



AEROSPACE RECOMMENDED PRACTICE

ARP5548

Issued

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Multi-Tasking Equipment (MTE) for Airfield Snow Removal
High Speed, Multi-Tasking Snow Removal Unit to include
Carrier Vehicle, Snow Plow, Rotary Broom High Velocity Air Blast

RATIONALE

This aerospace recommended practice (ARP) serves as a guideline for airports that require specialized multi-tasking equipment to meet the snow and ice removal demands as required in their airport's published snow plan and by the FAA in AC 150/5220-30A.

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1. SCOPE

This equipment specification covers requirements for Multi-Tasking Equipment (MTE) for airfield snow removal purposes. The unit shall include a combination of a carrier vehicle, snow plow, rotary broom and high velocity air blast system.

This vehicle as a unit shall be an integrated snow plow, rotary broom and high velocity air blast. Primary application is for the high-speed plowing, sweeping and cleaning of ice and snow from airfield operational areas such as runways, taxiways and ramp aprons.

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

The airport operator may require this specified piece of equipment in order to maintain the airfield during large and small snow events. When necessary, the MTE shall be a central and critical element in the winter pavement maintenance fleet in the effort to accomplish the airport's published snow plan.

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

2. REFERENCES

2.1 Applicable Documents

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

2.1.1 SAE Publications

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

SAE J931 Hydraulic Fluid Power Circuit Filtration - Application & Methods

SAE J1292 Automobile and Motor Coach Wiring

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

2.1.2 FAR & FAA Publications

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

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

2.1.3 FMCSR Publications

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

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

2.1.4 Latest release of Federal Spec 297, Rustproofing of Commercial (Nontactical) Vehicles

2.1.5 RTCA Publications

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

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

2.1.6 FMVSS - Federal Motor Vehicle Safety Standards

2.2 Definitions

See also, Dictionary of Automotive Engineering, Don Goodsell.

AIRPORT RUNWAY BROOM: A cylindrical rotary broom 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 and associated pavements 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.

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

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

CASTER ASSEMBLIES: Wheels, generally of small size, with the ability to swivel and their attachment mechanism(s) to the plow or rotary broom. The wheels ride along the pavement and may support some of the weight of the plow or broom and/or may provide a method of adjusting the clearance between the bottom of the cutting edge or brush and the pavement. Each caster assembly can be of the single or dual wheel type. Caster wheel assemblies may be equipped with pneumatic, foam filled or solid rubber tires. Caster tire and wheel assemblies shall be approved and rated for the speeds and loads they will encounter during use.

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 BROOM: 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.

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

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

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

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

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.

CUTTING EDGE: The portion of the plow that contacts and/or scrapes the pavement surface, traditionally available, but not limited to, steel, rubber, polyethylene, with or without tungsten carbide inserts.

CUTTING EDGE REINFORCEMENT: Supports the cutting edge and prevents damage to moldboard upon impact at cutting edge.

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

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 through high flow directional spray nozzles to windshield(s), side and rear window(s), mirror(s), and other surfaces to improve operational visibility from the cab.

DIFFERENTIAL: The gear assembly in the drive axle that permits one wheel to turn slower or faster than the other when negotiating a turn. The gear assembly in the transfer case that allows the front 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. An operator controlled provision may be offered to fully lock and unlock the differential action from the cab.

DIMENSIONS:

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

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

END DRIVE BROOM: 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, AND MULTIPLE REDUCTION: Single reduction gearing refers to one speed reduction through the gearing component. Multiple reduction refers to more than one step of speed reduction through the gearing component.

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

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

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

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 utilized to couple/uncouple an attachment to the carrier vehicle, then attaches to the plow drive frame.

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

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

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

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

IMPELLER (AIR BLAST): The internal rotating portion of the air blast which produces the air movement.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SINGLE ENGINE RUNWAY BROOM: Runway broom with a single engine that provides power to both the chassis motive power and the brush head.

SNOW DEFLECTOR: Devices designed to minimize blowing snow from coming over the top of the moldboard.

SNOW SHIELD: A cover for the brush hood or plow to keep snow from building up.

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

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

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

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

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

SWEPT SURFACE CONDITION: A measurement of coefficient of friction (braking action) on a clean swept pavement surface, measured from a friction measuring device. Also a visual inspection to determine the surface is clean and bare with no remaining debris or chunks of snow and ice.

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

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

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

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

TONS PER HOUR (TPH): A function of snow density x depth of snow x swept path x vehicle speed.

