condition using a test fixture as specified in Method A. The dynamic loading conditions need not take into account the secondary dynamic forces and snow load. Wind load shall be incorporated by calculation afterwards.

The design verification shall be done comparing measured stresses (with incorporated wind loads) and yield strength of the material in question. To pass the tests the minimum acceptable safety factors are as stated in Table 1. Strain Gauge verification:

Design verification of the aerial device for compliance shall be provided by the manufacturer using strain gage measurement techniques. Strain gage measurements shall include obtaining stress magnitudes from structural components on a prototype unit. How and where to mount strain gauges shall be done in accordance with recommendations from applicable industry standards.

3.4.7 The aerial basket shall be equipped with a complete set of controls which will permit the operator to move the boom and basket through any of its motions.

3.4.8 Duplicate controls shall also be provided at a location readily accessible to the driver (preferred) or in the vicinity of the boom base. The duplicate controls shall always override the basket controls.

3.4.9 All control levers shall directionally agree with boom movement as much as is practical, be of the “dead-man” type, and be large enough for grasping with a gloved hand. They shall be identified with permanent nonfading pictograms per ARP1838 or placards with descriptive wording. All basket mounted controls and switches shall be protected from fluid spray and inadvertent operation caused by snagging of clothing or contact by hoses.

3.4.10 The normal position of the personnel basket when at rest shall be forward and in front of the truck cab at ground level for optimum control and view when approaching aircraft or work area as well as for optimum ground access.

3.4.11 The basket shall be 122 cm long x 61 cm wide x 107 cm deep (48 in x 24 in x 42 in) at least, inside dimensions. The basket floor shall be covered with expanded metal or suitable equivalent to prevent ice buildup and permit moisture drainage. A nonmarking rubber bumper shall be installed on the external bottom and the bottom edges of the basket.

3.4.12 The aerial basket shall be provided with safe and easy entry and exit with positive latches on entry gates and/or retainer bars. This door or bar shall permit easy entry of an average sized operator dressed in winter protective clothing and shall open inward into the basket or shall incorporate a fixed safety bar at the height of the handrail. Attachment points shall be provided for safety harnesses/belts on the boom at basket level.

3.4.13 The basket shall be fitted with a cushioned protective "holster" for storage of the handheld spray gun, unless a turret nozzle is fitted. The holster shall be mounted on the outside of the basket, shall be of open construction to permit drainage, and shall be large enough to permit easy gun stowage and removal.

3.4.14 An emergency stop switch shall be provided in the basket to stop all boom movement and shut down fluid pumps and heater(s). See also 3.8.1.

3.4.15 Design of the aerial device and its attachment to the chassis shall be such that periodic structural inspection can readily be carried out without major disassembly.

3.4.16 An emergency hydraulic pump and motor powered by the chassis electrical system shall be provided, which will enable the aerial device and fully loaded basket to be maneuvered and lowered into the normal stowed position; in the event of auxiliary engine and/or chassis engine malfunction or shutdown. Duplicate controls shall be located at the basket position and at the base of the boom, or be readily accessible to the driver.

Additionally , it must be possible to lower the aerial device and basket from any achievable boom position to the ground safely and to such a position that the basket can be safely and easily exited by the operator(s) by releasing the pressure in the boom holding valve, either through a fixed orifice designed to limit flow to a safe rate of lowering or by means of a hand operated pump. Any manual operations to achieve this should not require the use of any tools.

3.4.17 A two-way headset communication system shall be installed in the basket and in the driver's cab. It should be heavy-duty and designed for severe weather and be audible in high noise and wind situations. It should have independent volume control at both stations and should provide continuous, hands free two-way communication.

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3.5 Fluid System Description:

3.5.1 Equipment manufacturer will generically label all fluid systems with one of the following labels: deicing, anti-icing or de/anti-icing as specified by the user. The user will be responsible for labeling the equipment with the specific fluid types and suppliers.

3.5.2 The fluid dispensing system shall provide the following features:

a. 6624 L (1750 gal) minimum total usable capacity with noncorroding tank(s) for Type I or Type II, III, and IV deicing fluid mixture. A separate Type II, III, and IV tank may be required (see 3.9.1).

b. Spray nozzles at basket location and ground level location. If a Type II, III, and IV anti-icing system is fitted, a Type II, III, and IV nozzle or other approved dispensing device shall also be provided in the basket (see 3.9.1).

c. Ground level nozzle shall dispense deicing fluid only.

