



# AEROSPACE RECOMMENDED PRACTICE

ARP5559™

Issued

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## Airfield Liquid Anti-Icing/Deicing Chemical Applicator to Include Carrier Vehicle

### RATIONALE

This SAE Aerospace Recommended Practice (ARP) serves as a guideline for airports that require specialized multitasking equipment to meet the snow and ice removal demands as required in their airport's published snow plan and by the FAA in AC 150/5220-30D.

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## 1. SCOPE

This equipment specification covers requirements for airfield liquid anti-icing/deicing equipment for airfield snow removal purposes. The unit shall include a combination of a carrier vehicle, liquid product tank, and dispensing system.

This vehicle as a unit shall be an integrated chemical dispensing deicing/anti-icing application system. Primary application is for the liquid chemical application for cleaning of ice and snow from airfield operational areas such as runways, taxiways, and ramp aprons.

The term "carrier vehicle" represents the various self-propelled prime movers that provide the motive power necessary to move snow and ice control equipment during winter operations.

The airport operator may require this specified piece of equipment in order to maintain the airfield during large and small snow events. When necessary, the airfield liquid anti-icing/deicing chemical applicator (ALAD) shall be a central and critical element in the winter pavement maintenance fleet in the effort to accomplish the airport's published snow plan.

This ARP defines the minimum functionality for a vehicle to be classified as an ALAD specifically as an integrated snow and ice removal system capable of performing multiple and simultaneous functions requiring no more than one operator. ALADs may be utilized to perform additional pavement maintenance tasks such as deicing or anti-icing, rubber removal, or others. If additional features are required, they must be defined by the airport operator as part of their ALAD specification. The airport operator may add to or delete from any item of this specification to meet its requirements providing there is no compromise in safety.

## 2. REFERENCES

### 2.1 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.

#### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

|           |                                                                    |
|-----------|--------------------------------------------------------------------|
| ARP1247   | Aircraft Ground Support Equipment - General Requirements           |
| SAE J185  | Access Systems for Off-Road Machines                               |
| SAE J514  | Hydraulic Tube Fittings                                            |
| SAE J516  | Hydraulic Hose Fittings                                            |
| SAE J517  | Hydraulic Hose                                                     |
| SAE J524  | Seamless Low-Carbon Steel Tubing Annealed for Bending and Flaring  |
| SAE J537  | Storage Batteries                                                  |
| SAE J931  | Hydraulic Fluid Power Circuit Filtration - Application and Methods |
| SAE J994  | Alarm - Backup - Electric Laboratory Performance Testing           |
| SAE J1292 | Automobile and Motor Coach Wiring                                  |

SAE J1503 Performance Test for Air-Conditioned, Heated, and Ventilated Off-Road, Self-Propelled Work Machines

SAE J1939 Serial Control and Communications Heavy-Duty Vehicle Network - Top-Level Document

#### 2.1.2 FAR and FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591,  
Tel: 866-835-5322, [www.faa.gov](http://www.faa.gov).

AC 150/5210-5B Painting, Marking, and Lighting of Vehicles Used on an Airport

AC 150/5210 Painting, Marking, and Lighting of Vehicles Used on an Airport

AC 150/5220-30D Airport Field Condition Assessment and Winter Operations Safety

#### 2.1.3 FMCSR Publications

Available from Federal Motor Carrier Safety Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590,  
Tel: 1-800-832-5660, [www.fmcsa.dot.gov](http://www.fmcsa.dot.gov).

Title 49, Chapter III, Subchapter B Federal Motor Carrier Safety Regulations

#### 2.1.4 NHTSA Publications

Available from National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590,  
Tel: 888-327-4236, <https://www.nhtsa.gov/>.