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

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

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

TRANSMISSION: Selective gearbox providing various combinations of gear ratios.

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

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

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

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

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

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

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

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

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

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

3. INTENT

- 3.1 The operating concept is that a single operator can operate a plow, runway broom and air-blast system simultaneously to clean the surface to bare pavement. Since the plow is located at the front of the carrier and the broom located approximately in the middle of the unit, a multi-tasking unit can move large amounts Tons Per Hour (TPH) of snow.
- 3.2 Typically, the MTE plow, broom, and air blast will be operating simultaneously with the broom following the plowed path at all times. Thus, one operator can perform the complete cleaning process in one pass, reducing labor costs, equipment maintenance costs and the number of vehicles on the airfield.

4. TECHNICAL REQUIREMENTS

4.1 General Description

The unit shall be self-propelled and consist of the necessary chassis configuration to provide the required maneuverability. There are three industry standard configurations of MTE which are Modular, Integral Non-Articulating and Integral Articulating. The following descriptions and illustrations in 4.1.1, 4.1.2, and 4.1.3 are non-scale, generalized and for conceptual purposes only. Any single operator configuration with a proven history of effective and efficient operation which positions the snowplow first, followed by the rotary broom and in turn followed by the high-velocity airblast system is acceptable providing said unit can adhere to the operational requirements, maintenance and storage capabilities of the airport operator. Other attachments or components such as anti-ice, deice systems or underbody scrapers which aid in the snow and ice removal process may be included providing the addition of such devices do not exceed operating capacities and/or parameters of the unit.

4.1.1 Modular

Typically consisting of a front mounted plow equipped power unit, employing a hitch, either fifth-wheel or pintle type, utilized to pull a trailer mounted tow-behind broom and airblast (a tractor/semi-trailer). Most modular configurations utilize separate drive engines, one dedicated to the traction unit, one dedicated to the tow behind broom/airblast.

Graphic references - Modular: Figures 1 thru 4.

