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CENTRAL WEST VIRIGNIA REGIONAL AIRPORT AUTHORITY
KANAWHA COUNTY, WEST VIRGINIA

ACQUISITION OF SNOW BROOM WITH AIR BLAST

ADDENDUM #2

OCTOBER 14, 2022

THRASHER PROJECT #060-10003.04

TO WHOM IT MAY CONCERN:

The following are clarifications and responses to questions posed by contractors for the above reference project.

A. GENERAL
None on this Addendum.

B. SPECIFICATIONS
3.2.3 Has been updated to reference FAA AC 150/5210-5D
A2.11 d has been updated to reference FAA AC 150/5210-5D
A2.14.1 has been updated to reference FAA AC 150/5210-5D

C. DRAWINGS
None on this Addendum

D. QUESTIONS AND RESPONSES
None on this Addendum

E. CLARIFICATIONS
None on this Addendum

If you have any questions or comments, please feel free to contact Thrasher at your earliest convenience. As a reminder, bids will be received until **10:00 a.m. on Tuesday, October 18, 2022** at The Thrasher Group, 600 White Oaks Blvd, Bridgeport, WV 26330. Good luck to everyone and thank you for your interest in the project.

Sincerely,

THE THRASHER GROUP, INC.

Jeff Gola, PE

JEFFREY L. GOLA
REGISTERED
15621
STATE OF WEST VIRGINIA
PROFESSIONAL ENGINEER

10/14/22

DIVISION 10 – TECHNICAL SPECIFICATIONS

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DETAILED SPECIFICATIONS INDEX

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1. DEFINITIONS

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 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.

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.

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

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:

RBM = Section Modulus x 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^{O} 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.

1A. REQUIRED SUBMITTALS

- DETAILED LIST OF PRODUCT OFFERINGS IN NEW EQUIPMENT
- WARRANTY
- TEST RESULTS THAT ARE INDICATED BELOW.

2. RUNWAY BROOM CONFIGURATIONS

2.1 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.

3. 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. 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.

3.1 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:

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:

- Broom configuration: front mount dedicated
- Required speed of operation (MPH): 30
- Brush swept path (feet): 18 feet
- Snow moving capacity (tons per hour): 4752
- Surface area swept rate (square feet per hour): 2,027,520
- Broom power supply horsepower (horsepower): 475
- Brush diameter (inches): 46
- Brush rotation speed (0-RPM): 0-525
- Brush available torque (foot-pounds): 3100
- Air blast capacities (CFM @ MPH): 22000 at 400 mph

- Bristle type and configuration: 50/50 combination of polypropylene and wire

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

3.2 Broom Chassis Platform

3.2.1 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. 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.

The lighting system, including reflectors, markers identification and clearance lights, shall conform to FMVSS 108 as though the vehicle were an on-highway vehicle. A ll LED wiring lighting system should be sealed 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.

3.2.2 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.

3.2.3 Vehicle Safety Identification Lights: The vehicle shall have a minimum one front and one rear revolving yellow beacon or flashing strobe mounted on its uppermost part (see FAA AC 150/5210-5D, 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.

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.

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

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. 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.

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 by-pass thermostat that regulates the flow of engine coolant. Drain cocks shall be installed at the lowest point of the 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. Coolant shall be per engine manufacture recommendation and approval. A tag or label shall be supplied at the fluid servicing point indication proper coolant.

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 0 degrees F and/or units stored outside, cooling system heaters, oil pan heaters, lubricating oil heaters, battery heaters, and cold start aides are required unless otherwise specified.

Engine speed shall be regulated by a governor set to provide the maximum operating speed recommended by the engine manufacturer.

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

An automatic engine protection system to prevent engine damage due to low engine 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.