3.5.3 The vehicle's fluid handling system shall be designed to be compatible with either SAE Type I or both Type I and Type II, III, and IV de-/anti-icing fluids. See 3.9.1, 3.9.3, and 3.9.4 for Type II, III, and IV fluid system requirements.

3.5.4 Fluid tanks shall be adequately baffled to prevent undue fluid motion and starving of the fluid pump during maneuvering. Return fluid shall be introduced near the bottom of the fluid tank as remote as possible from the outlet to pump. The tank and fluid system should be designed to thoroughly mix a 50% solution of SAE Type I and water, added separately, within the time it takes to heat the fluid from 15.5 °C (60 °F) to 82 °C (180 °F) heater outlet or nozzle temperature or 15 min, whichever is greater. Suitable vents, overflows, manual fill points, and liquid level gauges graduated in 500 L or 100 gal increments, shall be provided on each tank. Each tank shall be sloped or shaped for complete drainage and have a manhole with cover, in the top of the tank, for access to the interior of the tank.

3.5.5 Tank drainage fittings shall be 5 cm (2 in) minimum with valves mounted close to each tank with operating handles at the side of the truck. Valve operating handles should be located at the perimeter of the deicing vehicle. Remotely located drain valves for tanks which contain solutions that may freeze shall not be susceptible to freezing.

3.5.6 A manhole type gravity fill opening with an attached cover to alleviate rain entry shall be provided for replenishment of the tank. Adequate expansion space shall remain after filling to prevent fluid overflow or tank pressure build-up during heating.

3.5.7 The fluid pump(s) shall be self-priming and capable of running dry without damage for a period of 3 min. Suitable noncorroding strainer protection shall be installed in the pump inlet of a design preventing pump cavitation.

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3.5.8 Plumbing, pumps, heaters, valves, fittings, seals, etc. shall be compatible with the cold or heated fluids to which they are exposed. Anticipated fluid types are ethylene and/or propylene glycol base SAE Type I and Type II, III, and IV deicing/anti-icing fluids and alkaline water base cleaners. Pressure relief valves designed to prevent damage due to overpressure shall be provided on the discharge side of all pumps capable of damaging system components.

3.5.9 System design shall permit easy nonhazardous access to components for servicing or removal. Isolation shutoff valves shall be installed on the fluid tank(s) and at other locations where large spillage would occur if a line was opened.

3.5.10 The basket shall be equipped with a portable gun type spray nozzle to be held by the operator or a turret mounted nozzle. This nozzle shall be capable of applying an effective deicing fluid spray pattern to the top of the B747 vertical stabilizer [approximately 19.8 m (65 ft)].

3.5.11 The spray pattern shall vary from a fan shaped spray to a solid stream as selected by the operator. The variation in spray pattern will be accomplished by using an adjustable nozzle. The operator shall have full control of fluid flow by a nozzle rate-of-flow adjustment and a shutoff valve.

3.5.12 If the nozzle is handheld, the hose to spray gun coupling shall be of a swivel type that cannot become inadvertently disengaged while fluid is present under pressure in the fluid lines. Also, wherever practical, the fluid hoses at the basket should be connected to piping on the boom at a 90° angle to the basket so that a hose failure at the coupling would not spray deicing fluid directly at the operator.

3.5.13 The weight of the spray gun and unsupported hose shall not exceed a 15 kg (33 lb) lifting and/or reaction force (unless a turret nozzle or a turret support for the nozzle is fitted) when the gun is activated or shut off.

3.5.14 A 15.24 m (50 ft) minimum length ground hose with reel and handheld spray nozzle shall be installed and stowed in a lower compartment of the truck body for underwing and landing gear deicing. The nozzle shall be swivel mounted to the hose and provide a flow of at least 30 L (8 gal) per minute. A shutoff valve shall be installed immediately upstream of the hose.

3.5.15 The fluid heater(s) shall be suitable for continuous operation on the airport and during operation of the vehicle while in motion when deicing aircraft. The heater(s) combustion chamber(s) shall be of the closed type and shall meet the approval of the airport authorities for operation on airport areas.