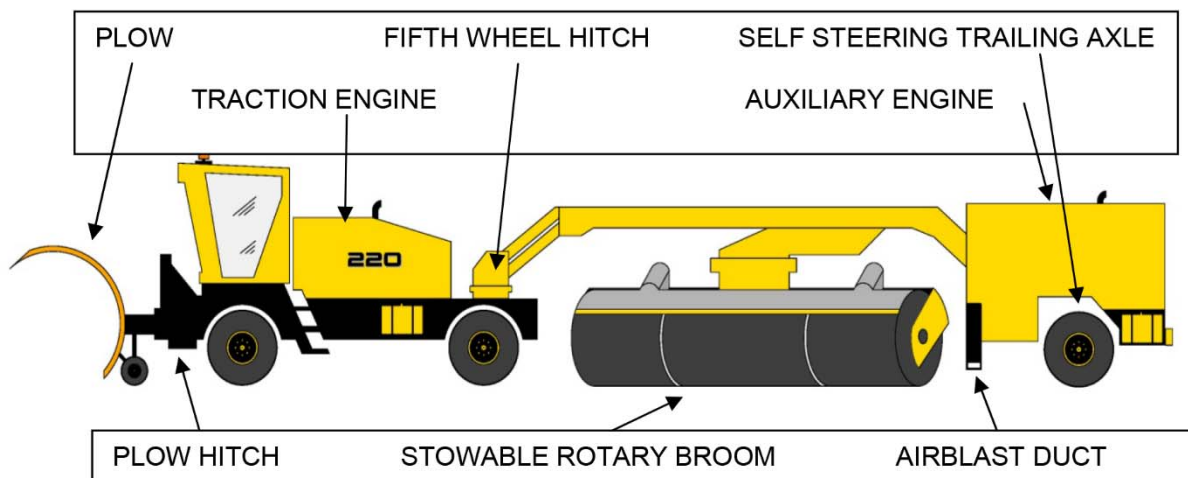


FIGURE 1 - MODULAR MTE CAB FORWARD MID-ENGINE POWER UNIT WITH TOW BROOM

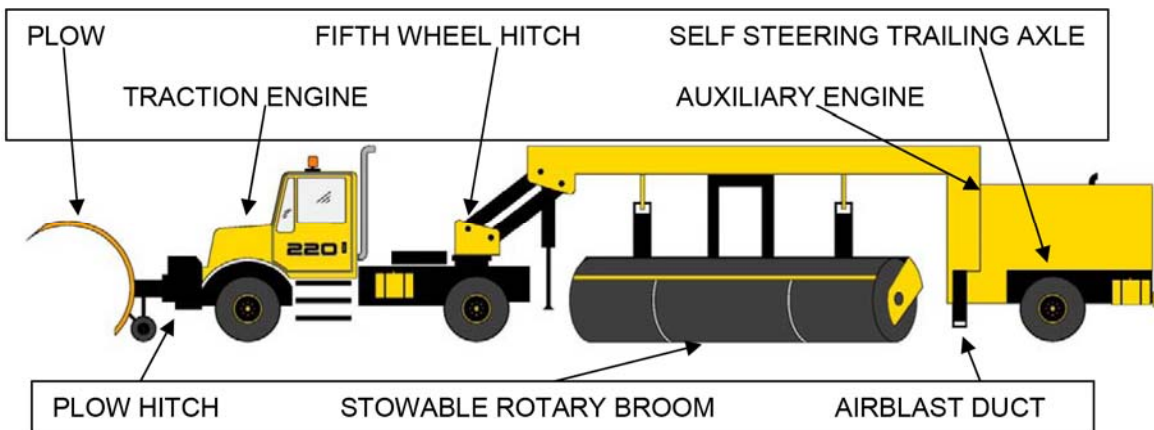


FIGURE 2 - MODULAR MTE CONVENTIONAL CAB POWER UNIT WITH TOW BROOM

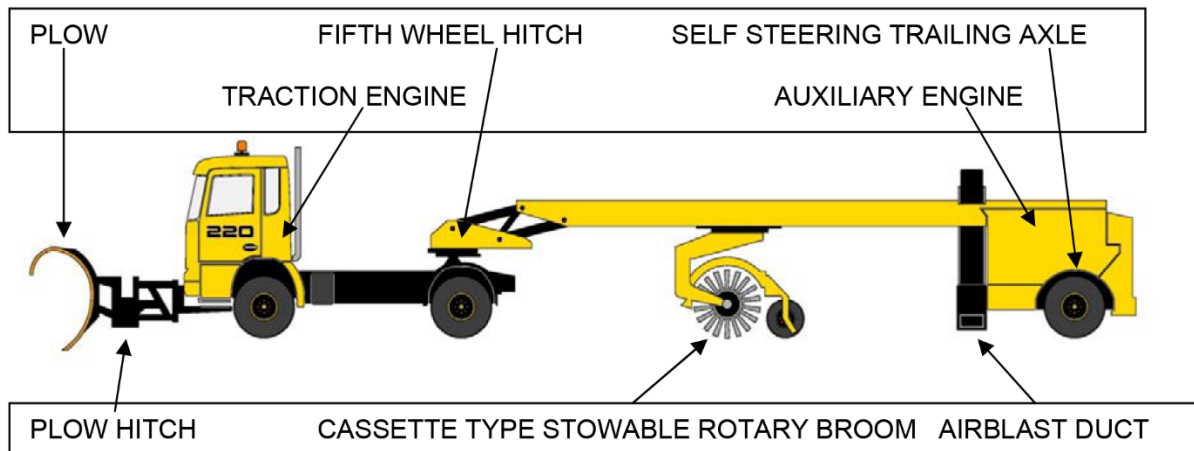


FIGURE 3 - MODULAR MTE CABOVER ENGINE POWER UNIT WITH TOW BROOM

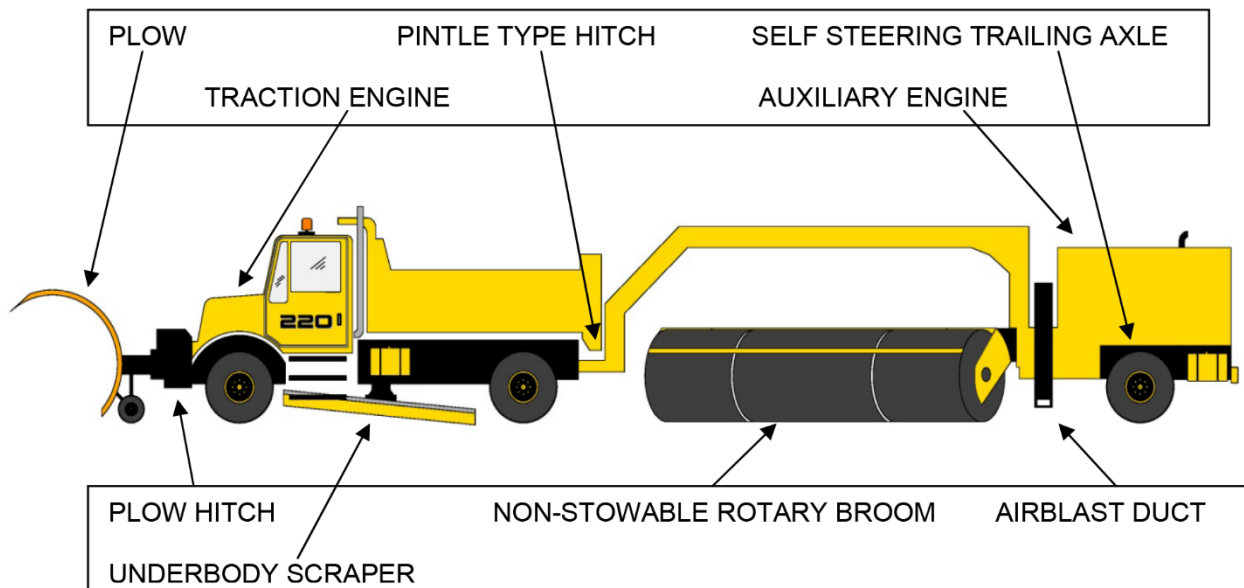


FIGURE 4 - MODULAR MTE CONVENTIONAL CAB POWER UNIT WITH TOW BROOM

4.1.2 Integral Non-Articulating

Typically consisting of a front mounted plow equipped power unit utilizing a rigid, non-articulating common chassis and two main load bearing drive axles, one front and one rear, each with steering capabilities so as to enhance maneuverability. The rotary broom is mounted amidships with the airblast discharge nozzles located at, near, or behind the trailing discharge ends of the rotary broom. An Integral Non-Articulating unit may be equipped with either one or two engines to provide the required power for traction drive and the power driven components.

Graphic references: Figures 5 and 6.

