SAE INTERNATIONAL

AEROSPACE RECOMMENDED PRACTICE

ARP5539™ REV. A

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Superseding ARP5539

Rotary Plow with Carrier Vehicle

RATIONALE

This document was issued in 2005, reaffirmed in 2013, and is now revised to provide international reference standards (versus just U.S. reference standards), to include different and more relevant quality assurance statements, and to increase performance requirements and reduce prescriptive requirements on how rotary plows with carrier vehicles needed to be manufactured to meet performance requirements.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) covers specification requirements for a rotary plow with carrier vehicle. The primary use is to cast heavy concentrations of snow approximately perpendicular to carrier vehicles across and away from airport operational areas, such as runways and taxiways. Rotary plows equipped with spot casting, or loading chutes are also used to cast snow in directions through approximately 100 degrees to the left or right of directly in front of the carrier vehicle, and also to load trucks or trailers used to haul snow away from removal area. The term “carrier vehicle” represents the various self-propelled prime movers that provide the power necessary to move snow and ice control equipment during winter operations.

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 a 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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J931	Hydraulic Fluid Power Circuit Filtration - Application and Methods
SAE J1503	Performance Test for Air-Conditioned, Heated, and Ventilated Off-Road, Self-Propelled Work Machines

2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

AC 150/5200-30	Airport Winter Safety and Operations
AC 150/5200-18	Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials
AC 150/5210-5	Painting, Marking, and Lighting of Vehicles on an Airport

2.1.3 Code of Federal Regulations (CFR) Publications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

United States of America: FMVSS

Canada: CMVSS

Other: Minimum - World Forum for Harmonization of Vehicle Regulations

49 CFR Subchapter B	Federal Motor Carrier Safety Regulations

2.1.4 Military Publications

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

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.

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

2.2 Definitions

2.2.1 AXLE CAPACITY

The allowable load on an axle based on supportive engineering data and the best judgment of the manufacturer of the axle. Usually based on all the components in an axle system, tire-wheel-bearings-spindle, etc.

2.2.2 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.

2.2.3 AXLE, DEAD

A means of support for the wheels at each end that is non-driven.

2.2.4 AXLE, LIVE

A means of support for the wheels at each end that is driven.

2.2.5 AUGER, DRUM-CUTTER TYPE

A structure used to disaggregate snow and transport it across the face of a snow blower. When used in a single-stage blower, the drum cutter also casts the snow. The helical flights of a drum cutter are affixed to a relatively large diameter cylinder, or drum, that serves as or is attached to the center axis of the auger. Drum-cutters on single-stage snow thrower rotary snow plows are also referred to as “turbines.” Drum cutter augers typically rotate on an axis perpendicular to the direction of travel.

2.2.6 AUGER, HELICAL

A structure designed to disaggregate and transport snow across the face of a snow blower, based on an open helix concept, the helix being mounted to the center axis of the auger, usually by some type of spoke arrangement. The center axis structure of a helical auger is relatively small in diameter when compared to the diameter of the helical ribbon. Helical augers typically rotate on an axis perpendicular to the direction of travel.

2.2.7 AUGER, SCREW TYPE

A screw type structure designed to disaggregate and transport snow across the face of a snow blower, the flights of which are closed and connected directly to the center axis of the auger. Several parallel screw type augers are often used together.

2.2.8 AUGER DRIVE

The auger drive is the final mechanism(s) employed to rotate the auger(s). An auger drive can be hydrostatically, hydraulically, or mechanically, or a combination of hydrostatically and mechanically. Mechanical auger drives must be protected by the inclusion of slip clutches or shear pins. Hydrostatic drives must be protected by the inclusion of pressure protection devices.

2.2.9 CAB

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

2.2.10 CAPACITY RATING

Also see performance rating. The capacity rating of a rotary snow plow is the maximum number of tons of snow a rotary snow plow can blow (see snow-blowers) or throw (see snow throwers) a defined casting distance.

2.2.11 CARRIER VEHICLE

The prime mover for a rotary snow plow. Also called chassis.

2.2.12 CASTING DISTANCE

The distance from the left to right center of a rotary snow plow to the center of the area of most concentrated snow cast observed during casting.

2.2.13 CENTER DRIVE AUGERS

Augers driven by a gear box located more or less in the center position of the auger axis in line with the center of the impeller.

2.2.14 CERTIFICATION

a. Application approval: A confirmation and testimony in writing by a qualified expert.

b. Performance: Manufacturer must provide certified, credible testing results.

2.2.15 CURB WEIGHT

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

2.2.16 DEFAULT PERFORMANCE VALUES

If a manufacturer is unable to provide third party performance testing data, the manufacturer may use the default performance values as described in the testing section of Appendix A.

2.2.17 DELUGE SYSTEM

A means of providing fluid to windshield(s), window(s), mirror(s), and other surfaces to improve operational visibility from the cab. Deluge systems shall be controlled from the operator station in the cab.

2.2.18 DIFFERENTIAL

The gear assembly on 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 drive-shaft to turn slower or faster than the other when negotiating a turn.

2.2.19 DIFFERENTIAL, AUTOMATIC LOCKING

Automatic locking differentials provide positive drive to both driven members while not requiring operator input or control.

2.2.20 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 but with provisions for the operator to fully lock and unlock the differential action from the cab. Bevel gears provide positive drive to both driven members.

2.2.21 DIMENSIONS

a. AE: Centerline of rear axle/tandem to the end of frame.

b. BA: Bumper to centerline of front axle.

c. BBC: Bumper to back of cab.

d. CA: Back of cab to centerline of rear axle.

e. CE: Back of cab to end of the frame (AE + CA = CE).

f. FH: Frame height from the ground to the top of frame.

g. OAL: Overall length.

h. WB: Wheelbase.

2.2.22 DROP BOX

A gear box (or chain box) that transmits power output to a driven implement.

2.2.23 DUAL ENGINE ROTARY SNOW PLOW

A dual engine rotary snow plow has two engines. One engine provides motive power and the other engine provides power to the rotary snow plow head. The engine providing motive power may also provide supplementary power to the rotary snow plow head.

2.2.24 EQUIPMENT, AUXILIARY

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. As another example, a snow casting or loading chute would be auxiliary equipment for a rotary snow plow.

2.2.25 FAN, FAN BLADES

See impeller, impeller blades.

2.2.26 MOTOR VEHICLE SAFETY STANDARDS

Universal guidelines for specifying design, construction, performance, and durability standards for motor vehicles and safety-related components, systems, and design features. Please see following FMVSS, CMVSS, and the World Forum for Harmonization of Vehicle Regulations

All motor vehicles that will be used, or licensed for use, on public roadways must be manufactured to local, federal, and/or state motor vehicle standards.

Vehicles that will not be used, or be licensed for use, on public highways must still be manufactured to any applicable local, federal, and/or state motor vehicle safety standards.

2.2.26.1 FEDERAL MOTOR VEHICLE SAFETY STANDARD (FMVSS)

Federal Motor Vehicle Safety Standards (FMVSS) are U.S. federal regulations specifying design, construction, performance, and durability requirements for motor vehicles and regulated automobile safety-related components, systems, and design features. They are the U.S. counterpart to the UN Regulations developed by the World Forum for Harmonization of Vehicle Regulations and recognized to varying degree by most countries except the United States.

2.2.26.2 CANADA MOTOR VEHICLE SAFETY STANDARD (CMVSS)

Canada has a system of analogous rules called the Canada Motor Vehicle Safety Standards (CMVSS), which overlap substantially but not completely in content and structure with the FMVSS. The FMVSS/CMVSS requirements differ significantly from the international UN requirements, so private import of foreign vehicles not originally manufactured to North American specifications is difficult or impossible.

2.2.26.3 WORLD FORUM FOR HARMONIZATION OF VEHICLE REGULATIONS (WFHVR)

The World Forum for Harmonization of Vehicle Regulations is a working party (WP.29) of the Sustainable Transport Division of the United Nations Economic Commission for Europe (UNECE). Its responsibility is to manage the multilateral agreements signed in 1958, 1997, and 1998 concerning the technical prescriptions for the construction, approval of wheeled vehicles, as well as their periodic technical inspection, and to operate within the framework of these three agreements to develop and amend UN Regulations, UN Global Technical Regulations, and UN Rules. Wherever FMVSS is noted in this document, state or local approved equivalents (e.g., CMVSS and WFHVR) can be substituted.

2.2.27 FRONT DISCHARGE ROTARY SNOW PLOW

A front discharge rotary snow plow locates the operator cabin to the rear of the rotary snow plow head. This provides for the snow to discharge in front of the operator.

2.2.28 FRONT/REAR AXLE DISCONNECT

A mechanism designed to engage and disengage torque to a front or rear axle.

2.2.29 FUEL CAPACITY, MAXIMUM

The maximum actual volume of fluid able to fit into on-board tanks.

2.2.30 FUEL CAPACITY, USEABLE

The maximum amount of fluid able to be drawn from an on-board tank with the vehicle and tank stationary and in the fixed, operating position.

2.2.31 GROSS AXLE WEIGHT RATING (GAWR)

The rating of the lowest rated member as defined by the component manufacturer(s) from the following components: tires, suspension, hubs/wheels, rims, bearings, beam, and brakes.

2.2.32 GEAR RATIO

The 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.

2.2.33 GEARED SPEED

The theoretical vehicle speeds based on maximum governed engine rpm, transmission gear ratio(s), driving axle ratios, and tire sizes.

2.2.34 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.

2.2.35 GRADEABILITY

The percent grade that a vehicle will negotiate.

2.2.36 GROSS VEHICLE WEIGHT RATING (GVWR)

The sum of the gross axle weight ratings (GAWR).

2.2.37 HIGH-INTENSITY DISCHARGE (HID) LIGHT

Light created by electric arc, not a filament in a light bulb.

2.2.38 HIGH SPEED

A high-speed rotary snow plow designed to perform at its maximum capacity tons per hour rating, while operating at a forward speed of at least 25 mph, without consideration of cast distance.

2.2.39 HITCH

A device to couple/uncouple a working head or appliance to its carrier vehicle. A hitch may be provided with dedicated units to improve maneuverability, entry and exit through narrow doors, and/or improved maintainability.