3.5.16 Location of the heater(s) in the fluid system shall be downstream of the fluid pump(s) so that fluid supplied to spray nozzles can be at a combination of tank temperature plus heat rise of the fluid passing through the heater(s).

3.5.17 The fluid heater(s) shall be equipped with a suitable temperature controller to regulate the fluid temperature, depending on the setting (to a tolerance of ±3 °C), to between 77 and 93 °C (±5 °F, between 170 and 200 °F) under all operating conditions after the initial temperature is reached, at which time the heater(s) may shut down or cycle off and on as necessary. The fluid heater controls shall also incorporate a separate over temperature shutdown switch.

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3.5.18 The fluid heater(s) shall be equipped with appropriate safety devices to prevent the occurrence of conditions which might damage the equipment or create an unsafe condition. A flame detection circuit, airflow monitor, fluid flow switch, heat exhaust spark arrester and device to prevent unburned fuel accumulation are required.

3.5.19 The heater(s) shall be completely enclosed within the vehicle shroud. Appropriate shielding shall be provided for the combustion chamber.

3.6 Controls and Instrumentation:

3.6.1 A heater/auxiliary engine control panel shall be located on the exterior left side (looking forward) of the vehicle or in the truck cab.

3.6.2 A fluid pressure gauge(s) shall be provided giving fluid pump pressure for SAE Type I or Type II, III, and IV mix either in the truck cab or at an outside control panel.

3.6.3 A temperature gauge shall be provided either in the cab or visible on the left side of the vehicle, which will indicate the approximate nozzle temperature of the fluid.

3.6.4 Heater “on-off” controls and function monitoring lights shall be installed.

3.6.5 The following auxiliary engine equipment is required on the operator’s control panel:

a. Hourmeter
b. Tachometer
c. Voltmeter, or charge indicator light
d. Ammeter, or charge indicator light
e. Engine start, run, and stop switch
f. Idle and high speed control or hand throttle
g. Oil pressure gauge (and override switch if required)
h. Engine temperature gauge or overtemp indicator light
i. Lighting for all gauges and placards

3.6.6 Heater hourmeter(s) shall be provided.

3.6.7 Permanent, nonfading placards with descriptive wording or pictograms (per ARP1838) shall be provided for all operating controls, instruments, fluid filling points, electrical switches, caution signs, and operating instructions.

3.6.8 Tank fluid level gauge(s) are required. Gauge(s) shall be visible when filling tanks. Major graduations shall be marked.

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3.7 Vehicle Body Description:

3.7.1 All major components other than the aerial boom shall be enclosed in a compartmentalized body (shroud) meeting recognized appearance and functional standards of the truck body industry.

3.7.2 The shroud shall cover tank, auxiliary engine, and other major components and have the external appearance of one continuous enclosure.

3.7.3 The top surface of the shroud(s) must be strong enough to support a 113.4 kg (250 lb) person, even if it is not to be used as a platform.

3.7.4 Access must be provided for servicing and changing components. Flush mounted panel doors and latches are preferred. Such panels and doors must be securely fastened and latchable to withstand jet blasts.

3.7.5 All exposed edges (corners) of the body should be radiused in accordance with standard manufacturing practices recognized in the automotive truck industry.

3.7.6 Walkways and ladders provided on the body for operational access to boom or tank shall conform to national safety standards.

3.8 Protective Equipment and Safety Devices:

3.8.1 An emergency auxiliary engine shutdown control shall be provided which is readily accessible from the driver's position.

3.8.2 All steps and platforms shall have a nonskid self-draining surface.

3.8.3 On vehicles not equipped with integral fire extinguishers, a small, lightly spring-loaded inward-opening door shall be provided into the heater compartment to permit insertion of a fire extinguisher nozzle in an emergency.

3.8.4 The vehicle shall be equipped with devices to automatically shut down systems, especially the heater(s), whenever a hazardous or self-destructive condition occurs, such as fire or loss of fluid flow through the pump. At a minimum, the heating system shall have safety devices to shut down the heater in the event of low airflow, low fluid flow, loss of flame, or excessive fluid temperature. All of these such safety systems shall allow the deicer to be driven away from the aircraft.

3.8.5 Fluid heater(s) and engines shall produce no noticeable smoke under normal operating conditions. Fumes shall not be evident 4.57 m (15 ft) downstream from exhaust outlets in still air.