6.4 Fuel System

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

Fuel Tank(s) and Lines: Useable fuel capacity should be no less than an 8-hour supply unless the user requires a longer period. Engine literature shall be provided in the bid package that includes certified fuel usage rates. For estimating purposes, useable fuel capacity may be calculated using the value of: (total maximum brake horsepower for all engines) x (0.055 gals/hr/bhp) x (desired operating hours) x (0.5 for a 50% load factor). 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 (or 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 in the engine compartment or 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.

Fuel Filler Pipe: The fuel filler pipe(s) shall be located outside of the vehicle cab preferably accessible 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). If fuel fillers are not installed on both sides of the vehicle, a label shall be installed in the cab near the fuel gauge indicating which side of the vehicle must be positioned towards the fuel pumps (e.g., Fuel Fill).

6.5 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 J1292. All broom electrical equipment, components, and wiring shall meet the requirements set forth in ARP1247, latest revision. 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 by 10%. Insulation of electrical wiring shall be equal to the recommended standards established for insulation materials by the Society of Automotive Engineers (SAE). All wiring shall be either harness, cable, split loomed, or shrink-wrapped. All wiring shall be color-coded or wire numbered matching drawing schematics and terminal strip, and labeled every 3 inches as to what it is used for. The gauge wire and processes shall be in accordance with common wiring practices, SXL insulation type. The wiring codes shall match information to be provided in the supporting service manuals.

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 or RMF fields encountered from

any airport operations. EMF 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.

The broom shall be equipped with self regulating electric alternators having an output capacity that exceeds the anticipated electrical load by 20% at idle.

The 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. A battery master disconnect switch shall be provided with a means to secure it in the off position for servicing.

The vehicle shall have an electrical starter that shall not introduce a voltage drop sufficient to adversely affect the ignition system. It shall be equipped with an overload protection device if such device is available from the manufacturer of the starter.

- 12 volt electrical/24 volt starting.

6.6 Sheet Metal Components and Accessibility

The engine and other components shall be positioned to allow easy access for inspection and maintenance purposes. Components that historically require frequent maintenance or those that have the potential to cause operational problems should particularly be located in unobstructed areas. Fluid capacities that must be checked during a pre-trip inspection, such as engine oil, engine coolant, 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. Lighting in these areas shall be adequate to perform the checks without the need for flashlights or other portable lighting. Cover plates shall be equipped with either quick- disconnect latches or hinges. Locks, controls and latches shall be designed to prevent over-torquing.

6.6.1 Engine Enclosure: The broom engine, as well as all attached hydraulic, electrical, and mechanical components, shall be protected wherever practical from snow, rain, chemicals, and other winter elements. Enclosures may be fabricated from aluminum, fiberglass, steel and/or other durable material commonly used for this application. Self tapping bolts are unacceptable in the construction of these enclosures. The enclosure shall be designed with openings which allow adequate cooling air flow to prevent overheating of the engine and other components. Adequate switched lighting shall

be included. Drain lines shall be provided for engine oil, radiator coolant and hydraulic oil.

6.6.2 Steps: Steps, stairways, ladders, walkways, handholds, and handrails used to access the cab, maintenance areas, operation areas, or other areas of the equipment shall conform to the most recent additions of J185 – Access Systems for Off-Road Machines, using the "preferred" dimensions offered in this standard. When required, four-way 'safety tread' design steps shall be supplied to ascend and descend certain high profile area. These steps, together with assist handles, shall be of ample size to ensure safe and easy access for persons wearing bulky winter clothing.

6.6.3 Walkways: A four-way safety tread design walkway shall be provided, as necessary, for access.

6.6.4 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.

6.6.5 Doors: Door openings of adequate size to facilitate equipment servicing shall be provided. 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).

6.6.6 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.

6.7 Broom Hitch

The broom hitch shall be capable of sustaining all loads imposed during operation. It shall provide low friction and free flotation for the brush head for bounce and skip free operation. It shall allow the brush head to be independent so the broom chassis does not induce bounce into the brush. The broom hitch shall have the necessary degrees of freedom to follow normal contours in the pavement and to accommodate surface irregularities, while sweeping at the rated speed, bouncing skipping, binding or sustaining damage. The broom oscillation shall provide true flotation left to right for the brush head. It shall have at least 8 degrees (+4, -4) of free floating oscillation from left to right.

