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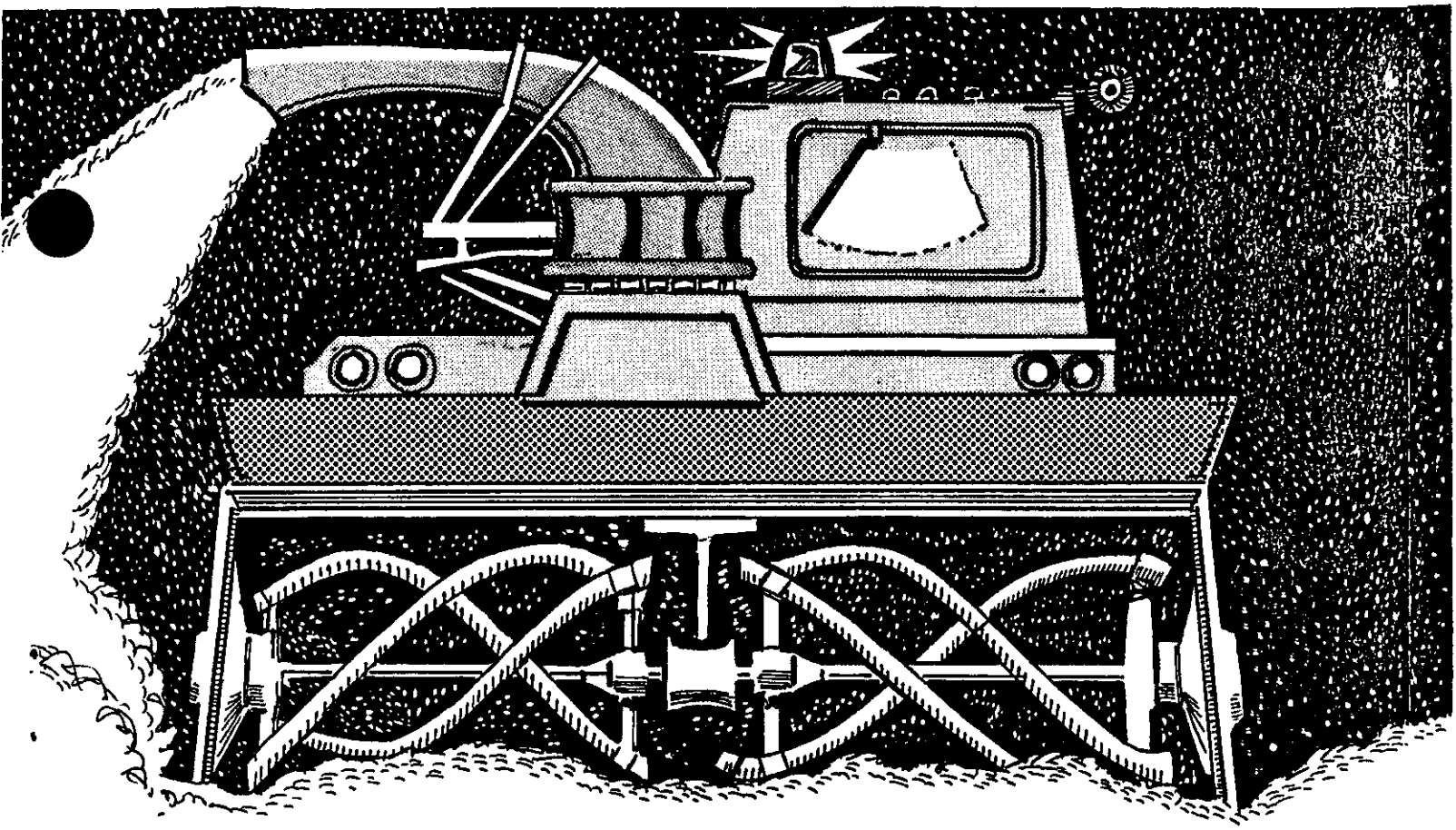
# ADVISORY CIRCULAR

# AIRPORT SNOWBLOWER

## SPECIFICATION GUIDE



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AAP-720

**AC NO:** 150/5220-11

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## DEPARTMENT OF TRANSPORTATION
## FEDERAL AVIATION ADMINISTRATION

**SUBJECT:** AIRPORT SNOWBLOWER SPECIFICATION GUIDE

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1. PURPOSE. This guide specification provides information covering a variety of multiple capacity rotary snowblowers. The words "shall" and "will" are not to be construed as mandatory requirements of the Federal Aviation Administration (FAA). They are specifically included so that portions of this guide specification may be copied verbatim by local specification writers.

