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Airport Runway Brooms

RATIONALE

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1. SCOPE

This aerospace recommended practice provides definition for Airport Runway Brooms and covers requirements for various configurations of runway brooms with and without a carrier vehicle. Runway brooms are primarily used to move and clear snow and ice down to bare pavement on airport operational areas such as runways, taxiways and ramp areas. The term carrier vehicle represents the various self-propelled prime movers that provide the forward motion of the various configurations of runway brooms.

1.1 Purpose

This aerospace recommended is intended to establish definition and minimum standards specification for Runway Brooms. It is subject to change as technology and requirements change. Other considerations such as local conditions, maintenance, commonality of fleet, product support, and advances in technology should also be used when specifying equipment.

2. REFERENCES

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

2.1 SAE Publications

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

J931	Hydraulic Power Circuit Filtration
J1503	Performance Test for Air-Conditioned, Heated, and Ventilated Off-Road, Self-Propelled Work Machines
J185	Access Systems for Off-Road Machines
ARP5943	Snowplows and Hitches
ARP5539	Rotary Plow with Carrier Vehicle
R-159	Dictionary of Automotive Engineering, Don Goodsell, 1995

2.2 AGMA: American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, VA 22314-1581 USA, Phone: 703-684-0211, Fax: 703-684-0242, www.agma.org.

2.3 FAR & FAA Publications

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

AC 150/5200-30A	Airport Winter Safety and Operations
AC 150/5200-18	Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials
AC 150/5210-5B	Painting, Marking, and Lighting of Vehicles on an Airport
AC 150/5220-20	Airport Snow And Ice Control

2.4 Federal Spec 297 D, Rustproofing of Commercial (Nontactical) Vehicles

2.5 FMCSR Publications

Available from Federal Motor Carrier Safety Administration, 400 Seventh Street SW., Washington, DC, 20590; Internet address: <http://www.fmcsa.dot.gov>.

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

2.6 FMVSS Standards-latest edition

2.7 RTCA Publications

Available from Radio Technical Commission for Aeronautics Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

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

3. DEFINITIONS

See also, Dictionary of Automotive Engineering, Don Goodsell

Airport runway Broom: A device designed to clean snow, slush and ice; and when specified, other materials such as sand, snow and ice control chemicals, debris, rubber residue, and other materials from airport runway, taxiway, and ramp areas by using a brush with bristles to clean the surfaces.

Air Blast: A device for developing and directing a continuous stream of forced air ahead or behind the brush for moving snow and debris.

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

Axle Capacity: The allowable weight load on an axle based on supportive engineering data and the best judgment of the manufacturer of the axle.

Axle Ratio: The numerical ratio of the drive shaft speed to the speed of the axle. The numerical ratio equals the torque multiplication factor of the axle.

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

Axle, Live: A means of support for the wheels at each end that is driven.

Broom: A complete operating unit. A broom contains a brush with bristles that sweep.

Broom Capacity Rating: The amount of snow moved per unit of time, normally in tons per hour, resulting in an acceptable surface condition.

Brush Core: The center rotating structure which supports the bristles

Brush Head: The portion of the runway broom which supports and carries the bristle and its core

Brush Hood Cover: A cover for the top half of the brush.

Brush: The rotating cylinder of many bristles

Brush Angling System: The capability of angling or rotating the brush head to allow the discharge of snow to the left or right of the carrier vehicle when moving in a forward direction. The angle is changed from the operator's position in the cab by use of a system such as hydraulic rams, hydraulic or electric motors, or other devices or mechanisms.

Brush Elevation Mechanism: A device for raising and lowering the brush. The height is changed from the operator's position in the cab by use of a system such as hydraulic rams, hydraulic or electric motors, or other devices or mechanisms.

Brush Pattern: The width, perpendicular to the brush core, of the area the rotating brush contacts with the surface in the down position.

Brush Pattern Adjusting System: A system for adjusting the pattern of the brush

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

Cab Conventional: A cab mounted just behind the drive engine for the chassis.

Cab Forward: A cab mounted to the most forward position on the chassis

Cab-Over Attachment: A cab mounted over the front attachment.

Cab-Over Engine: A cab mounted over the front mounted engine.

Carrier Vehicle: The prime mover for a runway broom of any configuration

Casting Distance: The distance the snow moves left or right measured perpendicular to the vehicle travel from the broom end, to the center of the area of most concentrated snow cast observed during casting.

Center Drive Brooms: Brush driven from the center position of the brush head.

Certification:

Application Approval: Confirmation by a manufacturer or qualified expert that the unit or component fulfills the requirement of the application.