For some configurations, an interchangeable hitch and hydraulic connections is required allowing fast changeover. There are various types of hitch and hydraulic connections which the user must specify.

6.8 Brush Angle

The brush angling mechanism shall be power actuated and controlled by the operator. The brush shall be capable of swinging at least 30 degrees left and 30 degrees right from the straight ahead position. Angling from full right to full left shall not take more then 10 seconds and shall not change the brush pattern. In between full left and full right, the pattern shall not change more then 50%.

6.9 Brush Elevation and Brush Pattern Adjustment

The brush elevation mechanism shall be power actuated and controlled by the operator, typically a joystick, which shall raise the brush off the surface and lower it for sweeping. The elevation mechanism shall have adequate stroke to achieve 4 inches of ground clearance with a new brush. The lift cylinders shall be equipped with a counterbalance valve, which prevents the brush head from creeping down.

An easily adjustable and accessible height adjustment that sets the brush pattern shall be provided. The adjustment, when preset, shall act as a stop for the elevation mechanism allowing repeatable pattern adjustment. A toggle switch near the adjustment for remote brush elevation control and pattern confirmation shall also be provided.

6.10 Brush Head

The brush head frame must sustain the loads imposed by the snow removal capacity of the unit. The brush head and air blast shall be hydrostatic drive with infinitely variable speed hydraulic pump(s) and fixed displacement motor(s) or as specified by the user. If gearboxes are used they shall be made with precision gears, AGMA 10 rating minimum, and a method for checking oil level without the use of tools. Hydrostatic motor(s) shall be tightly coupled to the brush core shaft with no looseness in any connection. The connection must be capable of handling the loads imposed by the hydrostatics.

The brush shall be vibration analyzed at final inspection with report on vibration provided upon request.

The brush head shall allow an easy access for core and / or bristle replacement allowing repeatable location of brush centerline alignment during brush core remove and replace operations.

6.11 Brush Hood

The brush hood shall be fabricated from heavy gauge sheet steel or other durable material and securely fastened to the brush frame. It shall shield the top half of the brush completely and shall be nonclog design to prevent snow and ice buildup underneath the hood. It shall provide the necessary quick access to the brush for replacement of bristles and for inspection.

There shall be a device on the front of the hood to strip the snow from the brush, preventing snow carryover from the front of the brush to the back of the brush. It shall be the full length of the brush. The device must be easily adjustable to the brush diameter as the bristles wear.

The broom must have the capability to control the snow and ice once it is airborne. The snow must be put where and only where the operator desires and the operator must have visibility. The snow control device must be automatic or adjusted by the operator from the operator control station.

6.12 Broom Casters

The weight of the brush head shall be supported by swivel caster tire assemblies. They shall be mounted along the rear of the brush frame. The quantity of tires shall be commensurate with the loading from the brush head. The mounting position must be spaced for uniform weight distribution and shall track within the swept path of the brush. The caster tire assembly shall be capable of revolving a full 360 degrees or 270 degrees if the brush head raises automatically when reversing the vehicle. The caster assembly shall not bind or come into contact with the brush or any other surface of the broom throughout their full rotational arc. Loading and operating speed of the broom shall not overload the caster assembly manufactures rating of the entire caster assembly including the tires, wheels, hubs, bearings and shafts. To keep the caster assembly from shimming, a shimmy damper device is required for each assembly. The mounting of the tire, wheel, hub, shaft and bearings must be quick change type for easy change while on the airfield.

6.13 Brush Bristles

The bristles for the brush shall be designed for runway operation and shall withstand the normal operation of the broom. They shall be made with adequate retention to keep the bristle from falling out, fatigue strength to keep them from breaking, and wear resistance for acceptable life. The bristles shall withstand storage temperatures ranging from -60 °F to + 160 °F and operating temperatures ranging from -40 °F to +125 °F, without functional degradation due to the environment.