2. APPLICATION. This guidance is intended for use by all airport owners/operators.

3. RELATED READING MATERIAL.

   a. AC 150/5200-23A, Airport Snow and Ice Control, dated 1/25/85.

   b. MIL-B-17041E, July 7, 1972, Military Specification for Self-Propelled Snow Removal Units.

   c. AK-71-09-048, Snow Removal and Ice Control at Canadian Airports, dated October 1976 by the Canadian Department of Transport.

4. HOW TO OBTAIN THIS CIRCULAR AND OTHER MATERIAL REFERRED TO IN THIS CIRCULAR.

   a. Additional copies of this circular and the circulars listed above may be obtained from the Department of Transportation, Utilization and Storage Section, M-443.2, Washington, D.C. 20590. FAA field personnel may obtain copies from their respective Regional Distribution Officers.

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b. MIL-B-17041E, July 7, 1972, Military Specification for Self-Propelled Snow Removal Units, can be obtained by writing to Item Manager, Snow Removal Equipment, WR-ALC/MM11CA4, Robins Air Force Base, Georgia 31098.

c. AK-71-09-048, Snow Removal and Ice Control at Canadian Airports, dated October 1976 by the Canadian Department of Transport. Write to Airports and Construction Services Directorate, Airport Facilities Branch, Mobile Support and Stationary Equipment Division, Ottawa, Canada.

ROBERT J. AARONSON
Assistant Administrator
Office of Airports Programs

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# CHAPTER 1. INTRODUCTION

## 1. BACKGROUND.

a. These vehicles are primarily intended for use in removal and casting of snow from airport operational areas, including runways, taxiways and ramp aprons.

b. This guide specification describes vehicles possessing the minimum performance capabilities recommended for an acceptable airport rotary snowblower. These vehicles are capable of removing and casting the quantities of snow specified for each size of snow blower listed on page 3, paragraph 2.

c. The vehicle specifications may be modified to meet user requirements. The equipment purchaser can select accessories that meet individual requirements from the production options in the quality assurance provision. The desired changes may be specified from the list in paragraph 67.

## CHAPTER 2. REQUIREMENT GUIDELINES

### SECTION 1. GENERAL EQUIPMENT DESCRIPTION

2. CLASSIFICATION. The following four classes comprise a family of snowblower vehicles. Snowblowers shall be rated by the maximum capacity of each class. Capacity classifications are illustrated in figure 3, page 31.

   a. Small Capacity Snowblower. The blower may be of any physical design having a demonstrated or manufacturer's certified snow removal capacity of up to 600 tons per hour with a minimum casting distance of 50 feet as measured from the blower to the point of maximum deposition under a no wind condition. (Class I)

   b. Medium Capacity Snowblower. The blower may be of any physical design having a demonstrated or manufacturer's certified snow removal capacity range of 600 to 1,000 tons per hour with a minimum casting distance of 75 feet as measured from the blower to the point of maximum deposition under a no wind condition. (Class II)

   c. Intermediate Capacity Snowblower. The blower may be of any physical design having a demonstrated or manufacturer's certified snow removal capacity of 1,200 to 1,500 tons per hour with a casting distance as measured from the blower to the point of maximum deposition under a no wind condition of:

      (1) 100 feet at a rate of at least 1,200 tons per hour.
      (Class III)

      (2) 75 feet at a rate of at least 1,500 tons per hour.

   d. Large Capacity Snowblower. The blower may be of any physical design having a snow removal capacity range of 1,700 to 2,500 tons per hour with a casting distance as measured from the blower to the point of maximum deposition under a no wind condition of:

      (1) 100 feet at a rate of a least 1,700 tons per hour.
      (Class IV)

      (2) 75 feet at a rate of at least 2,500 tons per hour.

      This classification does not preclude selection of any snowblower with a maximum capacity greater than 2,500 tons per hour.