2.2.40 HORSEPOWER (HP), GROSS BRAKE (OR ACTUAL DELIVERED HORSEPOWER)

A measure of the rate at which engine power is produced. The time rate of doing work, as measured by a pony brake or dynamometer. In other words, the amount of work done by a certain torque being exerted over a definite space of time. Brake horsepower is expressed as the torque (in pound feet) times the number of revolutions per minute divided by the constant 5252.

$$\text{Brake HP} = (\text{Torque} \times \text{Engine rpm})/5252 \quad \text{(Eq. 1)}$$

2.2.41 HORSEPOWER (HP), GROSS

The brake horsepower determined under conditions defined by dynamometer test of the stripped engine; that is, the brake horsepower of the engine with only those accessories and attachments necessary to the functioning of the engine during test.

2.2.42 HORSEPOWER (HP), NET

The brake horsepower delivered to the clutch, or its equivalent, with all accessories and attachments functioning (including, but not limited to, exhaust pipes, mufflers, tail pipes, and unloaded alternators and power steering pumps) which are standard or regular equipment on the engine as installed in the particular chassis. Gross horsepower less the parasitic loads.

2.2.43 IMPELLER

A rotary snow blower impeller (sometimes called a fan) is a rotating device with blades or fan blades. Normally, the device is disc shaped, with the disc rotating on an axis that is parallel to the direction of travel.

2.2.44 IMPELLER BLADES

The impeller blades (or fan blades) are located proud on the forward face of the impeller disc, shaped to produce a centrifugal pumping action of drawing snow into a low pressure area, and discharging snow from a high pressure area, these areas produced as a result of blade shapes and impeller rotation.

2.2.45 IMPELLER DRIVE

The impeller drive is the final mechanism(s) employed to rotate the impeller. An impeller can be hydrostaticly, hydraulically, or mechanically driven, or a combination.

2.2.46 IMPELLER HOUSING

The impeller housing, also sometimes called a volute or fan housing assembly, is the cylindrically shaped assembly that houses an impeller.

2.2.47 LOADING CHUTE

See spot casting chute.

2.2.48 MAXIMUM TIRE LOAD RATING

The load rating at the maximum permissible inflation pressure for that tire.

2.2.49 MAXIMUM LOADED VEHICLE WEIGHT

The sum of curb weight, passengers, and cargo; equal to the gross vehicle weight (GVW).

2.2.50 MAXIMUM PERMISSIBLE INFLATION PRESSURE

The maximum cold inflation pressure to which a tire may be inflated.

2.2.51 MAXIMUM SPEED

The speed attainable by accelerating at maximum rate from a standing start for 1 mile.

2.2.52 MAXIMUM STARTING GRADE

The percent grade on which a vehicle is able to start from a complete stop.

2.2.53 MAXIMUM SUSTAINED VEHICLE SPEED

Highest speed a vehicle can maintain under full load conditions on level ground.

2.2.54 MONOCOQUE CONSTRUCTION

A light weight type of construction where the sides of the vehicle bear a substantial part of the load in shear.

2.2.55 NHTSA

An abbreviation for the National Highway Traffic Safety Administration.

2.2.56 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.

2.2.57 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.

2.2.58 PAYLOAD

The actual weight of the useful cargo carried by a vehicle.

2.2.59 PERCENT OF GRADE

The figure used in computing the power requirements of a truck. Usually taken at the steepest grade a truck will be required to climb on its route. Percent of grade is determined by dividing the height of a hill by its length.

2.2.60 PERFORMANCE RATING

Also see capacity rating. The performance rating of a rotary snow plow is the minimum number of tons of snow a rotary snow plow can blow (see snow blowers) or throw (see snow throwers) a defined casting distance. Manufacturers must provide professional engineer, or third party professional engineer certified testing results stating compliant capacity ratings of TPH at 100 feet, or use default performance values (see in Appendix A).

2.2.61 PLY RATING

A unit of measurement used in tire construction to denote strength of tires.

2.2.62 POWER DIVIDER

Usually a small auxiliary gear box or chain driven device to allow distribution of drive shaft power to several different mechanical devices mounted on the same truck.

2.2.63 POWER TAKE-OFF (PTO)

A mechanical device used to transmit engine power to auxiliary equipment. Power takeoffs can be mounted on either a main or auxiliary transmission. Front-mounted and flywheel-mounted power take-offs are also used in various applications.

2.2.64 POWER TRAIN

All the components that handle the engine power from the truck engine to the driving wheels. This includes transmissions and drive shafts, as well as differentials and driving axles.

2.2.65 PUSHER AXLE

A non-driven (dead) axle installed forward of the driven axle(s) to increase the permissible gross weight, and, consequently, the payload.

2.2.66 REAR DISCHARGE ROTARY SNOW PLOW

A rear discharge rotary snow plow locates the operator cabin over the rotary snow plow head, and forward of the snow casting mechanism. This provides for the snow to be cast from behind, or to the rear, of the operator.

2.2.67 REFLECTORS

Glass or plastic prism lenses which reflect light.

2.2.68 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:

$$RBM = \text{Section modulus} \times \text{Yield strength} \quad \text{(Eq. 2)}$$

It is readily apparent from the above formula that the yield strength of a frame is as important as the section modulus. The RBM should, therefore, be taken into account whenever frames of unlike material and section modulus are being compared.

2.2.69 RIBBON

The relatively narrow flights that are formed into the helix portion of any helical auger.

2.2.70 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.

2.2.71 ROADSIDE

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

2.2.72 ROLLING RADIUS

Height measured from the center of the axle to the ground.

2.2.73 ROTARY SNOW PLOW HEAD

The rotary snow plow head is the main rotary snow plow housing incorporating the auger (if any), the impeller and impeller housing, the hitch, the spot casting chute (if any), and the balance of the fabricated assembly.

2.2.74 SERIAL NUMBER

A number issued to a vehicle or to a component of a vehicle for identification purposes. See vehicle identification number (VIN).

2.2.75 SET-BACK FRONT AXLE

The front steering axle is normally as close to the front of the vehicle as the design and wheel and tire size permit. When the front axle is purposely located farther toward the rear, it is referred to as being “set back.”

2.2.76 SELF-CONTAINED MOUNTABLE ROTARY SNOW PLOW

Self-contained is any type of rotary snow plow that is quick mountable, usually to the front, of a loader, truck, tractor, or other prime mover or chassis, that includes its own power source and all accessory equipment within one mountable/demountable package.

2.2.77 SELF-PROPELLED ROTARY SNOW PLOW

A rotary snow plow that is permanently mounted to a full time dedicated mobile carrier vehicle, chassis, or prime mover that is used for no purposes other than snow blowing.

2.2.78 SHIPPING WEIGHT

The dry weight of a complete truck with all standard equipment including grease and oil but without any fuel or coolant.

2.2.79 SIDE DRIVE AUGERS

Augers driven by a gear box, chain, hydraulic, or hydrostatic motor from the left, right, or both sides are side drive augers.

2.2.80 SINGLE ENGINE ROTARY SNOW PLOW

Snow plow with a single engine that provides both the power to the rotary snow plow and the motive power.

2.2.81 SINGLE-STAGE SNOW BLOWER ROTARY SNOW PLOWS

A single-stage snow blower rotary snow plow uses one or more rotating impellers to both disaggregate and cast the snow. Typically all components handling the snow in a single-stage snow blower rotary snow plow operate at the same speed and/or have the same axis of rotation. The axis of rotation is generally parallel to the vehicle’s direction of travel.

2.2.82 SINGLE-STAGE SNOW THROWER ROTARY SNOW PLOWS

A single-stage snow thrower rotary snow plow uses a single assembly to disaggregate, transport, and cast the snow. Typically, all components handling the snow in a single-stage snow thrower rotary snow plow operate at the same speed and/or have the same axis of rotation. The axis of rotation is generally perpendicular to the vehicle’s direction of travel.

2.2.83 SNOW CASTING CHUTE

The snow casting chute is part of, or attached to, the impeller housing assembly where the snow is discharged or cast. The snow casting chute may, or may not be attached to a spot casting chute. Also see spot casting chute.

2.2.84 SPLIT PACKAGE MOUNTABLE ROTARY SNOW PLOW

A split package rotary snow plow is designed for quick mounting of an unpowered rotary snow plow head to the front of a carrier vehicle while the power source for the snow plow is mounted in a different location on or behind the carrier vehicle. The remotely located engine drives the snow plow through extended hydraulic, hydrostatic, or mechanical drive systems.

2.2.85 SPOT CASTING CHUTE

The spot casting chute attaches to the rotary snow plow head in a manner that it can receive the snow being discharged from the rotary snow plow snow casting chute. A spot casting chute enables the operator to place the cast snow at various distances from the blower and/or cast the snow at various horizontal angles from the blower. In the simplest configuration, snow is directed through a chute. In an adjustable chute, provisions are made to enable the operator to direct the cast snow through the chute, or to bypass the snow around the chute as the operator may require. A spot casting chute is also often called a truck loading chute.

2.2.86 SPRING CAPACITY

The allowable load that can be supported by the spring(s).

2.2.87 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.

2.2.88 STEERING, POWER

Also commonly referred to as “hydraulic steering.” A steering system that uses hydraulic pressure to control a steering axle without a direct mechanical (controlling) link between the operator’s controls and the steering axle. On highway vehicles, a backup system must be provided to maintain steering at all times.

2.2.89 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).

2.2.90 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 on a horizontal surface.

2.2.91 STRUCTURAL MEMBER

A part of a vehicle designed primarily to support the load of a vehicle in operation.

2.2.92 SUCTION LINE

A tubular connection between a reservoir or tank and the inlet of a pump.

2.2.93 SYNCHRONIZED TRANSMISSION

A type of manual truck transmission with built in devices to automatically match the rotating speeds of the transmission gears.

2.2.94 TAG AXLE

A non-driven (dead) axle installed behind the drive axle(s) to increase the permissible gross weight, and, consequently, the payload. Also termed “trailing axle.”

2.2.95 TANDEM AXLE

Two axles mounted as a group. In a dual-drive tandem, both axles have drive mechanisms and are connected to the engine power unit.

2.2.96 TARE WEIGHT

The total weight of an empty vehicle in a condition ready to receive payload.

2.2.97 THIRD PARTY

An independent third party professionally qualified to observe, understand, and/or record test data, other than the manufacturer, that is acceptable to the purchaser.

2.2.98 TILT CAB

A cab that pivots forward to gain access to the engine or other major components.

2.2.99 TIRE CLEARANCE

Space between tires and the nearest part of the body or under-construction.

2.2.100 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.