6.13.1 Wafers, Flat: The bristles shall be fastened in a radial wafer fashion and shall consist of a steel support ring filled with steel wire bristles or polypropylene (poly) bristles. The wafers may be separated by a steel spacer.

Typical wafer bristles dimensions are:

Outside diameter: 36 inch, Inside diameter = 10.75 +0.13 -0.00 inches

Outside diameter: 46 inch, Inside diameter = 19.50 +0.13 -0.00 inches

The support ring for the wafer shall be made of coil steel, minimum thickness 0.048 inch with edge protection to protect bristle from premature wear and breakage. All joints shall be welded to insure structural integrity. Each ring shall have steel drive pins to engage the sweeper core. These pins shall have a minimum diameter of 0.250 inch and 0.63 inches long with 0.50 inches of protrusion from the inside of support ring. One of the drive pins shall be installed at the center of overlap of support ring. The 46 inch wafer shall have not less than 4 drive pins spaced at 90 degrees around the inside circumference. The 36 inch shall have 1 or more drive pins. Each wafer shall be marked on the ring to indicate the point of maximum static unbalance. The maximum static unbalance for any wafer shall be 50 oz-in.

The wire bristles shall be crimped and made of zinc galvanized drawn steel wire. The bristles shall have a minimum diameter of 0.0165 to 0.0180 inch nominal with minimum tensile strength of 325 000 pounds per square inch (psi). The bristles crimp shall be not less than 3 crimps per inch at amplitude of 1/16 inch minimum. The total weight of the 46 inch wafer shall be 10 pounds minimum. The total weight of the 36 inch wafer shall be 5.5 pounds minimum.

The poly bristles shall be made from extruded and pulled strands. The material shall be virgin polypropylene with UV inhibitor. Typically the bristles shall have an oval cross section not less than .060 x .090 inch with minimum tensile strength of 4800 pounds per square inch (psi). The total weight of the 46 inch wafer shall be 8 pounds minimum. The total weight of the 36 inch wafer shall be 5 pounds minimum.

The spacer ring which separates the wafer shall be made of coil steel with a minimum thickness of 0.048 inch. Forming the spacer shall create a flat bottom cross section with a welded overlap end seam to create adequate stiffness and strength to withstand the load imposed.

6.14 Brush Cores

The core shall be bearing supported and may be driven from either end, center, or from both ends. Each core shall be individually dynamically balanced by the manufacture at rated RPM. The bristles on the cores shall be full width to the rated length and replaceable. All steel on steel couplings of the drive and core must be replaceable hardened steel.

6.14.1 Wafers: The cores shall be made of tubular steel construction with four hardened steel (163 Brinell hardness minimum) drive bars, equally spaced to center each wafer bristle. The diameter which the four drive bars create must be such that the wafer bristle is easily installed and removed but not to allow movement of the wafer bristle on the core. The diameter of the core must also be industry standard for compatibility of various bristle manufacturers.

6.15 Forced Air Blast

The system shall feature either a single or double inlet centrifugal blower. Unless otherwise specified, the centrifugal impeller(s) shall be hydrostatically driven including a variable displacement pump and fixed displacement motor(s). It shall be capable of varying its speed allowing blower speed from the operator station.

Air duct(s) shall be installed at the outlet of the impeller(s). Nozzles(s) shall be attached to these air duct(s). Nozzle ends shall direct the flow to one side or the other. When the brush is angled, the airblower direction shall be capable of automatically following, directing air perpendicular to the direction of travel and toward the direction of broom discharge. The nozzles direction control shall be interlocked with the brush head angle to blow in the direction of broom casting thus controlled by the operator's joystick. A separate control shall allow the nozzle direction opposite of the brush angle by choice. The controls shall permit blowing without broom operation. All controls for the air blast shall be operated from the operator station.