3. SELECTION.

   a. Snowblower Selection. The selection of snowblowers is critical since selection of all other snow removal equipment is dependent on the number of snowblowers needed. (See AC 150/5200-23A. Airport Snow and Ice Control, dated 1/25/85. Selection of a snowblower of the correct capacity must consider the amount of time allowed for the removal task.

The clearance time factor has the following relationships to aircraft movements as discussed in AC 150/5200-23A paragraph 11b(1):

"(1) At airports served by turbojet aircraft or scheduled CAB-certificated air carriers, the recommended minimum equipment should include one or more high-speed snowblowers having a demonstrated or manufacturer's certified capacity sufficient to remove snow which has a density of 25 pounds per cubic foot, with a minimum casting distance of 100 feet (measured from the blower to the point of maximum deposition) from the above described areas under the following criteria:

(a) 40,000 or more annual scheduled CAB-certificated air carrier operations, remove one inch of snow within 30 minutes.

(b) 10,000 to 40,000 annual air carrier operations, remove one inch of snow within 1 hour.

(c) 6,000 to 10,000 annual air carrier operations, remove one inch of snow within 1 hour and 30 minutes.

(d) 6,000 or less annual air carrier operations, remove one inch of snow within 2 hours."

b. The Number of Snowblowers. The minimum number of snowblowers for a particular airport can be determined by using the following procedure as a guide:

(1) Calculate the airport surface area to be kept open during snow operations as recommended by AC 150/5200-23A. These surface areas are:

(a) The primary runway;

(b) Two taxiways; and

(c) All necessary parking, aprons/gates, the square footage of fillets, blast pads, and crash, fire and rescue (CFR) roads.

(2) Refer to figure 7, page 35. Locate airport square footage on bottom horizontal line and read up to sloped line corresponding to the number of operations conducted at the airport annually. From the vertical intercept on the applicable sloped line, read over horizontally to the left scales. Read the number of tons of snow per hour needed to be removed from the airport and the number of large, intermediate, medium or small snowblowers required.

Normally select the largest snowblower needed, i.e., one large blower instead of two medium blowers. Note that the actual capacity of the blowers may be greater than the graph indicates, thus providing overlap for selection. Blower efficiency, snow density, wind and temperature are variables incorporated in the graph plot. Alternatively, snowblower selection may be determined by the use of the equations and sample calculations presented in Appendix I.

4. MATERIALS. Materials shall conform to the specifications listed herein. When not specifically listed, materials shall be of the best quality used for the purpose in commercial practice. Materials shall be free from all defects and imperfections that might affect the serviceability of the finished product.

5. DESIGN. The design of the equipment shall be in accordance with the best engineering practices. The equipment design and accessory installation shall permit accessibility for use, maintenance and service. All components and assemblies shall be free of hazardous protrusions, sharp edges, cracks or other elements which might cause injury to personnel or equipment. All oil, hydraulic and air tubing lines and electrical wiring shall be located in protective positions properly attached to the frame or body structure and shall have protective loom or grommets at each point where they pass through structural members, except where a through-frame connector is necessary.

6. CONSTRUCTION. The vehicle shall be constructed so that no part should work loose in service. The vehicle shall be built to withstand the strains, jars, vibrations and other conditions incident to service intended. Design of the vehicle shall produce the necessary clearances to permit the satisfactory use of tire chains on all wheels.

7. PERFORMANCE STANDARDS. The fully equipped snow removal unit, loaded to gross vehicle weight (GVW) and with rotary plowhead in transport position, shall be capable of maintaining a continuous forward speed of not less than 25 miles per hour (mph) on dry level pavement and negotiating a 4 percent dry smooth paved grade at 25 mph. The completed self-propelled rotary snowblower shall be either single or 2-stage design (with appropriately designed auger, helical cutter, impeller systems and turbine fan required). The unit will have a demonstratable and manufacturer's certified minimum snow removal capacity as previously specified by the classifications for large, medium, intermediate, and small high-capacity snowblowers. The unit shall start and perform normal operations at an ambient temperature of -20° F. and shall be capable of warm weather performance at 70° F. The performance specifications are based on snow with a unit weight of 25 pounds per cubic foot. The unit must be capable of positioning the snow discharge on either side of the vehicle. The

entire snow handling assembly, including but not limited to blower head, discharge chute and engine, shall be equipped so as to allow full control of all normal operating functions and monitoring of essential parameters by a single driver/operator using minimum controls from the cab of the vehicle.