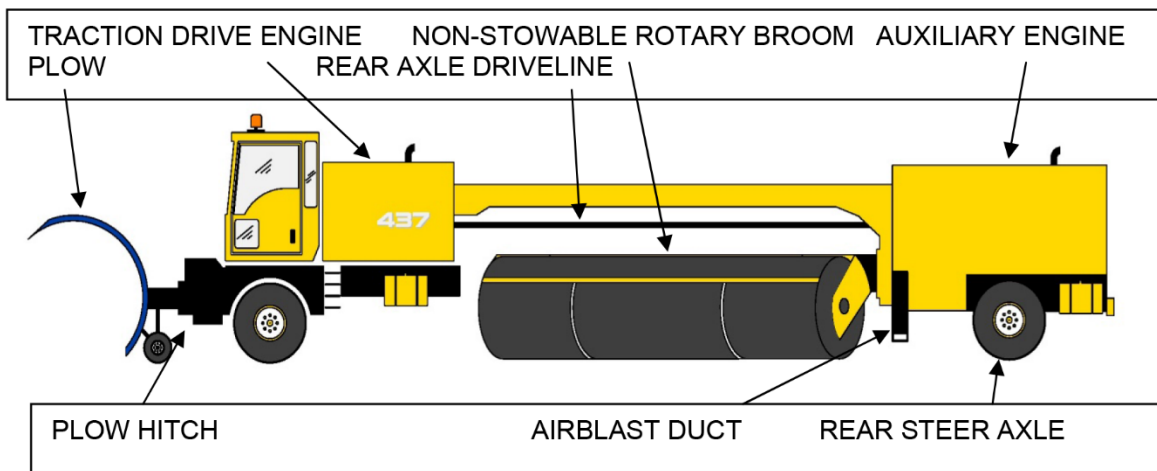


FIGURE 5 - INTEGRAL NON-ARTICULATING MTE

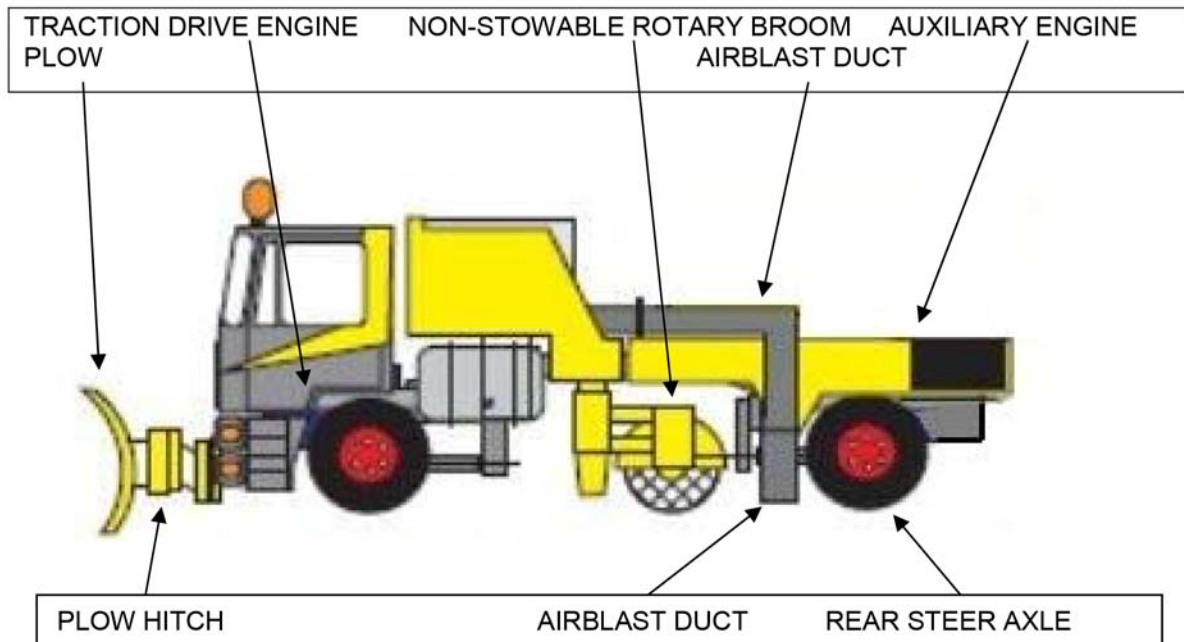


FIGURE 6 - INTEGRAL NON-ARTICULATING MTE

4.1.3 Integral Articulating

Typically consisting of a front mounted plow equipped power unit utilizing an articulating chassis with multiple load bearing axles, drive axles may be located at the front or rear of the unit. The rotary broom mounted amidships and the airblast system located at, near, or behind the trailing discharge ends of the rotary broom. Integral Articulating units are typically equipped with two engines, one required for the traction drive and the second for the power driven components.

Graphic references: Figures 7 and 8.