FMVSS 101 Controls and displays

FMVSS 102 Transmission shift position sequence, starter interlock, and transmission braking effect

FMVSS 103 Windshield defrosting and defogging systems

FMVSS 104 Windshield wiping and washing systems

FMVSS 105 Hydraulic and electric brake systems

FMVSS 106 Brake hoses

FMVSS 108 Lamps, reflective devices, and associated equipment

FMVSS 111 Rear visibility

FMVSS 113 Hood latch system

FMVSS 116 Motor vehicle brake fluids

FMVSS 119 New pneumatic tires

FMVSS 120 Tire selection and rims for vehicles other than passenger cars

FMVSS 121 Air brake systems

FMVSS 124 Accelerator control systems

FMVSS 201 Occupant protection in interior impact

|           |                                          |
|-----------|------------------------------------------|
| FMVSS 205 | Glazing materials                        |
| FMVSS 206 | Door locks and door retention components |
| FMVSS 207 | Seating systems                          |
| FMVSS 208 | Occupant crash protection                |
| FMVSS 209 | Seat belt assemblies                     |
| FMVSS 210 | Seat belt assembly anchorages            |
| FMVSS 302 | Flammability of interior materials       |

#### 2.1.5 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, [www.rtca.org](http://www.rtca.org).

RTCA DO-186 Minimum Performance Standards for Airborne Radio Communications Equipment Operating Within the Radio Frequency Range 117.975 - 137.000 MHz

#### 2.1.6 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

FED-STD-297 Rustproofing of Commercial (Nontactical) Vehicles

#### 2.2 Definitions

Refer to *Dictionary of Automotive Engineering* by Don Goodsell.

**AIRPORT LIQUID ANTI-ICING DEICING EQUIPMENT:** A liquid-dispensing device designed to melt snow, slush, and ice; and when specified, to prevent snow slush and ice from bonding to airport runway, taxiway, and ramp areas and associated pavements.

**AUXILIARY EQUIPMENT:** Any equipment, in addition to the basic chassis that is required for a piece of equipment/vehicle to perform its functions. For example, a winch would be auxiliary equipment for a tow truck.

**AXLE CAPACITY:** The allowable weight load on an axle based on supportive engineering data and the best judgment of the manufacturer of the axle.

**AXLE RATIO:** The numerical ratio of the drive shaft speed to the speed of the axle. The numerical ratio equals the torque multiplication factor of the axle.

**AXLE, DEAD:** A means of support for the wheels at each end that is non-driven.

**AXLE, LIVE:** A means of support for the wheels at each end that is driven.

**SPRAY BOOM:** A metal structure that extends from the chassis to each side which supports the plumbing and spray nozzles.

**SPRAY PATTERN:** The width, perpendicular to the chassis, of the area the covered with sprayed liquid with the spray booms in the deployed position.

**SPRAY BOOM PATTERN ADJUSTING SYSTEM:** A system for adjusting the pattern of the spray booms in both the vertical and horizontal directions.

**CAB:** An enclosed area on a vehicle designed and intended to hold and carry an operator.

**CAB CONVENTIONAL:** A cab mounted just behind the drive engine for the chassis.

**CAB FORWARD:** A cab mounted to the most forward position on the chassis.

**CAB-OVER ATTACHMENT:** A cab mounted over the front attachment.

**CAB-OVER ENGINE:** A cab mounted over the front mounted engine.

**CAN BUS:** Controller Area Network, a specialized internal communications network, interconnecting components inside a vehicle, utilizing a standard communication protocol. Interconnecting components include but are not limited to information processors for engines, transmissions, antilock brakes, lighting systems, body controllers, attachment controls, and the related sensors, servos, and user interfaces.

**CARRIER VEHICLE:** The prime mover to which a rotary snowplow, runway broom, or displacement plow is attached, or any vehicle designed and purchased for the purpose of transporting any working snow head.

**CERTIFICATION/APPLICATION APPROVAL:** Confirmation by a manufacturer or qualified expert that the unit or component fulfills the requirement of the application.

**CERTIFIED PERFORMANCE:** Written confirmation of the ability of a unit or component to performance as specified based on calculations or testing.

**COEFFICIENT OF FRICTION:** A unitless number that represents the resistance of sliding of two surfaces in contact with each other. These values should be between 0 and 1. Higher values indicate more resistance to sliding.

**CONFIGURATION:** The functional arrangement of parts or components assembled to make a working machine or apparatus.

**CURBSIDE:** The right side of the vehicle when viewed from the rear. Opposite side from roadside.

**CURB WEIGHT:** The weight of the carrier vehicle with all factory-installed and auxiliary equipment, in the travel position, full fuel tank(s), and a nominal 180-pound operator.

**“DE-CEL” TYPE CYLINDER:** A type of hydraulic cylinder designed to automatically control the speed of function as the cylinder reaches a certain point in its stroke.