2.2.101 TORQUE CONVERTER

A hydraulic drive which transmits power with the ability to change torque.

2.2.102 TRACTIVE EFFORT

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

2.2.103 TRANSFER CASE

Split power gear box transmitting drive to the front and rear axles.

2.2.104 TRANSMISSION

Selective gearbox providing various combinations of gear ratios.

2.2.105 TRANSMISSION, AUTOMATIC

A type of transmission designed to self select and change gear ratios based on load, and vehicle and engine speed.

2.2.106 TRANSMISSION, HYDROSTATIC

A hydrostatic transmission (HST) exists any time a hydraulic pump is connected to and dedicated to one or more hydraulic motors. A hydrostatic transmission in the case of a rotary snow plow would be when the motors are then connected to the front and rear axles or wheels, either directly or through mechanical drivelines.

Versatility is achieved by making either or both the pump(s) and motor(s) variable displacement.

2.2.107 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.

2.2.108 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.

2.2.109 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 comes into contact with the road.

c. The pattern of the surface of the tire that comes in contact with the road.

2.2.110 TRUCK LOADING CHUTE

See spot casting chute.

2.2.111 TRUNNION

a. The axis, pivot point, or center point between axles.

b. 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.

2.2.112 TURBINE

See auger, drum cutter type.

2.2.113 TURNING RADIUS

One half the diameter of a circle described by the center line of the outside front tire while a vehicle maneuvers through a 360 degree turn.

a. Wall-to-wall turning circle denotes the minimum distance between two parallel walls to allow a U-turn without any part of the vehicle, including appurtenances, from contacting the walls.

b. Curb-to-curb denotes the minimum distance between curbs for a vehicle to make a 180 degree U-turn without hitting the street curbs with its tires

2.2.114 TWO-SPEED AXLE

A driving axle arrangement whereby the driver can select one of two ratios.

2.2.115 TWO-STAGE SNOW BLOWER ROTARY SNOW PLOWS

A two-stage snow blower rotary snow plow uses one or more auger(s) or drum(s) in its first stage to disaggregate snow and transport snow to the ingress area of the second stage (impeller or fan) from which the snow is cast. Two-stage snow blower rotary snow plows have at least two distinct assemblies, one to disaggregate and one to cast the snow. The two stages must vary from each other in terms of speed and axis of rotation.

2.2.116 VEHICLE IDENTIFICATION NUMBER (VIN)

A 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.

2.2.117 VOLUTE

See impeller.

3. TECHNICAL REQUIREMENTS

3.1 General Description

The components that make up a complete rotary plow unit are based on the number of stages necessary to perform the functions of disaggregating (snow gathering) and casting snow. Based on knowledge of local conditions and snow removal requirements, the purchaser may specify either a single-stage or a two-stage style of snow blower.

3.2 Single-Stage Rotary

3.2.1 Turbine Box

Design box to withstand expected operational forces over the design life of the unit. Fabricate box with durable materials (e.g., heavy gauge welded alloy steel) that, with proper maintenance, will provide reliable operation over the expected service life. The turbine box shall have provisions for removable wear shoe(s), replaceable scraper blade(s), drive lines, controls, augers, bearing mounts, and other mechanical hardware as required. A removable scraper blade shall be fitted to the bottom of the box and run the entire width of the box. Fabricate the blade with durable material, such as high carbon steel or polyurethane, to provide expected service.

3.2.2 Turbines

Design turbines to withstand expected operational forces over the design life of the unit. Fabricate turbines with durable materials (e.g., high tensile steel) that, with proper maintenance, will provide reliable operation over the expected service life. Turbines shall be supported by bearings of adequate size for maximum expected snow loads and turbine velocities. The turbines shall be made of high tensile steel.

3.2.3 Turbine Drive

The operation of turbines shall be by hydraulic, hydrostatic, or mechanical means with the turbine rotation speed controlled by a single operator inside the vehicle cab. The drive shall be fully accessible for maintenance purposes.

3.2.4 Snow Casting Assembly

The casting assembly shall consist of a casting chute(s) that can be directionally controlled, a snow collector of either impeller or turbine design, and a control system. The casting chute(s) shall be able to rotate in either a vertical or horizontal plane and be able to cast to the left or right, as required by the purchaser. Casting distances shall range from zero to the maximum cast distance perpendicular to vehicle travel specified by the purchaser. The snow casting chute(s) shall be designed and positioned on the carrier vehicle so as to provide maximum operator visibility. Chutes shall be controllable by a single operator from within the vehicle cab.

3.2.5 Rotary Head Assembly

The rotary head assembly shall be equipped with either a hydraulic or mechanical lifting device that is capable of raising it a minimum of 8 inches (20 cm) from the pavement surface through the use of conveniently located controls in the vehicle cab. The drive system shall not bind, rub, or vibrate excessively when the assembly is being moved. When the vehicle is traveling, the assembly shall be supportable in the raised position.

3.2.6 Drive Protection System

All rotating assemblies shall be protected against sudden stops or damage that may be caused from foreign objects. Protection may be in the form of automatic clutches, release overrides, and/or shear fasteners.

3.2.7 Blower Head Drive Train

Drive shafts, universal joints, and other components of the drive train shall continue to provide power to the head assembly under normal operating conditions through the operating range of the blower head without physical damage.

3.3 Two-Stage Rotary

3.3.1 Rotary Head Box

Design rotary head box to withstand expected operational forces over the design life of the unit. Fabricate box with durable materials (e.g heavy gauge welded alloy steel) that, with proper maintenance, will provide reliable operation over the expected service life. The rotary head box shall have provisions for vehicle mounts, shoe or caster brackets, scraper blades, drive lines, controls, augers, and impeller bearing mounts and other mechanical hardware. A scraper blade shall be fitted to the lower leading edge of the box made of high carbon steel or polyurethane and be replaceable. The blade shall run the entire width of the box.

3.3.2 Input Auger

The auger(s) shall have a minimum of two bearing supports. The ribbon blades shall be easily replaceable and made of high tensile steel. They shall be bolted or otherwise attached to the auger shaft and be balanced to reduce vibration using best engineering practices.

3.3.3 Input Auger (Solid)

The solid auger shall have multiple cutter blades mounted on the auger drive shaft. Input auger shall be designed to feed snow to the discharge impeller to be cast away from the vehicle. The solid auger drive shaft(s) shall be balanced and supported by bearings, one at each end of the auger shaft (some designs may be configured differently).

3.3.4 Discharge Impeller System

The impeller capacity shall be at least equal to the capacity of the input auger(s). The impeller blades shall be made of high tensile steel using best engineering practices and be balanced to reduce vibration and shock damage.

3.3.5 Operation of the Rotary System

The operation of turbines shall be by hydraulic, hydrostatic, or mechanical means with the speed controlled by a single operator in the vehicle cab. Power shall be transmitted to these systems via mechanisms located on either side of or in the middle of the rotary head box. To ensure efficient snow flow where an auger and impeller share the same drive shaft, there shall be a reduction gear system between the two to provide a proper meshing of impeller speed and auger speed.

3.3.6 Snow Casting Assembly

The snow casting assembly shall consist of a casting chute(s) that can be directionally controlled, an impeller(s), and a control system. The casting chute(s) shall be able to rotate in either a vertical or horizontal plane, or both, as required by the purchaser. Casting distances shall range from zero to the maximum cast distance as specified by the purchaser. The snow casting chute(s) shall be designed and positioned on the carrier vehicle so as to provide maximum operator visibility. Chutes shall be controllable by a single operator from within the vehicle cab. The snow casting chute must be adjustable to allow for operator control of where snow will be thrown through a perpendicular to vehicle travel arc.

3.3.7 Rotary Head Assembly

The rotary head assembly shall be equipped with a device that is capable of raising it a minimum of 8 inches (20 cm) from the pavement. The locking device shall be activated through the use of conveniently located controls in the vehicle cab. The drive system shall not bind, rub, or vibrate excessively when the assembly is being moved. When the vehicle is traveling, the assembly shall have a means to be locked in the raised position. The purchaser may specify greater heights for local conditions.

3.3.8 Drive Protection System

All auger and impeller assemblies shall be protected against sudden stops or damage that may be caused from foreign objects. Protection may be in the form of automatic clutches, release overrides, and/or shear fasteners. Consideration shall be given to the location of protection devices to minimize the requirement to remove snow in order to gain access to and reset or replace the protection device. Mechanically driven impeller or ribbon drives must be protected by the inclusion of slip clutches or shear pins. Hydrostatic or hydraulically driven impeller drives must be protected by the inclusion of pressure protection devices and/or shear pins.

3.3.9 Blower Head Drive Train

Drive shafts, universal joints, and other mechanical components of the drive train shall continue to provide power to the head assembly under normal operating conditions through the operating range of the blower head without physical damage.

3.4 Minimum Performance Requirements (to be Specified by the Purchaser)

a. Anticipated uses and/or features of rotary plow (be specific).

b. Minimum capacity (tons per hour at 100 foot cast distance); see Appendix A.

c. Minimum casting distance at minimum capacity (feet or meters at snow density of ___ lb/ft^3 or kg/m^3).

d. Maximum required speed of operation (miles per hour or kilometers per hour).

e. Turning radius:

   1. Wall to wall (feet/meters).

   2. Curb to curb (feet/meters).

f. Unique conditions (if any).

3.5 Optional Equipment

See Appendix B.

3.6 Carrier Vehicle Description

Where MVSS is used below, apply purchaser acceptable local equivalents such as FMVCSS, CMVSS, or WFVHR, or any applicable local, federal, or state MVSS. The term carrier vehicle represents the various self-propelled prime movers that provide the power necessary to move snow and ice control equipment during winter operations. The design of the vehicle chassis shall be based on an all-wheel drive concept for optimized performance and safety. Vehicle selection is determined by the purchaser for the mission to be performed and the capacity of the selected equipment.

Where FMVSS is used below, purchaser-acceptable, local equivalents (e.g., CMVSS, WFHVR) can be used for vehicles that will be used or can be licenced for public roadway use.