8. TESTS. The manufacturer must submit with his bid the certified results of tests conducted establishing compliance with the foregoing requirements. The sponsor reserves the right, at his sole discretion and expense, to conduct a performance test in accordance with Appendix 2 of the Federal Aviation Administration (FAA) AC 150/5200-23A to assure contractor compliance with the stipulated requirements prior to acceptance. The manufacturer will be afforded an opportunity to witness the performance of this test; interpretation of the test results is, however, the sole responsibility of the sponsor. Figure 4, page 32, illustrates a typical test setup.

## SECTION 2. CHASSIS COMPONENT AND DESIGN

9. VEHICLE CHASSIS. The carrier chassis, complete with cab, shall normally be of 4 x 4 type design with an appropriate GVW rating. It shall be equipped with power assisted steering and automatic or hydrostatic transmission with suitable load ranges to accommodate normal operating conditions. If necessary, the vehicle will be equipped with a transfer case to achieve the required performance. All parts and accessories necessary for the safe operation of the vehicle shall be provided and conform to applicable provisions required in the Federal Highway Administration's (FHWA) Motor Carrier Safety Regulations, Part 393. The chassis frame shall be of riveted, bolted or welded construction. It shall be provided with adequate cross members, exclusive of engine supports, so designed and constructed as to support gross weight of the body and load, powerplants, blower assembly and all other equipment under the anticipated maximum operating conditions. No alterations shall be made to the frame which will reduce its designated strength. If a frameless integral body construction is used, the manufacturer shall certify that the design meets the above requirements. When the snowblower is a dual engine system, the blower engine shall either be skid mounted or integral, and installation shall not modify the structural integrity of the chassis. A pintle tow hook or two tow eyes capable of towing the vehicle shall be attached securely to the frame structure at the rear of the vehicle.

10. DIMENSIONS, WEIGHTS AND CLEARANCES.

a. Height. The overall static height excluding discharge chute, lights and exhaust stacks should not be more than 150 inches.

b. Width. The maximum overall width without rotary plowhead should not be more than 108 inches.

c. Length. The maximum overall length should be 35 feet.

d. Diameter. The wall to wall turning circle diameter without rotary head using two-wheel steering only should be 70 feet.

e. Ground Clearance. The ground clearance without rotary plowhead should be not less than 8 inches.

f. Axle Weight Distribution. Axle weight distribution ratios during tractive efforts while plowing shall not show greater than 15 percent differential. A 50 percent weight on the front axle and 50 percent weight on the rear axle is considered ideal for 4 x 4 single tire blower vehicles.

g. GVW. The GVW rating of the snow removal unit shall be dependent on the classification of the vehicles, figure 1, page 29. The weight should be consistent with the most common engineering practices in vehicles in each class to maintain maximum tractive effort and efficiency.

h. Weight Distribution. The center of gravity shall be kept as low as possible under all conditions of loading. The vehicle shall be capable of resting transversely on a side slope equivalent to a 30 percent grade without danger of overturning.

11. STRUCTURAL MEMBERS. The frame shall be of pressed or structural steel channel, reinforced as required to prevent distortion under maximum loads. Cross section design and area shall be sufficient to prevent distortion during normal operation. Frame rail depth on large blowers shall not be less than ten inches.

## SECTION 3. ENGINES AND COMPONENTS

12. ENGINES. The vehicle engine(s) shall be of the internal combustion, four or two-stroke cycle type. The engines will be air or liquid cooled, gasoline or diesel. Twin engined vehicles shall use a common fuel. The propulsion and blower engines shall not have less than four cylinders. The engine(s) shall develop the torque and horsepower of sufficient capacity to meet normal operational requirements without the engine(s) exceeding a "no-load" governed speed at the peak of a certified gross brake horsepower (bhp) curve. The engine(s) shall operate satisfactorily and shall be capable of demonstrating the performance characteristics specified herein with fuel conforming to regular commercial grade. Engine horsepower shall be dependent on gross vehicle weight and blower capacity. See figure 1, page 29.