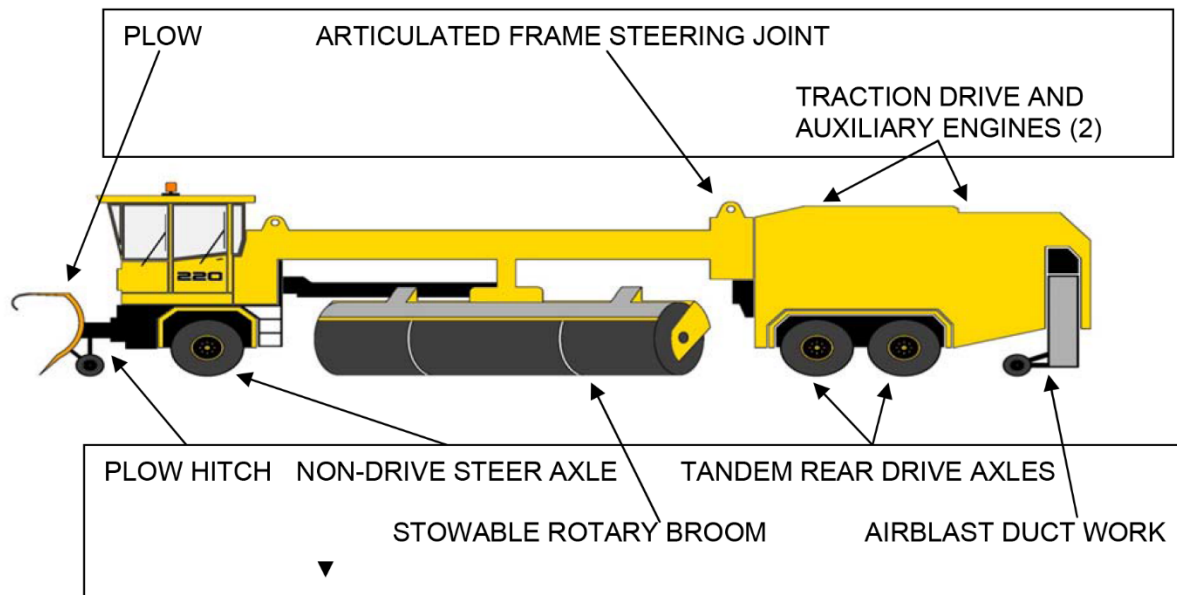


FIGURE 7 - INTEGRAL ARTICULATING MTE WITH STEERABLE FRONT AXLE AND ARTICULATED FRAME STEERING

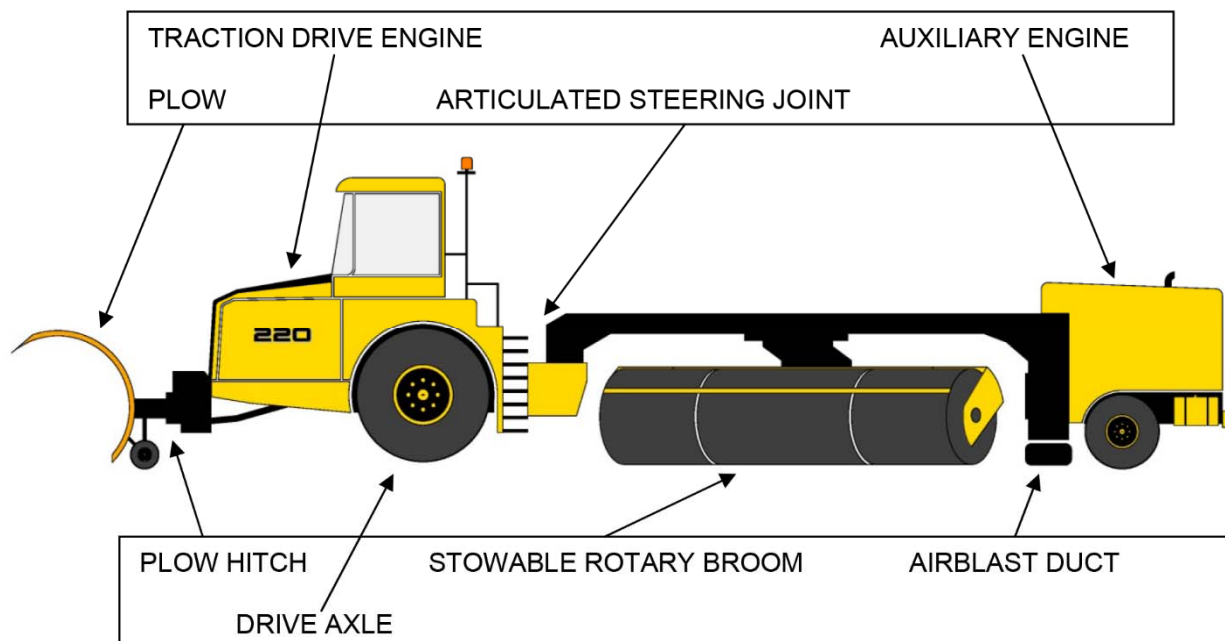


FIGURE 8 - INTEGRAL ARTICULATING MTE ON ARTICULATED OFF ROAD TRUCK CHASSIS

4.2 Minimum Performance Requirements

- 4.2.1 The equipment shall have the ability to remove snow, ice, slush, sand, and other debris at rated speeds of 35 MPH or faster, depending on conditions. Test procedures and airport/contractor obligations are listed in bold letters at the end of this section.
- 4.2.2 The design of this unit shall ensure positive tire-to-ground tractive effort while operating and performing full wall-to-wall turning diameter of 100 feet or less with plow and broom attachments unless otherwise specified. The vehicle shall be equipped with no fewer than two driving axles or one drive axle with differential lock.
- 4.2.3 The performance requirements are based on snow with a density of 15 to 40 pounds per cubic foot for the test to be considered valid with a designed speed of 35 MPH. A quick generalized reference of snow density is as follows:

TABLE 1

Snow Condition	Density
New fallen snow	2 to 6 pounds per cubic foot
Snow plowed or swept 1 or 2 times	5 to 10 pounds per cubic foot
Snow plowed or swept 3 or more times	10 to 15 pounds per cubic foot
Firm packed snow	25 pounds per cubic foot
Slush	40 pounds per cubic foot