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

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

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

Deflector (Brush): A device mounted on the front of the brush hood to allow the operator to direct the snow casting. The deflector position is changed from the operator's position in the cab by use of a system such as hydraulic rams, hydraulic or electric motors, or other devices or mechanisms.

Deluge System: A means of providing large amounts of fluid to windshield(s), side and rear window(s), mirror(s), and other surfaces to improve operational visibility from the cab.

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

Differential, Automatic Locking: The gear assembly in the transfer case that allows the front drive-shaft to turn slower or faster than the rear prop-shaft when negotiating a turn while providing maximum driving torque to both the front and rear axles. The gear assembly on the drive axle that permits one wheel to turn slower or faster than the other when negotiating a turn.

a turn while providing maximum driving torque to both wheels. Automatic locking differentials provide positive drive to both driven members while not requiring operator input or control.

Differential, Manual Locking (bevel gear): The gear assembly on the drive axle that permits one wheel to turn slower or faster than the other when negotiating a turn 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.

Dimensions:	AE	Centerline of rear axle/tandem to the end of frame.
	BA	Bumper to centerline of Front axle
	BBC	Bumper to back of Cab
	CA	Back of Cab to centerline of rear axle
	CE	Back of cab to end of the frame (AE + CA = CE)
	FH	Frame height from the ground to the top of frame
	OAL	Overall Length
	WB	Wheelbase
	OAH	Ground to top of highest point on the unit

End Drive Brooms: Brush driven from one or both ends

FMVSS: An abbreviation for the Federal Motor Vehicle Safety Standards.

FOD: Foreign Object Debris. Anything that does not belong.

Front/Rear Axle Disconnect: A mechanism designed to engage and disengage power to the axle.

Fuel Capacity: The actual volume of fuel able to be stored in on-board tanks.

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

Gear Ratio: 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.

Geared Speed: The theoretical vehicle speed based on maximum governed engine RPM, transmission gear ratio(s), driving axle ratio, and tire size.

Gears, Single & Multiple Reduction: Single reduction gearing refers to one speed reduction through the gearing component. Multiple reduction refers to more than one step of speed reduction through the gearing component.

Grade-ability: The percent grade that a vehicle will negotiate

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

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

High Speed Broom: A runway broom designed to perform at its maximum Capacity Rating while operating at a forward speed of at least 25 MPH.

Hitch. A device to couple/uncouple a working head or appliance to its carrier vehicle.

Horsepower, Gross brake (or actual delivered horsepower): A measure of the rate at which work is produced. The time rate of doing work, as measured by a Prony brake or dynamometer. Brake horsepower is expressed as the torque in foot – pounds times the number of revolutions per minute divided by the constant 5252.

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

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

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

Impeller (Air blast): The internal rotating portion of the air blast which produces the air movement.

Maximum Tire Load Rating: The load rating at the maximum permissible inflation pressure for that tire

Maximum Permissible Inflation Pressure: The maximum cold inflation pressure to which a tire may be inflated.

Maximum Speed: The speed attainable by accelerating at maximum rate from a standing start for one mile.

NHTSA: An abbreviation for the National Highway Traffic Safety Administration

New and Current Production Components: new, unused and free of all defects and imperfections that could affect the serviceability of the finished product. Component with a manufacture date no older than one (1) year prior to bid proposal.

New and of Current Production Unit (as in total unit Chassis and attachments): Unit whose manufacture (assembly of) started no earlier than the award date of the contract.

Performance Rating: Capacity Rating.

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

Power 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.

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

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

Reflectors: Glass or plastic prism lenses which reflect light.

Resisting Bending Moment (RBM): A calculation used to compare frames of different section modulus and of different material. It is the product of the section modulus times the yield strength of the frame material. The formula expression is:

$$\text{RBM} = \text{Section Modulus} \times \text{Yield Strength}$$

Road Rolling Resistance: Sum of the forces at the area of contact between a vehicle's tires and road surface acting against the direction of movement.

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

Rolling Radius: Height measured from the center of the axle to the ground

Serial Number: A unique number issued to a vehicle or to a component of a vehicle for identification purposes. Also see VIN number.

Single Engine Runway Broom: Runway broom with a single engine that provides power to both the chassis motive power and the brush head.

Snow Shield: A cover positioned over the brush hood, designed and intended to minimize cumulative weight caused by the accumulation of snow on the brush assembly, which can have a negative effect on the brush pattern.

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

Steering, All Wheel: Any system that augments the steering action of a chassis, providing for power or power assisted steering controlled by the operator in the cab, on all wheels of the vehicle.

Steering, Power: 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. A backup system must be provided to maintain steering at all times.