**DELUGE SYSTEM:** A means of providing large amounts of fluid through high flow directional spray nozzles to windshield(s), side and rear window(s), mirror(s), and other surfaces to improve operational visibility from the cab.

**DIFFERENTIAL:** The gear assembly in the drive axle that permits one wheel to turn slower or faster than the other when negotiating a turn. The gear assembly in the transfer case that allows the front driveshaft to turn slower or faster than the other when negotiating a turn.

**DIFFERENTIAL, AUTOMATIC LOCKING:** The gear assembly in the transfer case that allows the front driveshaft to turn slower or faster than the rear prop-shaft when negotiating a turn while providing maximum driving torque to both the front and rear axles. The gear assembly on the drive axle that permits one wheel to turn slower or faster than the other when negotiating a turn while providing maximum driving torque to both wheels. Automatic locking differentials provide positive drive to both driven members while not requiring operator input or control.

**DIFFERENTIAL, MANUAL LOCKING (BEVEL GEAR):** The gear assembly on the drive axle that permits one wheel to turn slower or faster than the other when negotiating a turn. An operator-controlled provision may be offered to fully lock and unlock the differential action from the cab.

**DIMENSIONS:**

AE centerline of rear axle/tandem to the end of frame

BA bumper to centerline of front axle

BBC bumper to back of cab

CA back of cab to centerline of rear axle

CE back of cab to end of the frame (AE + CA = CE)

FH frame height from the ground to the top of frame

OAL overall length

WB wheelbase

OAH ground to top of highest point on the unit

**DRIVE FRAME:** Portion of plow support structure that attaches to the moldboard to the hitch.

**FMVSS:** Abbreviation for the Federal Motor Vehicle Safety Standards.

**FUEL CAPACITY:** The actual volume of fuel able to be stored in onboard tanks.

**GAWR:** Abbreviation for Gross Axle Weight Rating. The rating of the lowest rated member of an axle as defined by the component manufacturer(s) from the following components: tires, suspension, hubs/wheels, rims, bearings, beam, and brakes.

**GEAR RATIO:** Ratio of the speed of the input to a gear to the speed of the output from the gear. For a pair of gears, the ratio is found by dividing the number of teeth on the driven gear by the number of teeth on the driving gear.

**GEARED SPEED:** Theoretical vehicle speed based on maximum governed engine RPM, transmission gear ratio(s), driving axle ratio, and tire size.

**GEARS, SINGLE, AND MULTIPLE REDUCTION:** Single reduction gearing refers to one speed reduction through the gearing component. Multiple reduction refers to more than one step of speed reduction through the gearing component.

**GRADE-ABILITY:** The percent grade that a vehicle will negotiate.

**GVWR:** Abbreviation for Gross Vehicle Weight Rating. The sum of the Gross Axle Weight Ratings (GAWR).

**HID LIGHT:** Acronym for High Intensity Discharge light. Light created by electric arc, not a filament type light bulb.

**HITCH:** A device utilized to couple/uncouple an attachment to the carrier vehicle, then attaches to the plow drive frame.

**HORSEPOWER, GROSS BRAKE (OR ACTUAL DELIVERED HORSEPOWER):** A measure of the rate at which work is produced. The time rate of doing work, as measured by a Prony brake or dynamometer. Brake horsepower (HP) is expressed as the torque in foot-pounds times the number of revolutions per minute divided by the constant 5252.

$$\text{HP} = \frac{\text{torque} \times \text{rpm}}{5252}$$

**HORSEPOWER, GROSS:** The brake HP determined under conditions defined by dynamometer test of the stripped engine, that is, the brake HP of the engine with only those accessories and attachments necessary to the functioning of the engine during test.

**HORSEPOWER, NET:** The brake HP delivered to the clutch, or its equivalent, with all accessories and attachments functioning (including exhaust pipe, muffler, and tail pipe) which are standard or regular equipment on the engine as installed in the particular chassis. Gross horsepower less the parasitic loads.

**MAXIMUM TIRE LOAD RATING:** The load rating at the maximum permissible inflation pressure for that tire.

**MAXIMUM PERMISSIBLE INFLATION PRESSURE:** The maximum cold inflation pressure to which a tire may be inflated.

**MAXIMUM SPEED:** The highest speed at which a vehicle, with its rated payload, can be driven for an extended period on a level first-class highway without sustaining damage.