13. COOLING SYSTEM, ACCESSORIES, AND WINTERIZATION.

a. Cooling Systems. The cooling system for the engine(s) shall be of the liquid or forced air type. Coolant temperature control of the engine(s) shall be accomplished by thermostatic or manual controlled radiator shutters and/or by thermostatically controlling the flow of engine coolant through the radiator. The system shall be designed so that upon failure of the thermostatic controls, the engine may continue normal operation without overheating resulting from restriction of engine coolant circulation or the restriction of air flow through the radiator shutters.

b. Coolant Temperatures. Coolant temperatures should be maintained at not more than 210° F or less than 140° F when operated in ambient temperatures of -20° F. In areas experiencing temperatures below -40° F, and where it is common industry practice to do so, it is considered advisable to design for winterization down to -60° F. For example, include preheating the cooling system devices, oil pan heaters, lubricating oil heating, battery block heaters, and ether vapor start systems.

c. Coolant Circulation Bypass. Provide a bypass to permit coolant circulation in the engine block, with thermostat closed, until normal operating temperature is reached. A 160/170° F thermostat shall be provided with the cooling system being designed to withstand an internal pressure minimum of seven pounds per square inch (psi). A coolant temperature gauge shall be provided on the cab instrument panel. Install drain cocks at the low point of the cooling system and at such other points as may be necessary to drain the system completely.

14. FUEL SYSTEM.

a. Fuel Tank(s) and Fuel Lines. Fuel tank(s) having a total capacity sufficient to supply fuel to engine(s) when operating at rated intermittent horsepower at governed speed for not less than eight hours shall be provided. Fuel lines shall be interconnected so that either or both engines may be supplied with fuel at the option of the operator. Fuel lines shall be securely fastened in place, installed to prevent chafing or strain, and protected by grommets where lines project through metal apertures. The fuel tank(s) shall be equipped with an accessible drain plug or quick drain. Large blowers shall have a filler neck that is at least four inches in diameter.

b. The Fuel System. The engine(s) fuel system shall be installed so as to preclude the possibility of a vapor lock. The system shall include carburetor(s) or fuel injector(s), a choke system (manual or automatic), fuel pump (s), fuel strainers, dry filter type air cleaners, all plumbing fuel lines, valves, drains, and necessary accessories needed to provide a complete operational system.

c. The Filler Pipe. The filler pipe opening shall be located in an accessible location outside of the cab and have a chain attachment to the filler cap. The tank shall be mounted so that it will not be damaged by distortion of the chassis and will not be affected by heat from the engine exhaust. The fuel tank shall conform to the requirements of the FHWA.

d. Additional Fuel Tanks. Additional fuel tanks can be attached where extra vehicle range is required. See paragraph 67s, page 27.

e. Air Cleaner. To preclude the possibility of ice freezeup, the air cleaner shall be a two stage type incorporating a centrifuging pre-cleaner stage and a dry type replaceable paper final stage. The air cleaner shall be equipped with an air cleaner service indicator to show when the dry type paper cleaner needs servicing. The connection between air cleaner outlets and the engine intake shall be waterproof and dust tight.

15. ENGINE GOVERNORS. The carrier engine governor shall be set to limit engine speed to the maximum operating speed recommended by the engine, driveline and power train specifications. The rotary plowhead drive engine (dual or single engine vehicle) governor shall provide a no-load and full-load maximum speed and must not adversely affect engine performance. The blower drive engine shall be equipped with the capability for an automatic emergency shutdown to preclude engine damage in the event of component failure.

16. LUBRICATION.

a. Lubricating Systems. The engine and chassis lubricating systems shall be the manufacturer's current standard production items. The oil filter for the engine(s) shall be either:

(1) A full flow type with replaceable elements; or

(2) A by-pass type with replaceable elements.

b. The rotary plowhead and drive train components shall have lubrication means provided for all required components. Where the use of high lubricating pressure may damage grease seals or other parts, a suitable pressure release device shall be provided. The snow removal unit shall be lubricated prior to delivery with lubricants designated for use in the ambient air temperature at the delivery point. The snow removal unit shall be conspicuously tagged to identify the lubricants and their temperature range.