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

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

Structural Member: A part of a vehicle designed primarily to support the load of a vehicle in operation

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

Swept Surface Condition: A measurement of coefficient of friction (braking action) from a friction measuring device after being swept. Also a visual inspection of whether the surface is clean and bare with no remaining debris or chunks of snow and ice.

Third Party: A disinterested party professionally qualified to observe, understand, and/or record test data other than the manufacturer that is acceptable to the purchaser.

Tilt Cab: A cab that pivots forward to gain access to the engine or other major component.

Tire Clearance: Space between tires and the nearest part of the body or under-structure.

Tons per hour: A function of snow density x depth of snow x swept path x vehicle speed.

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

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

Transmission: Selective gearbox providing various combinations of gear ratios.

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

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

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

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

Tread; Wheel Track: a) The distance between the centers of tires on the same axle at the points where they contact the road surface. Duals are measured from the center of dual wheels. (b) That portion of a tire that comes into contact with the road. c) The pattern of the surface of the tire that comes in contact with the road.

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.

Turning Circle, wall to wall: The diameter of a semi-circle described by the outmost edge of the vehicle and / or attachment while the vehicle maneuvers through an 180° turn and the attachment is at its worst case position.

Two-Speed Axle: A driving axle arrangement whereby the driver can select one of two ratios.

Vehicle Identification Number (VIN): A unique number issued to a vehicle for identification purposes. Format and code of a VIN is prescribed by law to identify manufacturer, configuration, and date of production.

4. RUNWAY BROOM USES

Airport runway brooms are primarily used to clean snow, slush, and ice from airport runway, taxiway, and ramp areas by using a brush with bristles to clean the surfaces. When specified other uses for runway broom are:

- **Rubber removal:** The brush is used to agitate and scrub the pavement with the aid of a rubber removal solution.
- **Dirt cleanup:** The broom is used to clean and move dirt and debris from pavement. A FOD box (large collection bin) can also be attached to the front of the broom for high speed FOD and debris pickup.
- **Cutting ice:** Using an all wire bristle brush, the broom is used at slow speeds to cut through hardpack and ice.

5. RUNWAY BROOM CONFIGURATIONS

There are many configurations of runway brooms with many different carrier vehicles providing the forward motion for the runway brooms. Typical configurations are described below and one is to be chosen by the user.

The front mount type clears snow before passing wheels or plow blades have a chance to compact and push the snow into the grooves and pores of the pavement.

5.1 Front Mount Dedicated

This type is a pushed broom and air blast only and configured with the broom preceding the carrier vehicle allowing the operator to observe the area being swept. Two power plant configurations possible are: a single engine that provides the power to the broom, high velocity air blast and the motive power. Or a dual engine; one engine provides power to the broom, air blast and the other engine provides motive power.

Visibility of the sweeping operation allows the operator to see the area being swept. The compact design enables maximum maneuverability in confined areas. The unit can only be used for brooming. It is not capable of sharing attachments with other similar equipment.

5.2 Front Mount Dual Purpose

This type is identical to the Front Mount Dedicated except it has the ability to accept a plow in place of the broom, making the unit capable of sweeping or plowing. An interchangeable hitch is required for the plow and broom, allowing fast changeover. The auxiliary engine is dedicated to the broom and air blast power requirements. The carrier vehicle engine is normally larger (more horsepower) than the Front Mount Dedicated broom configuration for pushing power for the plow.

5.3 Front Mount Multi Purpose

This type has the ability to accept a rotary plow in place of the broom or plow making the unit capable of sweeping, plowing or snow blowing. Not simultaneously. Again, an interchangeable hitch is required for fast changeover.

An interchangeable hitch is required minimizing changeover time, however snow removal operation time will be lost during the changeover.

5.4 Loader Mounted

This type has the broom preceding the loader. It requires an auxiliary engine dedicated for the broom and air blast. The engine assembly can be attached to the loader arms or mounted on the back of the loader chassis if the weight distribution allows this. The size of the broom must be matched to the capacity of the loader. Since the loader quick attach is used, changeover times to attached the broom are minimal. Sweeping speed may be limited due to the maximum speed of the loader.

5.5 Tractor Mounted

This type normally has the broom preceding the tractor. Power for the unit comes from the power take-off shaft (PTO) of the tractor. For efficient snow moving capacity, the PTO of the tractor must be adequate for the projected snow removal requirements. The uses, advantages and disadvantages are the same as the loader mounted. The tractor mounted broom is ideal for small area sweeping. Sweeping speed may be limited due to the maximum speed of the tractor.