**MOLDBOARD:** Portion of the plow that moves the snow, available in many shapes and sizes, depending on the local conditions and the combination of casting or rolling of the snow that might be required. Traditionally, moldboard surfaces have been made from, but not limited to, polyurethane, steel, or stainless steel.

**MOLDBOARD OVERHANG:** The longitudinal distance between the cutting edge and the top of the moldboard. Typically, the top edge of the moldboard is forward of the cutting edge.

**MOLDBOARD PITCH:** The angle of the cutting edge in relation to the pavement.

**NHTSA:** Abbreviation for the National Highway Traffic Safety Administration.

**NEW AND CURRENT PRODUCTION COMPONENTS:** New, unused, and free of all defects and imperfections that could affect the serviceability of the finished product. Component with a manufacture date no older than 1 year prior to bid proposal.

**NEW AND OF CURRENT PRODUCTION UNIT (AS IN TOTAL UNIT CHASSIS AND ATTACHMENTS):** Unit whose manufacture (assembly of) started no earlier than the award date of the contract.

**PERFORMANCE RATING:** Capacity Rating.

**PLY RATING:** A unit of measurement used in tire construction to denote strength of tires.

**POWER TAKE-OFF (PTO):** A mechanical device used to transmit engine power to auxiliary equipment. Power take-offs can be mounted on either a main or auxiliary transmission. Front-mounted and flywheel-mounted power take-offs are also used in various applications.

**POWER TRAIN:** All the components from a power source such as an engine to the powered device such as driving wheels of a chassis or the brush shaft of the broom. This includes engines, transmissions, gearboxes, drive shafts, differentials, driving axles, hydraulic pumps, motors, and hoses.

**REFLECTORS:** Glass or plastic prism lenses which reflect light.

**RESISTING BENDING MOMENT (RBM):** A calculation used to compare frames of different section modulus and of different material. It is the product of the section modulus times the yield strength of the frame material. The formula expression is:  $RBM = \text{Section Modulus} \times \text{Yield Strength}$ .

**REVERSING:** The capability to angle or pivot the plow moldboard or rotary broom on a center axis to discharge snow to the left or right of the carrier vehicle when moving in a forward direction. Power reversing is reversing from the operator's position in the cab by use of a system such as hydraulic rams, hydraulic or electric motors, or other devices or mechanisms to change the snow discharge angle from a plow or rotary broom.

**RIM PULL:** Actual amount of effort in pounds available at point of contact of tire and road surface.

**ROAD ROLLING RESISTANCE:** Sum of the forces at the area of contact between a vehicle's tires and road surface acting against the direction of movement.

**ROADSIDE:** The left side of the vehicle when viewed from the rear. Opposite of curbside.

**ROLLING RADIUS:** Height measured from the center of the axle to the ground.

**SAFETY CUSHION DEVICE:** A component designed to absorb impact to minimize damage to the plow, pavement surface, and/or operator.

**SERIAL NUMBER:** A unique number issued to a vehicle or to a component of a vehicle for identification purposes. See vehicle identification number.

**SHOCK/IMPACT ABSORBERS:** Devices utilized to absorb impact to prevent damage to plow, pavement surface, carrier vehicle, and/or operator.

**STEERING, ALL WHEEL:** Any system that augments the steering action of a chassis, providing for power or power assisted steering controlled by the operator in the cab, on all wheels of the vehicle.

**STEERING, POWER:** A steering system which does not include a direct mechanical connection between the operator and the steering axle. This can be accomplished by, but is not limited to, hydraulic or electric means.

**STEERING, POWER ASSISTED:** Steering gear or mechanism with a direct mechanical (controlling) connection to a steering axle that has provisions for part of the force required for operation to be provided by air, hydraulic, or other means, not including mechanical leverage (longer handles).

**STOPPING DISTANCE:** The distance traveled by a vehicle from the point of application of force to the brake control to the point at which the vehicle reaches a full stop.