17. EXHAUST SYSTEM AND MUFFLER. When applicable (generally on small and medium blowers), the vehicle and blower engines shall be equipped with an efficient exhaust system and muffler. The tailpipes shall be of such a size as to avoid undue increase in the back pressure. They should be located in such a manner that entrance of exhaust gases into the cab shall be minimized under all conditions of operation. Horizontal portions of exhaust systems shall be provided with a cover plate that will shed fluids if spilled fuel comes in contact with the system. Exhaust piping, when located at the rear of the carrier cab, shall be furnished with a heat shield. When design considerations permit, exhaust systems should be directed in a manner to minimize contact with splashing slush and snow under the vehicle, thus reducing exhaust system corrosion failures. The muffler(s) shall be aluminized stainless steel or ceramic coated. Provision shall be made to prevent rain or slush from entering the tail pipes.

18. ACCESSIBILITY.

a. Parts and components should be located or positioned for rapid and simple inspection and recognition of excessive wear or potential failure. Whenever functional layout of operating components determines that physical or visual interference between items cannot be avoided, the item predicted to require the most maintenance shall be located for best accessibility. The engine(s) compartment(s) should have an accessible layout to permit routine maintenance by personnel wearing bulky winter clothing. Locks, controls and fasteners shall be designed to prevent overtorquing by operators who lack feeling in their hands due to the wearing of heavy gloves.

b. Cover plates which must be removed for component adjustment or part removal should be equipped with quick-disconnect fastenings, or hinged panels.

c. Drains, filler plugs, grease fittings, hydraulic lines, bleeders, and check points for all components should be located so that they are readily accessible and do not require special tools for proper servicing. Design practices should minimize the number of tools required for maintenance.

d. All components shall be designed and protected so that heavy rain, snow, ice and slush will not interfere with normal servicing or operation. Adequate guards shall be provided for rotating driveline components.

## SECTION 4. DRIVETRAIN AND COMPONENTS

19. GENERAL TYPES OF DRIVETRAINS. The transmission shall be a continuous drive system either manual, hydrostatic, hydrostatic/automatic or automatic powershift transmission type incorporating a torque converter with suitable torque ratio. The torque converter shall not operate at less than 70 percent efficiency to meet the performance requirements specified herein. All of the suitable transmissions shall be matched to the operating characteristics of the carrier engine and will have suitable load ranges to accommodate expected normal operating conditions. If necessary, the vehicle shall be equipped with a transfer case to achieve the required performance. The transmissions shall include a range selector lever with reverse, neutral, and forward positions all clearly identified. The shifting of gears (non-hydrostatic) in forward speed either up or down through all gear ratios shall be possible without interrupting the output of power from the engine through the drivetrain of the carrier. The transmission shall operate efficiently and without detrimental effects to any components when lubricated in accordance with recommendations of the transmission manufacturer. The continuous drive transmission shall be certified as suitable for use in this vehicle by the transmission manufacturer. Torque capacity of the transmission components shall be adequate to transmit the maximum gross torque of the engine through all gear reductions or torque multiplications. Drivelines shall be designed to require a minimum number of joints and all components should be of the same power ratings, i.e., no reduction in shaft size to transfer through bulkheads.

20. TRANSFER ASSEMBLY. The transfer case, when required, shall provide positive drive to the front and rear axles. It shall be of a single or multi-speed type as required to meet the performance requirements. The multi-transfer case may be equipped with a manual front axle disconnect, a center differential with manual or automatic lockout, or an overriding clutch to compensate for the difference in travel between front and rear wheels. The case may be a unit with the transmission or a separate unit mounted independently and shall be certified as suitable for use in this vehicle by the transfer case manufacturer.

21. AXLES. Front and rear axles furnished shall be certified by the manufacturer as being suitable for use in this vehicle and designed for single tire mounting. The front and rear tread widths shall not vary more than two inches. Axle manufacturer's published rating shall not be raised to conform to the requirements of this specification and shall be at least equal to the load imposed at ground level when the vehicle is loaded to its rated GVW. Each axle is to be provided with no spin or other retarding type automatic differential lock to assure a torque transfer to each wheel retaining traction. If manual lockout is required, the lockout control

shall be located in the vehicle cab. The torque capacity of each axle and differential shall be at least 10 percent in excess of maximum torque to which the axle could be subjected under any operating condition with the carrier fully loaded. The power transmitting shaft on the steering front axles shall incorporate steering joints of a type that produce no objectionable steering characteristics throughout their range of angular travel with steering joints enclosed in shielded housings. When axles are specified as reduction types, they may be single, double or planetary reduction type. Large blowers shall have front and rear reduction axles.