The air ducts shall retract within the width of the vehicle for transport and storage unless otherwise specified. There shall be 8 inches of ground clearance minimum when raised unless otherwise specified.

The impeller / shaft assembly(s) shall be dynamically balanced at the rated RPM. The velocity and CFM at each nozzle shall be certified by an independent test facility and supplied with the bid.

6.16 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 detrimental reduction in power response.

All controls shall be located in the vehicle cab. All hydraulic functions of the broom shall be electric over hydraulic valving. Connectors to the solenoids shall be interlocking type to

provide a secure connection, which can withstand normal pressure washing procedures. All positioning functions (for example but not limited to: brush head lift, brush head swing, deflector, and air nozzle lift) shall be equipped with a position locking system as necessary to prevent unwanted movement. There shall be no hydraulic lines within the operator station

The system shall be ruggedly constructed and able to withstand all imposed loads. It shall maintain operating temperatures suitable to all system components throughout normal operating conditions. The hydraulic system shall meet the same low temperature requirements as the engine coolant system.

Filters within the hydraulic system shall conform to the Society of Automotive Engineers (SAE) Information Report, SAE J 931- Hydraulic Power Circuit Filtration. Proper filtering shall be done on both the high pressure and low pressure circuits. There shall be a 5-micron absolute rating on the hydrostatic pumps' filters and placed in the charge pressure lines. There shall be a clogged filter indicator light at the operator's station indicating filter replacement. Shut off valves for all filters below tank fluid level shall be installed to allow filter changes with minimal loss of oil.

All hoses for all systems shall be properly sized and strength to work with the pressure and volume of oil required and have the appropriate temperature ratings for the climate conditions in which they will be used. 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. Where required, hoses should be equipped with quick couplers as necessary to facilitate rapid removal and attachment.

The hydraulic fluid tank shall have; a filler neck with a strainer, a drain plug, a shutoff valve, an air vent and baffles. Its capacity shall exceed the volume of oil required for the operation of any combination of attachments by 50 percent. A sight glass shall be provided to allow the operator to verify that fluid level is sufficient for safe operation without the necessity of opening the system. A low oil level warning and engine shutdown device shall be provided in the cab. A high hydraulic oil temperature warning and engine shutdown devise shall be provided in the cab. A low hydraulic oil temperature or high back pressure warning shall also be provided in the cab.

6.17 Controls and Instrumentation

All controls shall be electric over hydraulic type. All instruments and controls shall be labeled in a manner to remain legible for the life of the unit and shall be illuminated. The operator station shall be conveniently mounted in-cab, user friendly and easily accessed by operators wearing heavy winter clothing. 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. The controls shall allow the operator to direct all functions required to fully operate the equipment. Gauges showing fluid pressures, temperature, and warning readings shall also be furnished. Instruments should display urgency-of-action lights, i.e., green for normal operation, amber for warning, and red for emergency. 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.

The operator's control shall have diagnostic capabilities for the broom, broom engine, and air blast. It must incorporate automatic diagnostics which displays what is wrong with a particular system. All systems for the broom and broom engine must be part of the diagnostics

The operator's control in the chassis cab shall have all the necessary functions to operate the broom and air blast and shall have the following:

- System On / off (keyed)
- Joystick for lift/lower and left/ right swing. The brush swing, lift and blower nozzle shall have automatic one touch for cycle control. This allows the operator to have hands free operation during cycle movement. Moving the joystick in the opposite direction can reverse the cycle. An additional switch shall allow the operator to use the automatic control or disengage the system.
- Engine oil pressure with visual and audible warning alarms
- Engine coolant temperature with visual and audible warning alarms
- Hydraulic oil temperature with visual and audible warning alarms
- Fuel level with low fuel visual and audible warning alarm
- Low coolant level alarm
- Engine tachometer
- Voltmeter and warning indicators
- Alarms for engine diagnostics and visual warning indicators and displayed faults.