5.6 Tow Behind

This type utilizes a trailer frame with and auxiliary engine for the broom and air blast, towed by a vehicle. The hitch to the towing chassis can either be a:

- Fifth-wheel type hitch with jackstand
- Direct pintle hook with jackstand
- Pintle hook on a tow pole with castoring front nose wheel. This is used when the towing vehicle cannot carry the weight load of a direct pintle. This configuration is very difficult to back up since there is an additional pivot point.

The operator controls for the broom are in the towing vehicle cab and are ergonomically mounted for use by the driver. The controls can either be integrated or in a removable box with quick disconnects.

The axle(s) on the tow broom frame can either be fixed or steering type as defined by the user. The steering type shall allow the broom to follow the towing chassis and ultimately keeping the broom in the plowed path.

5.7 Multi-Tasking (MTE)

This type is defined as a minimum of Plow, Broom, and Air blast. See ARP 5548 for complete description of this configuration.

6. TECHNICAL REQUIREMENTS / GENERAL SPECIFICATIONS

The specific components and systems that make up a complete airport runway broom differ for various classifications and configurations, but in general they are similar. Because of the many different classifications and configurations, all specific components and systems cannot be specified in detail here. The intent here is to provide a basis from which the user can develop detailed specifications for procuring a runway broom. Based on local conditions and needs the user must specify the parameters required. Other considerations such as local conditions, maintenance, commonality of fleet, product support, and advances in technology should also be used when developing their detailed specification.

6.1 General Description

This airport runway broom will be primarily used in the sweeping and cleaning of snow slush and ice from airport runway, taxiway, and ramp areas. The broom must be manufactured expressly for airport pavement sweeping. All items of design and equipment not listed in these specifications, but involved in carrying out their intent, are required to be furnished the same as if these items were specifically mentioned and described in these specifications.

Components shall be new, unused, 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. Components should be readily accessible for repair and replacement, with minimal removal or disturbance to adjacent parts or components. Designs must use components within their rated values. Parts which are exposed to wear shall be capable of being replaced. Regular maintenance and servicing should be readily accomplished under normal working conditions.

All broom components shall be designed to provide continuous service under difficult working conditions in -20 degrees F to +100 degrees F weather conditions or as specified without degradation of performance. The broom shall be designed to allow bristles to be easily replaced once worn or damaged. When mounted on a carrier vehicle, no components of the broom shall interfere with the servicing and maintenance of the carrier vehicle.

The broom shall have the ability to remove snow, ice, slush, sand and other debris at the rated speed, capacity, and conditions per the following (Also see Table A2 in the Appendix):

- a) The broom must be able to move 3 inches of snow at 15 pounds per cubic foot at the rated vehicle speed and full swept path.

And,

- b) The broom must be able to move 1 inch of snow at 40 pounds per cubic foot at the rated vehicle speed and full swept path.

At a minimum, the user must specify (See Table A2 and Table A3 in the Appendix for typical values):

- Broom configuration (Select per section 5):
- Required speed of operation (MPH):
- Brush swept path (feet):
- Snow moving capacity (tons per hour):
- Surface area swept rate (square feet per hour):
- Broom power supply horsepower (horsepower):
- Brush diameter (inches):
- Brush rotation speed (0-RPM):

- Brush available torque (foot-pounds):
- Air blast capacities (CFM @ MPH):
- Bristle type and configuration:

Care must be taken by the user when specifying the capacity in Tons per Hour. The broom must have enough "Available Horsepower" to meet the capacity (Tons per Hour) requirements of the specification. See example in section 7.5 of the appendix.

To confirm the brush rotational speed and available torque values, the manufacture must supply engineering hydraulic power calculations of the brush drive train from the engine or power supply to the brush shaft. This includes sizes and specifications of all components of the brush drive train from the engine to the brush shaft including specification sheets for the broom engine, brush and air blast hydrostatic pumps, motors, and gearbox(s) showing type, size, and manufacture. Efficiency losses must also be accounted for. The calculations must be understandable, complete, logical, and in a mathematical order per the Society of Automotive Engineers (SAE) and the Fluid Power Society standard formulas and practices. The burdened of proof is the responsibility of manufacturer. Failure to provide this information for whatever reason will result in disqualification

6.2 Broom Chassis Platform

This section must be defined by user based on configuration

- 6.2.1 Carrier vehicle: The term carrier vehicle represents the various self-propelled prime movers that provide forward motion for the broom, such as a truck chassis, tractor, or loader per section 7. Due to the many variations and for simplicity they are not described here. Specifications for the carrier vehicle must be developed based on the application. The design of this unit shall ensure positive tire to ground tractive effort while sweeping and doing full wall to wall turning circle of 75 feet or less or as specified. Tests for maneuverability, meeting the wall to wall turning circle requested or proposed. A sample truck chassis specification for a heavy duty front mount dedicated configuration is supplied in the Appendix.
- 6.2.2 Tow broom frame: The tow broom chassis frame shall be fabricated from heavy gauge tubular, channel or wide flange sections reinforced as required to minimize loading distortion. It shall have gussets front to rear at each welded joint. It shall be designed to minimize flexing and bouncing bounce.