22. BRAKES/AIR SYSTEM. A braking system which meets the FHWA requirements for similar type vehicles shall be furnished, complete with all necessary equipment to safely control the fully equipped and loaded or unloaded vehicle under all operating conditions. The brake mechanism shall be readily accessible to external adjustment. Braking systems shall be complete with all necessary components including the following:

a. Air compressor, unloader-head type, engine driven and engine oil lubricated, air or water cooled, having a capacity of not less than 12 cubic feet per minute. (Large/medium blowers.)

b. Air storage reservoirs with not less than 2,000 cubic inch total capacity. Each tank equipped with a drain and with safety and check valves between the compressor and the last reservoir tank. (Large/medium blowers.) The total cubic air storage capacity of the system shall not be less than 13 times the volume of the brake actuating chambers in any design. A low air pressure warning device shall be incorporated.

c. Foot control, suspended or treadle type. (Large/medium blowers.)

d. Limiting valve for front brakes combined with quick-release valve.

e. Quick-release valve for rear brakes. (Large/medium blowers.)

f. Moisture ejector or moisture elimination system. (Large/medium blowers.)

g. Service brakes for small vehicles of the hydraulic type provided on all wheels and equipped with power or air assistance and shall be capable of meeting the brake tests specified on page 25.

h. Service brakes for large, medium and intermediate vehicles of the full-air or air-over-hydraulic type provided with an air compressor designed to include an unloader head to prevent a buildup of excessive air pressure in the system when the compressor is not in operation.

23. STEERING MECHANISM. The vehicle's front wheels shall be equipped with a standard hydraulic or power assist mechanical steering mechanism operable from the driver's seat. Steering components shall be installed in a manner to protect them from damage. The steering mechanism shall be capable of easily controlling the vehicle during normal operations with the blower section engaged. Access for rapid lost motion adjustment shall be provided.

24. SUSPENSION SYSTEM. Vehicles shall be equipped with manufacturer's current suspension system having a rated capacity at least equal to the imposed load. This is to be measured at ground level with the vehicle loaded to its rated GVW and with the rotary plowhead in the transport position. Auxiliary suspension springs may be provided on front and rear axles. When spring capacity is rated at the spring pads, unsprung weight shall be deducted. Ratings shall not be raised to conform to the requirements of this specification and suspension shall evidence no overload or permanent set. Shock absorbers of the heavy duty type shall be mounted on front and back axles. Shock absorbers are not required on large and intermediate vehicles.

25. WHEELS, RIMS, TIRES, AND TUBES.

a. Wheels. The carrier shall be equipped with single front and rear wheels. Rims and tire ratings shall conform to the Tire and Rim Association's recommendations for the type and size of tires furnished.

b. Size and Inflation Pressure. Each tire, at recommended inflation pressure, shall have a rated carrying capacity at least equal to the gross load normally imposed on it by the evenly and fully loaded vehicle. So as to be interchangeable, tires, including the spare, shall be of the same size. An aggressive tire tread of the military or diamond tread or conventional snow tread is recommended for general service. Tires and tubes shall meet the first line commercial grade requirements.

c. A Spare Tire. A spare wheel or rim with tire and tube included shall be provided; however, provisions shall not be made to mount the wheel or rim on the vehicle.

## SECTION 5. HYDRAULIC SYSTEM

26. GENERAL. The hydraulic system shall consist of rams, pump, piping, fittings, valves, controls, fluid reservoir, fluid filter, and all other parts essential to efficient operation. The system shall be capable of positioning the hydraulically actuated equipment in any chosen position within the design limits of travel. It shall be of such capacity that all controls can be operated simultaneously without a noticeable

reduction in response. All hydraulic controls for operating the rotary plowhead shall be located in the carrier cab. Hydraulic system shall be constructed to withstand all loads imposed in snow removing operations without the use of mechanical locks. Filtration of the hydraulic system shall conform to the Society of Automotive Engineers (SAE), J931.