- Lights On / Off
- Deflector Up / Down
- Mode Auto / Manual
- Brush On / Off and speed adjustment
- Blower On / Off and speed adjustment
- Engine hour meter
- Brush down and operating hour meter for determining brush life
- Single circuit breaker with Master Battery disconnect

An additional "service" control station shall be supplied unless otherwise specified, at the broom engine assembly when the broom engine is not installed on the carrier vehicle such as a tow broom. This service control station shall have all of the same features as the main operator's control in the chassis cab. In additions it shall have a selector switch for main or service controls station. The service control station shall have engine speed control priority over main control station.

6.18 Finish and Paint

The broom shall be painted Chrome-Yellow in accordance with FAA AC 150/5210-5B: Painting, Marking, and Lighting of Vehicles on an Airport or as specified. The rear of the broom head on a front mounted broom shall have a non-glare finish to reduce glare for the operator or as specified. Other configuration brush heads can have a non-glare finish.

All equipment shall be cleaned first, then treated as necessary per coating manufacturer's recommendations with; corrosion inhibitor, primer, putty, sanding, and finally, the finish coating process. The coating of customer specified color shall be applied per the coating manufacturers approved process and shall consist of polyurethane enamel, acrylic enamel, acrylic urethane, or similar high durability, long life coating having a combined thickness per the manufacturer's recommendations.

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.

6.19 Technical Publications

The manufacturer shall furnish two complete sets of manuals. One in hardcopy form and one in electronic format. The set of manuals shall consist of:

- Operation, Maintenance, and Troubleshooting manual
- Supplied equipment manual
- Parts manual identifying every part on the unit both in parts list form and exploded view or schematic form in the case of electrical and hydraulic

6.20 Delivery, Start-up and Training

The unit must be fully assembled and tested prior to delivery. The manufacturer is responsible for the safe and timely delivery of the broom and its accessories, spare parts, and tools to the place of delivery.

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. A qualified factory representative must fully install, start-up, and test the unit prior to training. Training shall be performed by a factory trained and authorized technician. The training shall be performed at the customer's site and shall be 4 hours for operators training and an additional 4 hours for mechanics training (mechanics shall attend the operating training first). The purpose of this training is to review safe and effective procedures for use and maintenance of the machine, review and test all systems, assure the full function of the machine.

6.21 Warranty

The equipment provided shall be warranted against defective materials and workmanship for a period of 12 months after the machine is delivered. Warranty includes replacement or repair of defective parts or material and the associated labor to perform the repairs

6.22 Additional Equipment to be included in bid:

- LED marker lights located per SAE ARP 5564. The LED light on the back of the cab should be an amber beacon (ex. Supplier is nROADS) The light should be controlled in the cab by the operator.
- An automatic lubrication system for all possible grease points. The system shall automatically deposit the correct amount and type of grease to the application per

manufactures specifications.

- 20 pound fire extinguisher (ABC rated).

- LED light bar should be included on the front of the cab that covers the full width of the unit that is also operable by the worker in the cab. The light bar can be either alternating white and amber or all amber (ex. Supplier Whelen, Towman's light bar)

- VHF radio and Maintenance radio (either Kenmore or Motorola that has external speaker) should be incidental to the cost of the snow broom. The airfield radio is to be iCOMA120, the owner will program to meet their frequency requirements.

- Complete spare set of boxed refill bristle wafers with spacers.

- A complete set of replacement caster wheels, tires, bearings and axle assemblies.