**STRUCTURAL MEMBER:** A part of a vehicle designed primarily to support the load of a vehicle in operation.

**SUCTION LINE:** A tubular connection between a reservoir or tank and the inlet of a pump.

**THIRD PARTY:** A disinterested party professionally qualified to conduct the test and/or record test data other than the manufacturer that is acceptable to the purchaser.

**TILT CAB:** A cab that pivots forward to gain access to the engine or other major component.

**TIRE CLEARANCE:** Space between tires and the nearest part of the body or under-structure.

**TIRE LOADED RADIUS:** The distance from the center of the wheel to the road with tire loaded to rated capacity. Static radius applies when vehicle is at rest. Rolling radius applies for a vehicle in motion. Rolling radius is usually slightly greater than the static radius.

**TORQUE:** Force having a twisting or turning effect, expressed in foot-pounds.

**TRACTIVE EFFORT:** The maximum force developed by a vehicle power train at contact between the driven wheels and road surface with 100% available traction.

**TRANSFER CASE:** Split power gear box transmitting drive to the front and rear axles.

**TRANSMISSION:** Selective gearbox providing various combinations of gear ratios.

**TRANSMISSION, AUTOMATIC:** A type of transmission designed to self-select and change gear ratios based on vehicle and engine speed.

**TRANSMISSION, HYDROSTATIC:** A type of transmission that provides gear reduction between the engine and drive wheels that uses fluid under pressure to transmit power and torque rather than mechanical components.

**TRANSMISSION, MANUAL:** A type of transmission that can function only with periodic mechanical input from an operator to select the gear reduction or drive ratio used in the transmission, and a mechanism (clutch) to disengage the power from the engine to the transmission during the mechanical shift input from the operator.

**TRANSMISSION, POWERSHIFT:** A type of transmission that can function only with periodic input from an operator to select the gear reduction or drive ratio in use in the transmission. Powershift transmissions include a device that allows the change of drive ratios or gears by means of an internal device that does not require operator action to interrupt power from the engine while changing the gear or drive ratio.

**TREAD; WHEEL TRACK:** (a) The distance between the centers of tires on the same axle at the points where they contact the road surface. Duals are measured from the center of dual wheels. (b) That portion of a tire that meets the road. (c) The pattern of the surface of the tire that meets the road.

**TRIP MECHANISM:** A method of allowing the plow cutting edge to pass over surface objects and automatically return to the original plowing position. Examples include Trip Edge design, where only the cutting-edge trips while keeping the moldboard in a fixed position; Trip Moldboard design, where the complete moldboard can rotate; and Moldboard Cushioning design, where the cutting edge and moldboard, as one, deflect rearward and/or upward.

**TRUNNION:** (a) The axis, pivot point, or center point between axles. (b) Journals allowing pivoting or turning such as a tandem axle spring or walking beam assembly. (c) The axis or pivot point of power transmission in a steerable drive axle where the turning member joins the non-turning member of the axle.

**TURNING CIRCLE, WALL TO WALL:** The diameter of a semicircle described by the outmost edge of the vehicle and/or attachment while the vehicle maneuvers through a 180-degree turn and the attachment is at its most favorable as well as its worst-case position.

**TWO-SPEED AXLE:** A driving axle arrangement whereby the driver can select one of two ratios.

**VEHICLE IDENTIFICATION NUMBER (VIN):** A unique number issued to a vehicle for identification purposes. Format and code of a VIN is prescribed by law to identify manufacturer, configuration, and date of production. A unique VIN shall be assigned for separate identification of traction drive chassis versus trailers (tow brooms) in modular configured ALAD units.

### 3. INTENT

- 3.1 The operating concept is that a single operator can operate an ALAD to spray liquid evenly on the pavement surfaces at varying rates, speeds, and widths on the go from the chassis cab.

### 4. TECHNICAL REQUIREMENTS

#### 4.1 General Description

The unit shall be self-propelled and consist of the necessary chassis configuration to provide the required maneuverability power and proper weight carrying capacity. The standard configuration consists of a chassis with the product tank mounted directly behind the cab. The spray booms mounted at the rear of the tank with the outer booms folded alongside the tank when not in use and deployed perpendicular to the vehicle when spraying.

Other attachments or components, such as snowplows, flusher nozzles, and hose reels, which aid in the snow and ice removal process may be included providing the addition of such devices do not exceed operating capacities and/or parameters of the unit.