FMVSS 101	Controls and Displays
FMVSS 102	Transmission Shift Lever 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	Rearview Mirrors
FMVSS 113	Hood Latch Systems
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 Impacts
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

a. Truck type vehicles: Truck type vehicles are standard production models designed primarily to meet an airport's snow and ice control needs, but can also have the ability to perform secondary functions. They may be self-contained, designed specifically for a singular purpose, or they may be multi-functional, or they may be multi-purpose. They should conform to the manufacturer's recommendations and be suitable for mounting all specified accessories.

b. Special purpose vehicles: Special purpose vehicles are customized specifically to meet special airport operator needs such as high-volume and/or extra wide swath clearing operations.

c. Wheel loader vehicles: Wheel loaders are standard production four-wheel drive articulated and non-articulated vehicles, normally equipped with a front-mounted bucket, that operate at low speeds of 5 to 20 mph (8 to 30 km/h). They are very efficient for short haul operations and are used to clear compacted snow and ice from heavily used ramp and terminal areas and around pavement lights. Other applications include snow loading and stockpiling and loading of solid chemicals and abrasives.

d. 4x4 tractors are standard production industrial or multi-purpose (including agriculture) tractor models adapted for snow and ice control work in confined areas. While similar to wheel loaders, most are built to operate at higher speeds.

3.6.1 Materials

Materials used on a carrier vehicle shall conform to the specifications listed in the appropriate sections of Title 49, Subchapter B, Chapter III, Federal Motor Carrier Safety Regulations (or acceptable by purchaser local equivalents per above). When not specifically listed, materials shall be of the best quality available for their intended commercial use. Component parts shall be new, unused, and of current production to the satisfaction of the purchaser. They shall be free of all defects and imperfections that could affect the serviceability of the finished product.

3.6.2 Design

Design entire rotary snow plow vehicle and all accessories and attachments to withstand expected operational forces over the design life of the unit. Fabricate with durable materials that, with proper maintenance, will provide reliable operation over the expected service life of the rotary snow plow. This also includes the incorporation of ergonomic designs specifically directed at the vehicle's cab environment. Vehicle design shall include current state-of-the-art procedures that consider improved cab visibility, communications systems, interior lighting, and the mitigation of noise and vibration. Design and installation of equipment shall permit easy accessibility for maintenance and service. All vehicle stress points shall be designed to distribute and dissipate shock forces.

3.6.3 Construction

Vehicle construction shall provide maximum protection against structural member failures. Equipment shall withstand the cold, moisture, strains, jars, vibration, and other conditions that are likely to be encountered during operation. All components and assemblies shall be free of hazardous protrusions, sharp edges, cracks, or other elements that might cause injury to personnel or damage to equipment. Location of all oil, hydraulic, and air lines and electrical wiring shall be in protected positions properly attached to the frame or body structure. Wherever these lines pass through apertures, they shall be protected with looms or grommets, except where a through-frame connector is necessary.

3.7 Chassis

The design of the vehicle chassis shall be based on an all-wheel drive concept for optimized performance and safety. It shall have power assisted steering and a transmission with suitable load and speed ranges to accommodate normal operating conditions. Vehicles shall have heavy-duty tow hooks, tow eyes, or other suitable tow connections attached to the rear of the vehicle. The tow hooks, eyes, or other suitable tow connections shall be attached to the frame or structure of the vehicle, and provide adequate strength to allow lifting and/or pulling the vehicle for emergency recovery situations. A pintle hook, rated at not less than the GVWR, shall be permanently attached to the rear frame structure capable of towing a vehicle. All installed parts and accessories necessary for the safe operation of the vehicle shall conform to applicable provisions of Title 49.

3.7.1 Structural Members

The frame shall be made of either pressed or structural steel shape and reinforced as required to prevent distortion under maximum load conditions. All frames and stiffeners shall be treated with a corrosion inhibitor and shall be primed and painted before assembly.

3.7.2 Dimensions and Clearances

Carrier vehicles with snow removal attachments shall have the following overall dimensions:

a. Minimum ground clearance: The minimum ground clearance of a vehicle chassis shall be 8 inches (20 cm).

b. Maximum overall height: The maximum overall height of a vehicle, including discharge chutes, lights, and exhaust stacks (with rain cap up if so equipped), shall not exceed 13 feet (4.0 m), unless otherwise specified by the customer. A placard shall be installed in the vehicle cab stating the maximum overall height. If practical, the placard should be located at the top of the windshield as nearly over the steering wheel as possible to be immediately visible to the operator when looking upwards.

c. Maximum overall width: The overall width of a vehicle including rotary plow head shall be specified by the purchaser who shall take into consideration gates and doors to equipment shops at the airport.

d. Maximum overall length: Maximum vehicular length may be specified by the purchaser who shall take into consideration shop areas and maneuverability expected of the vehicle during operation.

3.7.3 Weight Distribution

The gross vehicle weight of the vehicle shall be distributed over its axles in accordance with best engineering practices. The center of gravity shall be kept as low as possible under maximum load conditions. While it is loaded, the vehicle shall be capable of resting on a 20% transverse grade without danger of overturning. A copy of the calculated weight distribution shall be provided to the customer prior to construction, and the produced vehicle shall not deviate from the calculated weight distribution by more than 5% on any axle, or for the gross weight as determined by weighing the unit at a public certified scale.

3.8 Engine

Engine and vehicle manufacturers shall provide an application approval, at the time of vehicle delivery that states the engine is suitable for use in the vehicle as configured and that the installation is approved by the engine manufacturer. The vehicle engine shall be of internal combustion type. Unless otherwise specified, the diesel engine shall be designed and tuned for operation using ASTM D2 diesel fuel. Anti-freeze, crankcase and gear oils, greases, automatic transmission fluid, and hydraulic oils shall be as per current SAE, API, or ASTM specifications and not be proprietary products. It shall be able to meet the performance characteristics specified herein on commercial grade fuel. Dual engine vehicles shall use a common fuel. The engine shall develop sufficient torque and horsepower to meet its normal operational requirements without exceeding the no-load speed at the peak of its certified gross brake horsepower curve. Engine noise and vibration shall be reduced in the vehicle cab by use of best engineering practices and machine layout. Idle time limiters or other automatic shut down devices designed to limit emissions, conserve fuel, or enhance operating costs must be permanently disabled if such devices could leave a unit disabled on a taxiway or runway. Permanently disabled means the disabling must be done in such a manner so as not to be easily or accidentally re-activated.

3.8.1 Cooling System

The engine cooling system shall be based on either a liquid or forced air design. Internal temperatures of liquid cooled engines shall be controlled by a bypass thermostat that regulates the flow of engine coolant. Drain cocks shall be installed at the lowest point of a liquid cooling system and at other points necessary to completely drain the system. A sight glass or other device is required in all liquid cooling systems to allow the operator to determine that there is sufficient fluid for normal and safe operation without the need to open the system.

3.8.2 Coolant Temperatures

The design and installation of the system shall assure that coolant temperatures shall remain within the engine manufacturer's operational specification (both high and low) when properly maintained and operated in ambient temperatures during snow removal operations. In areas which frequently experience temperatures below 20 °F, cooling system heaters, oil pan heaters, lubricating oil heaters, battery and block heaters, and cold start aides are required, unless otherwise specified.

3.8.3 Fuel System

The fuel system shall comply with Title 49 and include all components necessary for a complete operational system.

3.8.4 Fuel Tank(s) and Lines

Useable fuel capacity should be not less than a calculated value of: (total maximum brake horsepower for all engines) x (055 gal/h/bhp) x (desired operating hours) x (0.8 for an 60% load factor). Normal operating hours should be eight unless a higher number is desired by the customer. If dual tanks are used, the supply system shall be designed to ensure an uninterrupted flow of fuel to the engine(s) without input by the operator, and to allow shutoff of each tank should the crossover lines of either tank be damaged. Dual tanks shall also have adequately sized crossover lines to allow refilling both tanks from one location. Fuel lines shall be securely fastened in place, installed to prevent chafing or strain, and protected by grommets where lines project through metal apertures. Each fuel tank is to be equipped with an accessible bronze or brass drain plug or a quick drain. A properly rated fuel water separator with integral heater shall be installed in an accessible location near the tank. If the engine requires a boost pump to assure adequate fuel flow to the engine, a pressure operated switch with in-cab warning light shall be furnished to warn the operator of low boost pump pressure. The boost pump should be installed to shut off when the engine is turned off, or to have an emergency shutoff switch or circuit breaker located near the light to allow the operator to shut off the boost pump in the event of fuel leakage downstream of the boost pump.

3.8.5 Fuel Filler Pipe

The fuel filler pipe(s) shall be located outside of the vehicle cab in an area accessible for refueling from the ground. A light chain shall be attached near its opening and to the filler cap to prevent loss of the cap. The filler neck shall include a screen to prevent the entry of foreign objects into the tank. The fuel filler cap shall be painted a color appropriate for the type of fuel, and a permanent label shall be affixed as close as practical to the fill neck(s), in an area visible to the person refueling the vehicle, stating the appropriate fuel and capacity of the tank(s). A label shall also be installed in the cab near the fuel gauge indicating which side of the vehicle must be positioned towards the fuel pumps if the vehicle cannot be filled from either side (e.g., Fuel Fill →).

3.8.6 Air Cleaner

The air cleaner shall be of a two-stage design. The first stage incorporates a pre-cleaner while the second consists of a dry type replaceable paper filter. A restriction indicator is required in the cab for each engine air intake system. The connection between the air cleaner outlet(s) and the engine intake(s) shall be waterproof and dust tight. The air cleaner intake shall be positioned in a manner to discourage the ingestion of snow and other contaminants, e.g., within the hood cavity.

3.8.7 Exhaust System and Muffler

The engine shall be equipped with an efficient and safe exhaust system including mufflers. Its location shall minimize noise and exhaust gases entering the vehicle cab under all operating conditions. Further noise reduction by noise suppression materials, such as muffler insulation, is encouraged. Horizontal portions of exhaust systems shall be protected, whenever possible, from corrosive agents and fuel spills. Mufflers and exhaust components positioned in or near normal operator work areas shall include appropriate guards to minimize the burn risk to airport personnel. Exhaust systems shall be positioned on the vehicle in a manner to minimize contact with slush and snow. Muffler(s) are to be made of aluminum, aluminized steel, stainless steel, or materials coated with ceramics. Devices shall be installed to prevent snow and slush from entering vertical exhaust stacks. Customers may specify the location and direction of exhaust system discharge when appropriate for storage building ventilation systems or other operational needs.

3.8.8 Governor

Engine speed shall be regulated by a governor set to provide the maximum operating speed recommended by the engine, driveline, and power train manufacturers.