3.8.6 Two weatherproof sealed beam floodlights on universal mounts and with control switch shall be permanently installed on the basket for night operations. These floodlights shall be readily available for adjustment by the operator while in the basket.

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3.8.7 A light and “on-off” switch shall be installed to illuminate the auxiliary engine and fluid system compartment(s).

3.8.8 Combustion heaters that are equipped with hydraulic motor driven blowers shall include temperature and pressure compensated flow controls to provide speed control for the heater blower(s). Individual heater operation shall be incorporated.

3.8.9 A vehicle speed control device shall be provided to prevent the operator from exceeding 6 km/h (4 mph) when the boom is in the raised position.

3.9 Optional Equipment:

3.9.1 Type II, III, and IV Anti-Icing System: A low flow 45 to 95 Lpm (12 to 25 gpm) fluid system with a separate handheld Type II, III, and IV nozzle in the basket. The nozzle shall be of a design to allow for the minimum possible degradation of the fluid. The nozzle shall also allow for both fan and straight streams and without high pressure (below 483 kPa (70 psi)) shall deliver fluid at least 9.1 m (30 ft) horizontally from the nozzle. Alternatively, the nozzle shall facilitate coverage of the aircraft wings by a long extension. The Type II, III, and IV tank shall be between 760 and 2270 L (200 and 600 gal) and fully protected from any possibility of contamination from the Type I fluid.

If a SAE Type II, III, and IV fluid system is specified, special design requirements must be met to avoid degrading the fluid by excessive shear from relief valves, high speed pumps, improper nozzles or from contamination from corroding materials or noncompatible plastics. All piping and fittings shall be stainless steel, nonreactive plated (such as nickel or chrome), compatible plastic (avoid PVC except for low temperature applications) or hoses.

All Type II, III, and IV systems shall be tested for correct quality of sprayed fluid. The fluid must be able to meet the holdover requirements of ARP4737 when sprayed.

Pumps shall be of a positive displacement type, such as a rotary diaphragm pump, and tested for degradation of SAE Type II, III, and IV fluids under at least 483 kPa (70 psi) pressure and 68 Lpm (18 gpm) flow rate for anti-icing fluid systems. Type II, III, and IV fluid systems shall be tested under at least 1030 kPa (150 psi) pressure, 151 Lpm (40 gpm) flow, and 71 °C (160 °F) fluid temperature. All Type II, III, and IV fluid pumps shall operate on demand only, that is only while mixing, heating, or spraying. In the case of circulating/mixing pumps, the flow path back to the tank shall be open and without relief valves.

Nozzles for anti-icing systems shall be designed for low flow rates and tested for degradation of Type II, III, and IV fluids under at least 345 kPa (50 psi) pressure and 68 Lpm (18 gpm) flow rate for anti-icing systems. Nozzles for Type II, III, and IV deicing shall be tested for degradation of the fluid under at least 517 kPa (75 psi) pressure, 151 Lpm (40 gpm) flow rate, and a temperature of at least 71 °C (160 °F).

The tank(s) shall be made from compatible material(s) that are recommended by the fluid supplier for deicing fluid systems. All Type II, III, and IV systems shall be compatible with SAE Type I fluids as well as pure water for testing purposes or washing.

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3.9.2 Type I Fluid Proportional Mix System: A system to allow for the selection of mixtures between 20% Type I/80% water and 60% Type I/40% water to be sprayed from the basket nozzle. It shall have at least settings for every 10% of mix between these points. It shall also provide for spraying 0% Type I/100% water. It shall be accurate within +10% and -0% (Type I). It shall include a refractometer to verify mixture settings. It must include a purge system to protect all water piping, hoses, pumps, nozzles, and heaters that cannot be readily drained by a single valve. The ground nozzle shall spray a fixed setting of 40 to 50% Type I/60 to 50% water. The Type I fluid shall be heated by conduction through tank walls, directly by a heater with stainless steel coils or by heat exchangers. The Type I tank shall be from 1135 to 2650 L (300 to 700 gal) and shall be made from stainless steel.