- Battery heater, cold start aids and a plug in (weatherproof) engine block heater

APPENDIX A – ADDITIONAL INFORMATION CONCERNING AIRPORT RUNWAY BROOMS

A.1 CARRIER VEHICLE

A.1.1 Carrier Vehicle Description:

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 four-wheel drive concept for optimized performance and safety. Although these units may not be designed as over-the-road highway vehicles, the following Federal Motor Vehicle Safety Standards shall apply as though they were an on-highway vehicle:

FMVSS 101 Controls & Displays

FMVSS 102 Transmission Shift Lever Sequence, Starter Interlock &

Transmission Braking Effect FMVSS 103 Windshield Defrosting &

Defogging Systems

FMVSS 104 Windshield

Wiping & Washing Systems

FMVSS 105 Hydraulic &

Electric Brake Systems FMVSS

106 Brake Hoses

FMVSS 108 Lamps, Reflective Devices, &

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 & 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 & Door

Retention Components FMVSS 207

Seating Systems

FMVSS 208

Occup

ant Crash Protection

FMVSS 209 Seat

Belt Assemblies

FMVSS 210 Seat Belt

Assembly Anchorages

FMVSS 302

Flammabilit

y 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-tasking, or they may be multi-purpose. They should conform to the manufacturer's recommendations and be suitable for mounting all specified accessories.

A.1.1.1 Materials: Materials used on a carrier vehicle shall conform to the specifications listed in the appropriate sections of Title 49, Chapter III, Federal Motor Carrier Safety Regulations. When not specifically listed, materials shall be of the best quality available for their intended commercial use. Component parts 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.

A.1.1.2 Design: Equipment shall be developed in accordance with the best engineering practices available. This 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.

A.1.1.3 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.

A.1.2 Chassis:

The design of the vehicle chassis shall be based on a four-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.

A.1.2.1 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.

A.1.2.2 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: 18 feet wide.

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.

A.1.2.3 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.

A.2.3 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 specified, the diesel engine shall be designed and tuned for operation using ASTM D 2 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 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.

A.2.3.1 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 by-pass thermostat that regulates the flow of engine coolant. Drain cocks shall be installed at the lowest point of the 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.

A.2.3.2 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°, cooling system heaters, oil pan heaters, lubricating oil heaters, battery and block heaters, and cold start aides required unless otherwise specified.

A.2.3.3 Fuel System: The fuel system shall comply with Title 49 and include all components necessary for a complete operational system.

A.2.3.4 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 (0.55 gals/hr/bhp) x (desired operating hours) x (0.5 for a 50% 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.

A.2.3.5 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 where possible. 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 (e.g., Fuel Fill $\rightarrow$).

A.2.3.6 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.

A.2.3.7 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.

A.2.3.8 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.

A.2.3.9 Lubrication: An engine's lubricating system shall be equipped with standard production fittings and accessories. Engine oil filter(s) shall be engine manufacturers approved design and 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.

A.2.3.10 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.

A.2.3.11 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.

A.2.4 Drive Train

A.2.4.1 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.

a. 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.

A.2.4.2 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 transfer case may be a separate unit mounted independently or integrated with the transmission. The transfer case can be manufacturer's standard as long as the vehicle is four-wheel drive.

A.2.4.3 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 brush up, down, right, left; 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.

A.2.5 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.

A.2.6 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. A ll wheel steer is required and is to be front wheel steer.

A.2.7 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. When writing specifications for a runway broom, it should always be a concern that the equipment does not

overload the GAWR of the axles, wheels, tires, springs or steering of the vehicle to which it is to be installed.

A.2.8 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 broom up, down, right, left). 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. The front and rear tread widths shall not vary by more than 4%.

c. Spare Rim/Tire. One spare tire on rim shall be included.

A.2.9 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 controls whenever possible. If a high pressure line must be located within the cab, it shall be properly shielded to protect the operator to the satisfaction of the purchaser. 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 J931.

A.2.9.1 Pump(s) and Power Takeoff: The pump(s) shall be ruggedly constructed and 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.

A.2.9.2 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. Where local climatic conditions require, the purchaser should consider requiring arctic type
hoses with temperature ratings appropriate for the location. 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.

A.2.9.3 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 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.

A.2.9.4 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 during servicing.

A.2.10 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 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 the Society of Automotive Engineers (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.

A.2.10.1 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 or RMF fields encountered from any airport operations. EMF 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.

A.2.10.2 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. An electrical load analysis worksheet shall be provided to the customer prior to construction showing the electrical loads during the above described conditions.