3.8.9 Lubrication

An engine's lubricating system shall be equipped with standard production fittings and accessories. Engine oil filter(s) shall be the engine manufacturer's approved design and be able to accept commercial replacement elements. All engine(s) shall receive lubrication prior to delivery with lubricants designated for use under ambient temperature conditions at the point of delivery. The unit(s) shall be tagged to identify the proper lubricants and their temperature ranges.

3.8.10 Engine Protection System

An automatic engine protection system to prevent engine damage due to low engine oil pressure, high coolant temperature, or low coolant level is required. A provision for the emergency movement of the unit from a runway or taxiway must be provided.

3.8.11 Accessibility

a. Component location: Engine and chassis components shall be positioned to allow easy access for inspection and maintenance purposes. Components that historically present maintenance problems or those that have the potential to cause operational problems should particularly be located in unobstructed areas. Locks, controls, and fasteners shall be designed to prevent over-torquing. Fluid capacities that must be checked during a pre-trip inspection, such as hydraulic oil level(s), windshield washer fluid level, and diesel fuel level, shall be visually observable or otherwise capable of being checked without the need for tools, and without requiring work stands, portable ladders, or other equipment to check the service levels. To the extent practical, lighting in these areas shall be adequate to perform the checks without the need for flashlights or other portable lighting.

b. Cover plates: Cover plates shall be equipped with either quick-disconnect fastenings or hinges.

3.9 Drive Train

3.9.1 Transmission

Transmission and vehicle manufacturers shall provide an application approval at the time of vehicle delivery that states the transmission is suitable for use in the vehicle as configured and that the installation is approved by the transmission manufacturer. The transmission shall operate smoothly and efficiently and be capable of transmitting the maximum gross torque generated by the engine to the drive wheels through all gear reductions. Safety interlocks to prevent starting the engine unless the transmission is in neutral or the clutch is disengaged shall be installed. Drive trains shall be in conformance with SAE requirements and shall be designed to minimize the number of joints. The purchaser shall specify the type(s) of transmission(s) that are acceptable. They may be either manual or automatic as follows:

a. Manual: This type of transmission shall have a clutch assembly rated to match the expected load ranges encountered under normal operating conditions. The gear selector shall clearly identify gear positions.

b. Automatic: Automatic or non-manual transmissions are either hydrostatic (with or without transfer case), automatic power shift, standard power shift, or fully automatic. Designs utilizing torque converters shall have a suitable torque ratio for the expected load ranges. The torque converter shall not operate at less than 70% efficiency. The gear or range selector shall have forward, neutral, and reverse positions clearly identified.

3.9.2 Transfer Case

The vehicle and transfer case manufacturers shall provide an application approval at the time of vehicle delivery that states the transfer case is suitable for use in the vehicle, as configured. Transfer case assemblies shall provide positive drive to the front and rear axle(s) and may be of optional single or multi-speed design. Three proven alternatives are the manual front axle disconnect type, the center differential with manual or automatic lockout type, or an overriding clutch type. The purchaser shall specify the type(s) of transfer case(s) that are acceptable or may elect to accept the manufacturers standard transfer case(s). The transfer case may be a separate unit mounted independently or integrated with the transmission.

3.9.3 Axles

The axle and vehicle manufacturers shall provide an application approval at the time of vehicle delivery that states the front and rear axles are suitable for use in the vehicle, as configured. The axle manufacturer's published rating shall at the least be equal to the load imposed at ground level when the vehicle and/or each component is in its maximum load configuration (i.e., rotary plow up and rotary plow down; and/or a material body, if any, loaded to its cubic rated volume). Each non-steering axle shall be equipped with a retarding type device to ensure a torque transfer to each wheel having traction. When appropriate, manual lockout controls shall be located in the vehicle cab. The torque capacity of each axle and differential shall be at least 10% in excess of the maximum torque that the axle may experience under any GVW operating condition. The power transmitting shaft on each steering axle shall incorporate steering joints that do not produce objectionable steering characteristics while the vehicle is operating on uneven surfaces. Two proven designs are single reduction with all gear reduction taking place in the central housing of the axle, and planetary, in which a second speed reduction takes place beyond the axle's center housing.

3.10 Brake System

Vehicle service and emergency braking systems shall meet Title 49 requirements for vehicles of similar design. These systems, whether air, hydraulic, or of another design, shall be complete with all necessary equipment to safely control, stop and hold a fully equipped vehicle under all normal operating conditions. Both systems shall be readily accessible for external adjustment. Anti-lock brakes may be specified for improved safety on the airport operational areas.

3.11 Steering Mechanism

The vehicle shall have a steering mechanism that is operated from the driver's seat. During normal operations, the mechanism shall be capable of controlling the vehicle with all equipment operating. Steering equipped with power assistance shall revert to manual operation in the event of power assist system failure, or be equipped with a dual power steering system that operates in a fail-safe manner so that the failure of one system will not lead to a loss of steering. The design of the steering mechanism should, in the event of a power assist failure, be capable of safely maneuvering the vehicle off the primary operational areas of the airport and to a park position from the maximum design speed allowed on the airport. All-wheel steering may substantially increase the handling ability of the vehicle and, therefore, its productivity. The purchaser shall specify if all wheel steer is required, and if all-wheel steering is required, if it is to be front wheel steer, rear steer, crab steer, coordinated steer.

3.12 Suspension System

Vehicles shall be equipped with a current production model suspension system having a minimum rated capacity equal to the GVW of the carrier vehicle. When required, front and rear axles shall have auxiliary suspension springs. Manufacturer's capacity ratings may not be arbitrarily raised to conform to the requirements of this specification. The suspension system shall exhibit no permanent set after the load is removed.

3.13 Wheels, Rims, Tires, and Tubes

a. Wheels, rim, and tire ratings shall conform to The Tire and Rim Association's published recommendations.

b. Tires: Each tire shall have a rated carrying capacity at least equal to the loads imposed on them in the maximum load configuration (i.e., rotary plow up and rotary plow down). Tires on each individual axle shall be of the same size. Tires between axles may vary due to loads, configurations, and engineered gearing sets. In such cases, care must be taken, and all components must be viewed as a system that provides an acceptable speed match between driven axles. Tires shall have an aggressive tire tread. Tires (and tubes, when applicable) shall meet the first line commercial grade requirements for the speed and type of service required.

c. Spare rim/tire: The purchaser shall specify if a spare rim(s) and tire(s) are required. If one size and configuration of tire and wheel cannot be immediately interchanged to all positions on the vehicle, the airport sponsor shall consider specifying one spare rim and tire for each distinct configuration.

3.14 Hydraulic System

The hydraulic system shall consist of appropriate rams, pumps, piping, fittings, valves, controls, fluid reservoirs, filters, coolers, and other parts essential to its full operation. The system shall be capable of hydraulically positioning equipment through the entire range of its design limits. It shall be capable of operating all controls simultaneously without a noticeable reduction in power response. All hydraulic controls shall be located in the vehicle cab. The equipment manufacturer shall avoid high pressure hydraulic lines within the cab by means of remote cable or electric over hydraulic. The system shall be ruggedly constructed and able to withstand all loads imposed on it without relying on the use of mechanical locks. Adequate cooling must be included to maintain acceptable hydraulic oil temperatures throughout expected vehicle operational ranges. Filters within the hydraulic system shall conform to SAE J931.

3.14.1 Pump(s) and Power Takeoff

The pump(s) shall be powered by the engine through a power takeoff. It shall have sufficient capacity to operate the hydraulic equipment specified herein under all operating conditions and speeds. Belt driven pumps should be avoided whenever possible.

3.14.2 Lines and Fittings

Only commercial quality hydraulic lines, hoses, and fittings that are capable of withstanding system working pressures under load are acceptable. Hydraulic hoses shall have a bursting pressure of three times their rated working pressure. The use of fittings, joints, and connections shall be kept to a minimum. Test gauge connection fittings shall be provided at all suitable points throughout system for maintenance and trouble-shooting. All hydraulic system components are to be shielded from engine exhaust heat, and heat shields shall be installed on the engine exhaust system to divert any possible leakage from the hydraulic system. Hoses shall be installed inside steel tubing wherever necessary to deflect the flow of fluid from exhaust and electrical system components in the event of hose rupture or leakage. When specified by the purchaser, provide arctic type hoses with temperature ratings appropriate for the location of intended use

3.14.3 Fluid Tank

The hydraulic fluid tank shall have a filler neck consisting of a strainer, drain plug, shutoff valve, air vent, and baffles. Its capacity shall exceed the volume of oil required for the hydrostatic operation of any combination of attachments by 50%. A sight glass or other device shall be provided to allow the operator to verify that fluid level is sufficient for safe operation without the necessity of opening the system. An oil level warning device shall be provided in the cab for all hydraulic systems. A label shall be installed as close as practical to the filler neck indicating the proper fluid for servicing the hydraulic system, and the capacity of the tank.

3.14.4 System Winterization

Hydraulic systems shall be designed and operated in accordance with the requirements specified in ARP1247. The hydraulic system shall meet the same low temperature requirements as the engine coolant system. Where appropriate, properly sized shutoff valves shall be installed on each side of all filters to facilitate filter changing with minimal fluid loss. If filters are installed in compartments or other areas where fluid collection is possible, drain holes will be installed to allow fluid drainage and collection during servicing.

3.15 Electrical System

The electrical system shall be negatively grounded and installed in accordance with current state-of-the-art practices and appropriate federal requirements. All vehicle wiring shall be in accordance with SAE J1292. All vehicle body electrical equipment, components, and wiring shall meet the requirements set forth in ARP1247. All parts of the electrical system shall be waterproof, easily accessible, securely mounted, and protected against extreme temperatures, physical damage, snow, oil, and corrosion. All electrical circuit wiring shall be made of stranded conductors with a capacity exceeding the anticipated maximum circuit loading. Insulation of electrical wiring shall be equal to the recommended standards established for insulation materials by SAE. All electrical circuit wires shall be identified by color or number along their entire length. The wiring codes shall match information to be provided in the supporting service manuals.

3.15.1 Magnetic Field Interference

All vehicle components and systems shall operate without being affected by interference damage or disruption including detrimental effects or interference to on-board computer modules from either vehicle generated noise, or stray EMF, MMF, or RMF fields encountered from any airport operations. EMF, MMF, and RMF noise sources that may be generated by the vehicle, especially if such noise is detrimental to aircraft, Air Traffic Control, or air navigation equipment, shall be shielded.