3.9.3 Type II, III, and IV Fluid Pre-mix De-/Anti-icing System: A system to mix, heat, and spray SAE Type II, III, and IV deicing/anti-icing fluid from the main deicing fluid tank(s). This system shall be able to mix a 50% solution of Type II, III, and IV fluid and water thoroughly within the time it takes to heat the fluid from 15.5 °C (60 °F) to the maximum temperature setting (between 65 and 85 °C (149 and 185 °F)) as measured at the heater outlet or nozzle, or 15 min, whichever is greater. It shall be able to pump at least 151 Lpm (40 gpm) at the basket with a pre-nozzle discharge pressure of at least 517 kPa (75 psi). The nozzle shall be approved for Type II, III, and IV fluid and shall include the ability to spray fan and straight stream patterns. The entire fluid heating, pumping, and spraying system shall be designed to minimize the degradation of Type II, III, and IV fluid solutions and shall spray an acceptable quality of fluid that meets the holdover requirements of ARP4737.

This option shall not preclude the option of an anti-icing system per 3.9.1.

3.9.4 Type II, III, and IV Fluid Proportional Mixing System: A system to allow for selection of 50% Type II, III, and IV/50% water, 75% Type II, III, and IV/25% water, and 100% Type II, III, and IV/0% water (for anti-icing) to be sprayed from the basket. It shall be accurate within +10% and -0% (Type II, III, and IV). It shall include a refractometer to verify mixture settings. It must include a purge system to protect all water piping, hoses, pumps, and heaters that cannot be drained by a single valve. The ground nozzle shall at a minimum provide for a fixed setting of 75% Type II, III, and IV/25% water. The Type II, III, and IV fluid shall be heated directly by heat exchangers or by a heater. The Type II, III, and IV tank shall be from 100 to 200% of the capacity of the water tank and shall be made of stainless steel. All Type II, III, and IV systems shall be tested for correct quality of sprayed fluid. The fluid must be able to meet the holdover requirements of ARP4737 when sprayed.

3.9.5 Temperature Gauges: Measures temperature of fluid in tanks. Should provide for both the water and de/anti-icing fluid tanks if a proportional mix system is specified.

3.9.6 Meters With In-Cab Readouts: Fluid meters installed to measure the total amount of each fluid sprayed (Type I, Type II, III, and IV , and/or water) out of all nozzles with illuminated readouts in the truck cab. The readout should either be in liters or gallons and numerals should be at least 3 mm (0.12 in) high. There should be permanent nonresettable totals for each fluid as well as resettable totals. Fluid meters shall be calibrated to customer/equipment specifications.

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3.9.7 Engine Block Heaters: For cold weather starting installed on both propulsion and auxiliary engines. They shall be 110 or 220 V AC (Europe-230 V AC) and have a common plug.

3.9.8 Cold Starting System: Installed on diesel engines, chassis and auxiliary (such as ether injection). Glow plugs or thermal start system should be offered as well as an ether injection starting system as separate options.

3.9.9 Automatic Fire Extinguisher: An integral fire extinguisher system which, by automatically tripping, will discharge agent and cause the heater and the auxiliary engine (if so equipped) to shut down. Manual system activation is also required.

3.9.10 Automatic Purge: To purge water lines and heaters with a deicing fluid mix, upon unit shutdown and if approaching a freezing temperature (acceptable exception - piping within tanks - boom line may be manual).

3.9.11 Purge Alarm: An audible and/or visual alarm to be activated if the unit is shut down without purging by glycol in order to prevent damage by freezing.

3.9.12 Low Level Alarm: Audible and visual warning in cab when approaching a low tank level condition (separate indication for each tank), indicating approximately 2 min of basket spraying remaining.

3.9.13 Heater Identification Plate: States the actual J/sec (BTU/hour) heat output of the heater(s) with the normal fuel consumption figure. Fuel used must be specified.

3.9.14 Special Protective Devices: Fitted to the truck and auxiliary engines as follows:

a. Engine coolant low level engine kill switch with reset.

b. Low oil pressure engine kill switch with reset.

c. Engine coolant over-temperature engine kill switch with reset.

d. Vacuum kill switch in the suction side of the fluid pump(s) to prevent catastrophic pump failure.

NOTE: Indicator lights can be fitted to the control panel to show when a, b, c, or d has been the cause of a shutdown.

e. Starter cut-out circuit to prevent energizing the starter when engine is running.

f. Spark arrester exhaust system.

3.9.15 High Capacity Washer System: A windshield and overhead window washer and washer fluid container with a capacity of approximately 19 L (5 gal) shall be provided for the truck cab windshield and overhead observation window.

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