- 4.2.4 The drive system shall be capable of continuous operation with the necessary refueling during an entire snow event without maintenance. A snow event shall be considered to be at least 72 hours in duration. The vehicle shall require only one operator to perform all functions and shall provide comfortable operating environment with adequate conditioned air, visibility, and ease of control to operate for a minimum period of at least 8 hours with the necessary breaks.
- 4.2.5 Written installation and/or application approval from the manufacturers of ancillary components shall be provided upon request of the airport operator. This shall include various components such as the engine, drive train, hydraulic systems, electrical, electronic and data processing devices.
- 4.2.6 Hydraulic pressure, flow and temperature parameters shall be within the limits prescribed by the component manufacturer for this installation while the vehicle or subsystem is operated at its normal duty cycle in the maximum or minimum ambient temperature conditions normally expected. These approvals shall be delivered with the vehicle upon request of the airport operator.
- 4.2.7 Approvals for engine and transmission installation shall be based upon successful completion of installation tests conducted according to the component manufacturer's guidelines. Approvals shall indicate the cooling system and general installation allows the vehicle or subsystem to be operated continuously at full rated capacity in the maximum or minimum ambient temperature conditions normally expected without exceeding any of the maximum or minimum allowable temperature criteria established for installation approval. Any deviations allowed from standard criteria must be specifically waived in the written approval by the component manufacturer. These approvals shall be delivered with the unit upon request of the airport operator.
- 4.2.8 Axles, transmissions, transfer cases and other gear reduction or multiplication devices shall be designed for continuous operation at maximum rated capacity in the maximum or minimum ambient temperature conditions normally expected without exceeding the maximum recommended operating temperatures as specified by the component manufacturer.

- 4.2.9 An MTE shall be designed to produce consistently clear pavement within the operating width without residue caused by bouncing or skipping of either the plow or rotary broom or other adverse effects such as oscillations of the plow or broom caster wheels while operating at a forward speed of at least 35 MPH. To conform to a High Speed requirement the manufacturer shall provide testing results certified or conducted and certified by a PE or an officer of the company.

The purchaser shall reserve the right, at his/her sole discretion and expense, to conduct a performance test to ensure performance and quality compliance within the stipulated requirements prior to acceptance.

4.3 Test Procedures and Airport/Contractor Obligations

- 4.3.1 The airport operator may perform operational and performance testing.

The subject testing may involve multiple runs on a runway or taxiway of sufficient length in snow densities of 15 to 40 pounds per cubic foot and depths of snow (1 inch, 2 inches, etc.), at speeds as high as 35 MPH to verify machine performance. Operations may be conducted with and/or without the high velocity air blast. Testing for snow removal capabilities may be delayed well beyond the time of delivery because of prevailing weather conditions and/or the lack of snow covered pavements.

Tests for maneuverability may involve meeting the wall-to-wall turning diameter requested or proposed with considerations given to exceptions agreed upon in writing prior to issuance of the contractual agreement. Additional operational testing may include but not be limited to acceleration, braking ability measured by G-force or stopping distance, operation of all systems and accessories electrical, pneumatic or hydraulic, vibration, leaks, unusual noises, water tightness of the cab and any NEMA rated enclosures. An airport operator may weigh the unit to ensure the vehicle weight is within acceptable axle weight ratings.

It is recommended the airport operator perform maneuverability and operational testing prior to the recorded in-service date or date of acceptance. The manufacturer may witness the tests, however, interpretation is the sole responsibility of the purchaser. The airport operator may consult with the equipment manufacturer on the design and protocol for the test procedure.

- 4.3.2 The airport operator shall be obligated to document in writing, all performance, reliability, design or quality related deficiencies that may be realized during performance testing and/or the warranty period. Electronic media (e-mail) shall be an acceptable means of communication and documentation.
- 4.3.3 The Contractor/Manufacturer shall be obligated to acknowledge such discrepancies in writing, electronic media is acceptable. The contractor/manufacturer acknowledgement shall include:
- a. Action plan with a schedule to verify, address and correct any discrepancies revealed by testing or during the warranty period.
 - b. The contractor's action shall be sensitive to the needs of the airport operator in regard to an out-of-service equipment status.
 - c. The time duration for the contractor/manufacturer to address such action items shall be mutually agreed upon and stated in writing by the contractor or manufacturer.
 - d. A written description of all actions taken to correct the discrepancies.