3.15.2 Power Supply

The carrier vehicle shall be equipped with self regulating electric alternators having an output capacity that exceeds the anticipated electrical load. The minimum idle output of the alternator shall be 20% greater than that required by the vehicle with the engine operating at idle, heater and defroster set at low fan setting, parking and/or marker lights on, communication radio(s) on, windshield wipers operating, and either hazard flashers or vehicle safety identification lights on. The minimum output of the alternator when operating at governed engine speed shall be 20% greater than that required by the vehicle in its operating mode with the heater and defroster set to maximum settings, headlights and marker/tail lights on, communication radio(s) on, windshield wipers at maximum setting, and the vehicle safety identification lights operating.

3.15.3 Batteries

Batteries shall be securely mounted and adequately protected against physical injury, water, chemicals, and exhaust heat. They shall be properly sized based on vehicle manufacturer recommendations and be readily accessible for change out and for other purposes. Enclosed battery compartments shall have adequate ventilation. Battery capacity (cranking amps, voltage, reserve power, continuous/deep cycle demand) shall be compatible with the size of the engine and the anticipated electrical load expected under normal operating conditions. An on-board self-regulating battery charger may be specified by the purchaser.

3.15.4 Starting Device

The vehicle shall have an electrical starter equipped with an overload protection device if such device is available from the manufacturer of the starter. The airport sponsor shall specify the type(s) of electrical systems that are acceptable.

a. 12 V electrical and starting.

b. 12 V electrical/24 V starting.

c. 24 V electrical and starting.

3.15.5 Ignition System

Under extreme weather conditions, a block heater or other heating device should be considered for improved compression (diesel) ignition. A high idle control for efficient engine warm up and stand by operations shall be provided. High idle switches or throttle controls shall be designed to operate only when the transmission is in neutral.

3.15.6 Backup Alarm

All vehicles that have limited rear view visibility and/or have a GVWR of 26000 pounds shall be equipped with a backup alarm installed at the rear of the vehicle. The backup alarm shall be activated whenever the transmission is placed in reverse. The backup alarm shall be a SAE J994, Type B vehicle backup alarm or approved equivalent.

3.15.7 Horn

The vehicle shall be equipped with an electric or air horn to allow the operator to provide an audible warning in an emergency.

3.16 Lighting System

The lighting system, including reflectors, markers identification, and clearance lights, shall conform to FMVSS 108 or approved equivalent, as though the vehicle were an on-highway vehicle. Customers may specify an all LED sealed wiring lighting system. In addition, task-oriented lights and other lighting shall be furnished to help the operator identify the overall width, and, when practical, to project a beam or light pattern on the ground in front of the blower to assist the operator in determining those areas to be cleared and to provide adequate illumination for the operator and service personal when the unit is on darkened aeronautical areas.

a. Headlights: The carrier vehicle shall be equipped with two or more sealed-beam quartz-halogen, LED, or high energy discharge type headlights with upper and lower driving beams and a foot or hand controlled switch for beam selection. If snow removal attachments obstruct forward illumination of these lights, an auxiliary set of comparable lights shall be provided to overcome the obstruction. A control to select the secondary lights shall be provided in the operator cab.

b. Backup lights: There shall be at least two backup lights installed at the rear of and at either side of the vehicle that will automatically be activated when the vehicle is shifted into reverse gear.

c. Vehicle safety identification lights: The vehicle shall have a minimum of one revolving yellow beacon or flashing strobe mounted on its uppermost part (refer to FAA AC 150/5210-5B) or local approved equivalent(s). The light emitted from the beacon should not reflect off rearview mirrors and into the operator's eyes.

3.17 Operator's Cab

3.17.1 General

Carrier vehicle cabs shall be made of either metal or fiberglass construction and be of conventional, cab forward, or cab-over design. They shall be fully enclosed accommodating a single operator only (half cab) or purchaser can specify a single operator plus assistant/trainee cab. A definite separation shall exist between the engine and the operator's compartments. All non-glass surfaces, such as the floor, sides, and roof of the cab, shall have insulation to reduce exterior noise. The maximum interior cab noise measured at the operator's seat shall not exceed 85 dBa under the following conditions: windows closed, heater and defrost systems at maximum operation, and carrier vehicle and equipment engines operating at maximum rated capacity. Manufacturers of the equipment are encouraged to improve upon the specified noise level. To the extent possible, the interior of the cab shall be ergonomically designed providing the operator with a pleasant working atmosphere that is devoid of the stark conditions normally associated with older equipment. All cabs shall provide at least two differently oriented routes of egress to allow the operator to exit the cab in the event of rollover or overturn.

3.17.2 Communications Equipment Space

Transceivers shall be installed in carrier vehicles to establish voice communication with other vehicles, the air traffic control tower, and snow control center and maintenance facilities. The vehicle cab shall be designed to provide convenient space near the operator for the installation of a pair of transceivers. The airport operator may specify required two way radio equipment and frequencies.

3.17.3 Fire Extinguisher(s)

The vehicle cab shall have at least one 2A-10BC (or approved equivalent) interior mounted fire extinguisher that is readily accessible to the operator. Vehicles equipped with fuel tank(s), hydraulic oil tank(s), or any flammable liquid tank(s) that have a total combined volume of 200 gallons or more of flammable liquid shall be equipped with one 20 B:C: Purple K (or approved equivalent) type fire extinguisher installed on the vehicle or equipment at a place readily accessible from the ground.

3.17.4 Operator Seat

The vehicle cab shall provide an operator seat that can easily be adjusted up and down, fore and aft, a minimum of 3 inches (7.6 cm) in each direction. The seat should also be capable of reducing the effect of vehicle vibration by featuring air-cushion shock absorbing seat systems, or systems of comparable design. All vehicle seats shall have three-point (minimum) seat belts, certified by the vehicle manufacturer to have been tested and in conformance with FMVSS or equivalent requirements. Seats shall be fully upholstered with a durable fabric that resists wear and tear and is easy to clean and maintain.

3.17.5 Windows and Windshield

Unless otherwise specified, an electrically heated windshield shall be provided. The vehicle cab shall maximize the use of glass, including the placement of panels if possible in the lower sections of door panels, to increase the operator's view of operational areas and ground surfaces. All installed glass shall be laminated, safety rated, and conform to all FMVSS requirements. Customer to specify tinted or clear glass. The location and size of the windshield shall minimize visual obstructions to the operator. The windshield shall be designed to avoid snow build up and be equipped with one or more variable speed intermittent operating wipers (standard or wet arm). The windshield wiper system shall be capable of sweeping a clear view for all occupants and be equipped with at least one variable speed automatically operating wiper (standard or wet) that is capable of sweeping a clear view for all occupants. The windshield washer reservoir shall have a capacity of at least 1-1/2 gallons (5.6 L). Fluid applicators shall be located to provide at least 75% coverage of the windshield. The cab shall be equipped with sun visors. Windshields and other glass surfaces in the vehicle cab used in the operation of the vehicle and/or to view pavement surfaces, including rear windows if installed, shall be cleared by means of a defroster system that is part of the cab's heating system. The standard circulating air type defroster may be complimented by electrical type heating systems for glass areas as required by the purchaser.

3.17.6 Exterior Rearview Mirrors

Two electrically heated exterior rear view mirrors of the extension arm type shall be mounted one on each side of the vehicle cab. Rear view mirrors are to be powered and remotely controlled. Each mirror shall have an area of not less than 100 in^2 (650 cm^2).

3.17.7 Heater

The carrier vehicle cab shall have a heating system that is capable of maintaining a minimum interior temperature of 65 °F (18 °C) at an ambient outside temperature of -20 °F (-29 °C), or a minimum as required by the purchaser. Heat output shall be controllable from within the cab by a selector switch that is conveniently located to the operator. Under all conditions of heating and ventilation, the temperatures measured in the operator's immediate environment should be uniform within 9 °F (5 °C) (refer to SAE J1503).

3.17.8 Ventilation

Ventilator/heater fan shall have blower capacity equal to one cab volume per minute. Cab ventilator intakes should be screened and positioned in such a manner to minimize the entry of snow.

3.17.9 Hour Meters

Every engine permanently attached to a carrier vehicle shall be equipped with an hour meter that registers engine operation time from 0 to 99999 hours. Hour meters shall be prominently displayed so that they can be easily read by an operator or service personnel. The hour meters shall be of direct read design and shall only register when the engine is running.

3.17.10 Instrumentation

The cab shall display an instrument panel equipped with rocker and/or toggle switches and controls (instruments) that are friendly to operators wearing bulky winter clothing. Toggle switches, where used, shall have a minimum length of 1-1/2 inches (4 cm). Frequently used instruments shall be located in direct line-of-sight and within forearm reach of a medium sized person sitting in the operator's position. All instruments shall be clearly identified with labels that indicate their function. Furnish instruments that display urgency-of-action lights, i.e., green for normal operation, amber for warning, and red for emergency or purchaser approved equivalents. Instruments shall be illuminated by background lighting regulated by dimmer switches capable of providing infinitely variable lighting intensities. Circuit breakers shall be grouped for easy access and convenience. Typical instruments that report and track major functions of a carrier vehicle and mounted equipment are as follows:

a. Engine:

    1. Voltmeter.

    2. Lubricating oil pressure gauge(s).

3. Coolant temperature gauge(s).

4. Tachometer(s) (including hour meter(s)).

5. Starting controls (including auxiliary cold start controls).

6. Hydraulic oil pressure and temperature gauge, if applicable.

7. Transmission.

b. Vehicle chassis:

1. Brake-air pressure gauges, if applicable.

2. Low-air pressure warning, visual and audible type, if applicable.

3. Light switches and headlight beam indicator.

4. Speedometer with recording odometer.

5. Fuel quantity gauge(s).

6. Equipment controls.

3.18 Sheet Metal Components

3.18.1 General

The carrier vehicle engine, as well as its mechanical components, shall be protected wherever possible from snow, rain, and other winter elements. Body and engine enclosures may be fabricated from aluminum, fiberglass, and/or steel. Self-tapping bolts are unacceptable in the construction of these enclosures.

a. Steps: Four-way safety tread, open design steps are required to ascend and descend high profile carrier vehicles. These steps, together with assist handles, shall provide for constant three-point contact, and shall be of ample size to ensure safe and easy access for persons wearing bulky winter clothing.

b. Walkway: A four-way safety tread, open design walkway shall be provided, as necessary, for access.

c. Handrails: Handrails shall be provided as required at all steps, walkways, and work stations. They shall be made of corrosion-resistant materials or otherwise treated to prevent corrosion.

d. Fenders: All carrier vehicles shall be equipped with fenders and when determined by the operator, non-sail mud flaps to prevent wheels from throwing snow and other debris.

e. Drains: Plugged or free flowing drains shall be provided at all body and compartment locations where standing water can collect. Free flowing drains shall not drain onto sensitive mechanical or electrical components or on areas anticipated to be occupied by personnel during normal operations.

f. Doors: Doors shall be equipped with a positive closing mechanism and, where appropriate, a locking mechanism. Top hinged compartment doors shall be held in the open position by a support arm(s).

g. Gutters: The vehicle cab shall be equipped with gutters, located above the entrance doors, of sufficient length to span the door width and provide runoff protection to occupants either entering or exiting the cab.