Axles for the broom frame shall be rigid suspension (no springs) type and shall use a standard truck axle and air brakes (or electrical, user to specify) for ease of service and parts availability. The axle, wheels and tires manufacturer's published rating shall at least be equal to the load imposed at the maximum load configuration. The equipment shall not overload the rating of the frame, axles, wheels, tires, or steering.

The suspension shall be rigid (no springs). All tires and wheels on the unit shall be interchangeable. User shall specify air or electric brakes. Air brake units shall have ABS brakes, FMVSS 121 compliant for trailers. When electrical brakes are used they shall be controlled utilizing an electric brake controller in the tow vehicle and shall be equipped with ABS brakes if available. The electric brake controller and connector shall be supplied and installed in the towing chassis by the user.

The hitch to the towing chassis shall be: (The user must define what best suits their requirements based on towing vehicle configuration)

- A single pintle lunette eye with height adjustment for chassis frame leveling and hydraulic jack stand for ease of hooking up and detaching. A single pintle hook shall be supplied and installed by the user at the rear of the towing chassis.
- A front dolly wheel with tow pole, 360 degree swiveling. A single pintle hook shall be supplied and installed by the user the rear of the towing chassis.

- Fifth wheel type with SAE 2" diameter kingpin with height adjustment for chassis frame leveling and hydraulic jack stand for ease of hooking up and detaching. The fifth wheel receptacle on the tow chassis shall be supplied and installed by the user.
- Dual pintle hooks with draw bar with height adjustment for chassis frame leveling and hydraulic jack stand for ease of hooking up and detaching. Two pintle hooks shall be supplied and installed by the user at the rear of the towing chassis.

When trailer steering is specified, the brush must follow in the plowed path at all times. There shall be provisions for centering and disengaging the axle steering system from both the main (cab) and service control consoles. There shall also be a provision for constantly and automatically recentering the steering system during operation to accommodate any drift in the system.

The lighting system, including reflectors, markers identification and clearance lights, shall conform to FMVSS 108 as though the vehicle were an on-highway vehicle. Customers may specify an all LED sealed wiring lighting system for reduced maintenance costs and improved lighting system reliability. 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 broom 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.

In addition at a minimum one high mounted stop light and a back-up alarm shall be provided.

6.2.3 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.

6.2.4 Vehicle Safety Identification Lights: The vehicle shall have a minimum of one revolving yellow beacon or flashing strobe mounted on its uppermost part (see FAA AC 150/5210-5B, Painting, Marking and Lighting of Vehicles on an Airport). The light emitted from the beacon should not reflect off rearview mirrors and into the operator's eyes.

An SAE 7 pin or 7-wire flat prong (type must be specified) trailer connector shall be supplied and installed by customer at rear bumper of the towing chassis by the user.

The wiring for broom controls, which shall be a harness with weatherproof and structurally sound connectors at both the cab and rear bumper, shall be supplied and installed by the manufacture. Trailer lights connector and the broom controls connector cannot be interchangeable.

6.3 Broom Engine Assembly (or Power Supply)

The broom engine manufacturer and broom manufacturer shall provide an application approval, at the time of sweeper delivery, which states the engine is suitable for use in the broom as configured and that the installation is approved by the engine manufacturer. The engine shall develop sufficient torque and horsepower to meet the operational requirements of the broom. It shall be of internal combustion type. It shall meet current (at time of build) federal emissions standards and local requirements as defined by the user. It shall be equipped with electronic controls for fuel injection and engine management including an automatic shutdown system with manual override and an electrical connector for diagnostic system. The diesel engine shall be designed and tuned for operation using ASTM D975-93 Standard Specifications for Diesel Fuel Oils, unless otherwise specified by the user, at the performance characteristics specified herein. Engine noise and vibration shall be minimized for the operator by use of best engineering practices and machine layout. The brush and air blast must be designed to efficiently utilize the rated engine horsepower.

The engine shall be provided with a full-flow replaceable oil filter and bypass filter and an air intake with a three-stage air cleaner. A filter restrictor indicator with tattletale features shall be supplied.

- External turbine type pre-cleaner or other means to prevent snow ingestion into the air cleaner
- Internal fixed vane centrifugal pre-cleaner
- Primary dry element and safety element