A.2.10.3 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.

A.2.10.4 Starting Device: The vehicle shall have an electrical starter that shall not introduce a voltage drop sufficient to adversely affect the ignition system. It shall be 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 volt electrical/24 volt starting

A.2.10.5 Ignition System: Under extreme weather conditions a block heater or other heating device should be considered for improved 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.

A.2.10.6 Backup Alarm: All vehicles that have limited rear view visibility and/or have a GVWR of 26,000 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

A.2.10.7 Horn: The vehicle shall be equipped with an electric or air horn to allow the operator to provide an audible warning in an emergency. Manufacturer's standard is acceptable.

A.2.11 Lighting 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 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 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. An LED light bar shall be attached the to the top of the cab to add additional lights.

c. 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.

d. 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 150/5210-5D, 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.

A.2.12 Operator's Cab

A.2.12.1 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 single operator plus assistant/trainee (full cab). A definite separation shall exist between the engine and operator's compartment. 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 different routes of egress to allow the operator to exit the cab in the event of rollover or overturn.

A.2.12.2 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. An airfield radio and a vhf radio should be included as part of the purchase of the snow equipment.

A.2.12.3 Fire Extinguisher(s): The vehicle cab shall have at least one 2A-10BC 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 type fire extinguisher installed on the vehicle or equipment at a place readily accessible from the ground.

A.2.12.4 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 requirements. Seats shall be fully upholstered with a good quality fabric or plastic material.

A.2.12.5 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 up 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 1½ gallons (5.6 liters). 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.

A.2.12.6 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).

A.2.12.7 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). 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) (see J1503).

A.2.12.8 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.

A.2.12.9 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 9999 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.

A.2.12.10 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 1½ 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. Instruments should display urgency-of-action lights, i.e., green for normal operation, amber for warning, and red for emergency. 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

A.2.13 Sheet Metal Components:

A.2.13.1 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.

A.2.14 Painting, Marking, and Lighting of Vehicles

A.2.14.1 Painting and Marking: The vehicle shall be painted Chrome-Yellow in accordance

with color tolerance charts that have been made available for FAA regional airport inspectors and key potential users in the aviation safety equipment industry (see AC 150/5210-5D).

A.2.14.2 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 Chrome-Yellow polyurethane enamel, acrylic enamel, acrylic urethane, or similar high durability, long life paint as required by the purchaser, applied to produce full hiding.

A.2.14.3 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.

A.2.15 Miscellaneous

A.2.15.1 Plastic Plates: Plastic plates are acceptable only in locations that are not exposed to the elements and subject to weathering or excessive heat.

A.2.15.2 Information: Plates shall identify make, model, serial number, and any other relevant data.

A.2.15.3 Technical Publications: The manufacturer shall furnish two complete sets of manuals. One set of manuals shall consist of an Operator's manual, Parts Manual, and Maintenance and Service Manual.

A.2.15.4 Operator's Manual: The operator's manual includes lubrication charts and instructions.

A.2.15.5 Parts Manual: The parts manual identifies and lists all parts, components, and sub-assemblies used in the fabrication of the carrier vehicle and mounted equipment.

A.2.15.6 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.

A.2.15.7 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.

A.2.15.8 Lug wrench and any other special tire tool required to change a flat tire.

A.2.15.9 Jack: A jack specifically adapted to the carrier vehicle and of adequate capacity to be capable of raising it to a position where a flat tire can be changed.

A.2.15.10 Specialized Tools: Specialized tools required for routine servicing of the carrier vehicle and its auxiliary equipment.

A.2.16 Delivery

A.2.16.1 Shipment: The vendor (seller) is responsible for the safe and timely delivery of the vehicle and its accessories, spare parts, and tools to the agreed place of delivery.

A.2.16.2 Marking: Carrier vehicles shall be marked for shipment in accordance with instructions agreed to by the purchaser.

A.2.16.3 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 24 hours or as required depending upon crew size.