3.19 Painting, Marking, and Lighting of Vehicles

3.19.1 Painting and Marking

The vehicle shall be painted in accordance with the purchaser's color requirements.

3.19.2 Preparation and Finish

The carrier vehicle and all mounted and towed equipment shall be cleaned first, then treated with a corrosion inhibitor, primed, puttied, sanded, and finally painted. The paint shall consist of not less than two coats of polyurethane enamel, acrylic enamel, acrylic urethane, or similar high durability, long life paint as required by the purchaser, applied to produce full hiding.

3.19.3 Quality

The finished paint shall be free of “fisheye,” “orange peel,” chips, runs, or other imperfections that detract from the equipment’s corrosion resistance and appearance.

3.19.4 Design Certification

The original equipment manufacturer (OEM) shall certify, by the signature of the OEM lead engineer and stamp of a third party professional engineer, that a chassis and rotary snow plow attachment design can be operated and maintained per OEM recommendations/requirements without major component failure for a period of not less than 10 years or 6000 operational hours. The certification statement implies operation of the equipment for its intended use for snow removal from airfield pavement and excludes consumables such as tires, lubricants, belts, sacrificial cutting edges etc. Major components included are described as, but not limited to, structural frame components, engines, transmissions, drop cases, transfer cases, axles, power dividers, power uniters, planetary gear boxes, hydraulic pumps, and hydraulic motors.

3.20 Miscellaneous

3.20.1 Plastic Plates

Unless specifically manufactured to withstand the elements, plastic plates are acceptable only in locations that are not exposed to the elements and subject to weathering or excessive heat.

3.20.2 Information

Plates shall identify make, model, serial number, and any other relevant data.

3.20.3 Technical Publications

The manufacturer shall furnish two complete sets of paper manuals. One set of manuals shall consist of an operator’s manual, parts manual, and maintenance and service manual.

3.20.4 Operator’s Manual

The operator’s manual must include lubrication charts and operating instructions.

3.20.5 Parts Manual

The parts manual identifies and lists all parts, components, and subassemblies used in the fabrication of the carrier vehicle and mounted equipment.

3.20.6 Maintenance and Service Manual

A maintenance and service manual provides guidance to non-specialists performing routine services. The manual should also describe in detail with appropriate schematics the overhaul and major maintenance procedures required to maintain and repair the vehicle. The maintenance manuals shall include complete schematics of the electrical, air, and hydraulic systems as applicable. Number codes on wires and hoses as found on the vehicle shall match those provided in the maintenance manual schematics.

3.20.7 Accessories and Tools

The carrier vehicle shall be equipped with tire tools, a jack, shear pins, and specialized tools as specified by the purchaser. They shall be kept either in a secure and readily accessible enclosure that is permanently affixed to the vehicle, or in the maintenance facilities of the airport as required by the purchaser.

3.20.8 Special Tire Repair Tools

Lug wrench and any other special tire tool required to change a flat tire.

3.20.9 Jack

A jack of adequate capacity to be capable of raising vehicle or rotary snow plow to a position where a flat tire can be changed.

3.20.10 Shear Pins

A minimum of six pins shall be provided in support of each shear pin located on the carrier vehicle and its auxiliary equipment.

3.20.11 Specialized Tools

Specialized tools required for routine servicing of the carrier vehicle and its auxiliary equipment.

3.21 Delivery

3.21.1 Shipment

The vendor (seller) is responsible for the safe and timely delivery of the vehicle and its accessories, spare parts, and tools to the purchaser's specified place of delivery.

3.21.2 Marking

Carrier vehicles shall be marked for shipment in accordance with instructions agreed to by the purchaser.

3.21.3 Instruction and Training

The manufacturer shall, at no additional cost, furnish the services of trained personnel to the purchaser at a time and place agreed to by all parties. These individuals shall provide instructions to airport personnel sufficient to familiarize themselves with the operational and maintenance characteristics of the vehicle and its auxiliary equipment. The period of instruction shall be a minimum of 24 hours, or as required and specified by the purchaser.

3.21.4 Quality Assurance Compliance

The manufacturer must develop and maintain a quality plan that addresses (1) quality management, (2) quality assurance, and (3) quality control. While ISO 9001 certification is not necessary, quality plans not covered by an ISO 9001 certification require the confirmation of conformance under the signature of a professional engineer.

The quality plan shall include, as a minimum, the following elements:

1. An overview of the product and manufacturing process.
2. The organizational structure detailing essential team members and external vendors:
    - Team member's responsibilities and qualifications.
    - Task responsibilities.

3. Customer focus:
    - Requirements.
    - Communication.
    - Feedback.
4. Process approach:
    - Key processes.
5. Design and development:
    - Design input.
    - Design verification.
    - Design validation.
6. Supplier criteria:
    - Supply standards.
    - List of qualified suppliers.
7. Production performance:
    - Acceptance criteria.
    - Testing parameters.
    - Quality control.
    - Traceability.
    - Documentation.
8. Internal audit.
9. Qualifications:
    - Training.
    - Certifications.
10. Continual improvement:
    - Corrective actions.
    - Customer feedback.

4. NOTES

4.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

Table 1 - Snow field - uniform snow

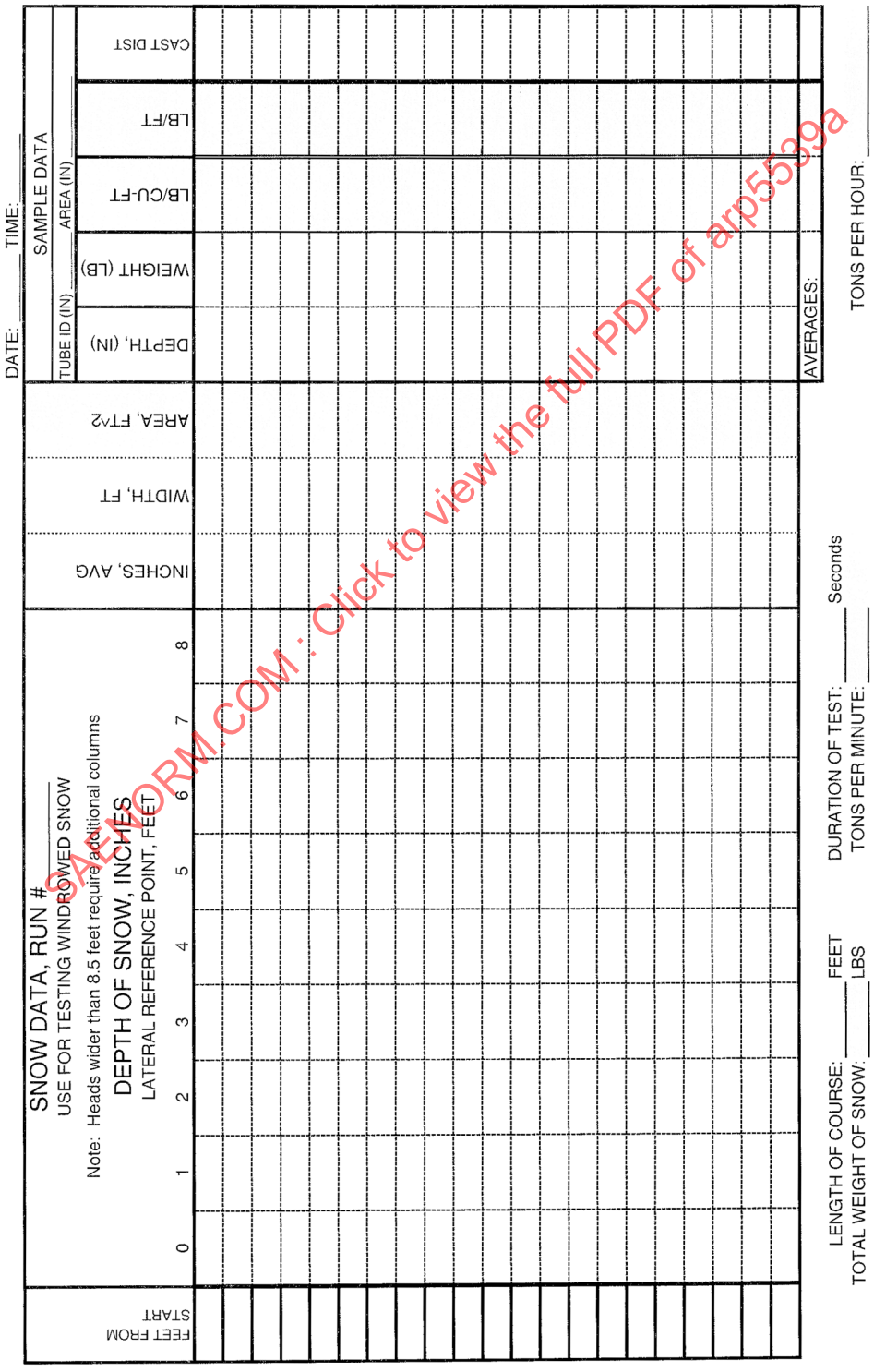
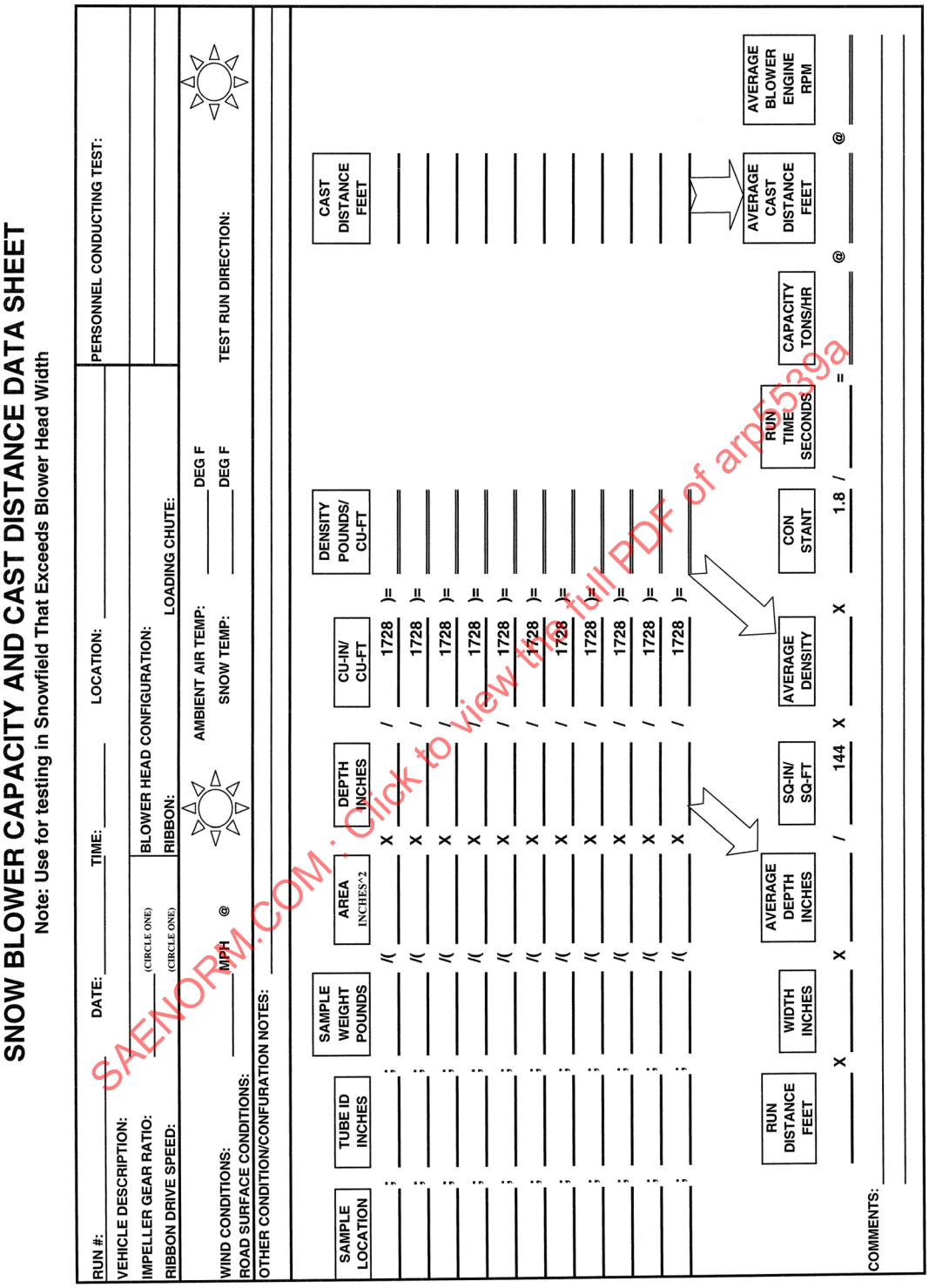


Table 2 - Windrowed snow



APPENDIX A - PERFORMANCE TESTING

A.1 OBJECTIVE

The objective of this procedure is to determine the tonnage and casting capacity of a rotary snow blower. Potential suppliers of rotary plow equipment in response to requirements based on this SAE document shall conduct capacity tests based on this procedure. Testing is not required on the production unit prior to delivery, but shall be conducted on a prototype or vehicle of similar configuration with similar components and design to that being offered.[1]

A.2 CRITERIA

The snow removal unit with blower attached shall make at least three snow removal passes in a windrow or snow field not less than 18 inches deep. In each pass, the snow removal unit shall clear a path not less than 500 feet long by the full width of blower head, or along the length of a constructed windrow.

Snow depth and density shall be determined in at least five intermediate locations evenly spaced along the path and an average value calculated. Whenever possible, density shall be determined from a vertical section of the snow depth.

The time required to complete each pass shall be measured by a stop watch. The volume of the snow removed shall be determined by the procedure contained in this appendix.

Measurement of snow shall be the appropriate measurement method described herein. The snow removal rate shall be calculated by means of the formula below. The cast distance shall be measured to determine the casting ability of the vehicle by methods described below. A wind speed greater than 5 mph shall be considered unacceptable for testing cast distance and cast distance testing shall be rescheduled.

There shall be no adjustment to calculated capacity based on shear strength of the snow.

In capacity testing for a unit deemed to be a “high-speed” unit, the size of the windrow or depth of the snow field must be limited to allow the vehicle to reach its intended tonnage (but not casting, because cast distances are affected inversely to speed) capacity at the required speed (greater than or equal to 25 mph). The maximum size must be calculated backwards from the required speed of the vehicle and density of the snow. For accuracy and applicability, high-speed testing should be conducted with a constructed windrow only, designed to simulate actual conditions expected.

A.3 PROCEDURE

Equipment required:

- 200 foot measuring tape.
- Stopwatch.
- Soil conservation coring tools, 12 inch for horizontal samples, and of sufficient length for vertical samples as test conditions may require. Note that density sample accuracy increases as the inside diameter of the sampling tubes increases.
- Large aluminum or plastic spatula.
- Accurate scale.
- Wind speed indicator.
- Marker cones or bright and dark colored spray paint.

[1] Examples of components and designs whose change materially affect blower capacity include, but are not limited to, such items as impeller and ribbon dimensions, impeller and ribbon gear ratios, clearances, tolerances and design, and drive systems, engine horse power, engine torque, and variations in parasitic loads required of the blower engine.

A.4 SNOW FIELD TEST

Prior to each test run the wind speed shall be measured. A wind speed greater than 5 mph shall be considered unacceptable and testing shall be rescheduled.

A snow field can be an undisturbed field of snow, or snow can be moved, windrowed, and shaped to the desired configuration depth. For a snow field test, snow depth must be a minimum of 18 inches, but less than the intake height of the blower. For its entire length, the snow field must be wider than the blower head and of a consistent depth across and outside the blower head to help assure accuracy of the testing.

The snow field shall be a minimum of 700 feet long and clearly marked every 100 feet. The test shall be conducted through at least 500 feet of the course. Approximately 100 feet is required at the beginning of the test field to allow the operator to adjust the speed and operation of the vehicle to achieve optimal, maximum tonnage and 100 foot cast distance (see below) in the conditions. Sufficient additional snow is required at the end of the test field to assure accurate timing through the entire 500 foot test length.

The vehicle shall make a snow removing pass through the entire length of the prepared site. The time required to make the complete 500 foot pass shall be measured and recorded. A minimum of three such tests shall be conducted.

During the test, the cast distance from the centerline of the snow removal unit's path to the center of mass within the perimeter of the cast pattern shall be measured and recorded. At a minimum, this measurement shall be marked at each 100 foot interval. Because the momentum of cast snow tends to slide it further away from the blower's path, care shall be taken to mark the landing point of the center of the mass and not its final position.

Figure A1 - Measuring the rotary plow's width and depth pass when employing the field testing method

After the blower's test pass, measurement of the blown path is made.

The overall width of the blower's path shall be measured. This should be consistent for the entire test track.

Depth of snow is determined on both sides of the blown path. Depth measurements shall be taken at each 100 foot interval on both sides of the blower's path. Depth shall be determined by tape measure from the pavement surface to the surface of the snow on both sides of the blower's path. The measured depths shall be recorded.

The residue left after the blower passes shall be measured at each measurement site, recorded, and subtracted from the measured depth.

NOTE: It is recommended that the depth measurement be taken from the snow surface to the pavement and a separate measurement of the residue be gathered and recorded. The ability to adjust a blower to an acceptable and/or desirable level of residue is a critical factor in snow blower evaluation and should receive attention and visibility.

Snow density measurements shall be taken at a minimum of five evenly spaced intermediate locations along the test site on both sides of the blower's path, including the beginning and end of the marked course. Density measurements must be taken at each individual snowfield run immediately after the snow blowing run is complete.

Density samples shall be obtained by taking a vertical sample from the snow surface to the pavement. Snow density samples shall be taken with a soil conservation service coring tool or similar device. The volumetric capacity of the coring tool must be known and the empty coring tool(s) must be accurately weighed.

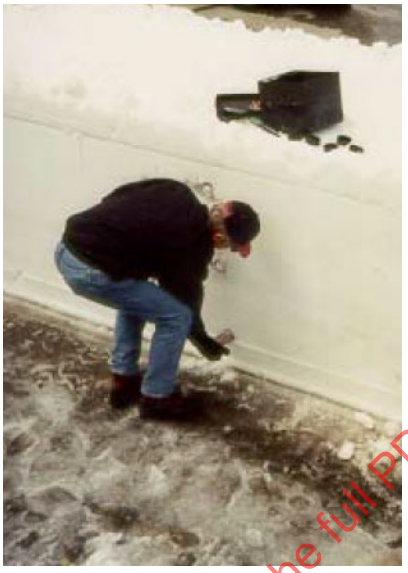


Figure A2 - Using the coring tool when field testing

The 24 inch coring tool shall be forcefully inserted through the snow to the pavement surface directly alongside the blown path.

If snow depth is less than the length of the coring tool, make sure the tool's bottom end rests on the pavement surface and remains there throughout this activity. Snow from around the tube is shoveled away from two sides. The third side must remain undisturbed to allow an accurate tape measurement to assess the actual volume of snow contained within the coring tool.

A flat aluminum spatula or similar tool shall be slipped between the pavement surface and the bottom of the coring tool. The coring tool and its contents of snow are moved on the spatula away from the original location and placed on a scale. Extraneous snow shall be removed from the outside of the tool and the scale's surface, and an accurate weight of the tool and its contents is taken and recorded.

If the snow field is greater than the length of the coring tool, three density core samples should be taken horizontally from each side of the test pass at each sample location. Using the 12 inch coring tool, take one sample approximately 8 inches from the pavement surface, one at mid depth, and one approximately 8 inches below the snow surface. For accuracy of data, care shall be taken to assure all snow within the sample be included in the calculation. Conversely, care shall also be taken to assure no additional snow is packed into the coring tool. These samples are then averaged to provide a relatively accurate density for the snow field.