27. HYDRAULIC PUMP AND POWER TAKEOFF. The pump shall be of a heavy duty type driven by the carrier drive engine. It shall have sufficient capacity to operate all hydraulic equipment specified herein under all operating conditions and speeds.

28. HYDRAULIC LINES AND FITTINGS. Hydraulic tubes, hoses, and fittings conforming to commercial quality for existing pressures shall be used. A minimum number of fittings, joints, and connections shall be used to prevent excessive back pressure, vibration, and leakage. Hydraulic lines shall be of sufficient size to permit free flow of hydraulic fluid at temperatures down to -40° F. Hydraulic hoses shall have a bursting pressure of three times the rated working pressure.

29. HYDRAULIC FLUID TANK AND COOLER. The hydraulic fluid tank shall be equipped with a filler neck with strainer, drain plug, and shutoff valve. An air vent shall be incorporated. Baffles as required shall be provided. The tank capacity shall be adequate to hold not less than 50 percent of the volume of oil required for operation of any combination of attachments. Hydraulic oil cooler shall be provided if system operating temperatures are excessive during normal operation. Hydraulic oil level indicators or gauges shall be provided.

30. ROTARY HEAD LIFT SYSTEM. Lift system shall be designed for a minimum lift capacity of 50 percent greater than the plowhead gross weight.

31. WINTERIZATION OF THE HYDRAULIC SYSTEM. Winterization shall be based on meeting the same lower temperature requirements as the engine system. This includes heating devices for the hydraulic oil tanks, piping, valves, pumps, etc., and insulating compartments housing these system units so that the vehicles can continue in operational status during prolonged periods of freezing temperatures described in the cooling system winterization preparations.

## SECTION 6. ELECTRICAL SYSTEM COMPONENTS

32. GENERAL. The electrical system and devices shall be negative ground and be installed in accordance with the best modern practices for the type of service required. All parts of the electrical system shall be of a waterproof type, easily accessible, securely mounted and protected against heat, physical damage, snow, oil and salt corrosion. All electrical circuit

wiring shall be made with stranded conductors of a carrying capacity commensurate with the anticipated maximum circuit loading. It shall have insulation in accordance with the recommended standards of the SAE for such loading at the potential employed.

33. POWER SUPPLY. An electric alternator or generator of not less than 80 amperes capacity shall be provided. It shall have an output adequate to exceed the full anticipated electrical load and be provided with full automatic regulation. When receptacles or other facilities providing 110-volt A.C. or D.C. power are installed, such receptacles or other facilities shall be of weatherproof type and circuits or associated wiring shall have, at the source of 110-volt supply, overload protection rated at the carrying capacity of the conductor. The 110-volt A.C. power supply is for energizing the engine jacket water heater, oil pan heater, or battery pad heater as required.

34. BATTERIES. Batteries shall be securely mounted and adequately protected against physical injury, water spray, and engine and exhaust heat. If an enclosed battery compartment is provided, it shall be adequately ventilated and the batteries be readily accessible for examination, test, and maintenance. Battery capacity shall be compatible with the size of the engine and the anticipated electrical load, or 120 ampere-hour rating at a 20-hour discharge rate for a 12 volt small vehicle system. When a dual battery system is supplied, each battery shall be of the capacity required for a single battery system. One receptacle shall be provided for charging all batteries.

35. STARTING DEVICE. An electrical or pneumatic starting device shall be provided. Their characteristics are as follows:

a. Electric Starting. The electrical starting device shall be such that the current draw, when operating under maximum load, will not introduce a voltage drop sufficient to adversely affect the function of the ignition system or other electrical equipment.

b. Pneumatic Starting. The pneumatic starting system shall utilize the brake system air compressor as the source of compressed air. The system shall include a cranking motor, air reservoir of not less than 11 cubic feet volume, filter and all necessary piping and valves.

36. IGNITION SYSTEM FOR GASOLINE ENGINES. Ignition shall be of the battery supplied distributor and coil type in connection with a single set of spark plugs.

37. BATTERY CHARGING CONNECTION. A waterproof plug for charging the battery shall be provided and mounted on the rear of the vehicle.

38. LIGHTING SYSTEM. The lighting system, including reflectors and clearance lights, shall be the manufacturer's current standard provided the equipment shall meet the FHWA's Motor Carrier Safety Regulations and local highway requirements. The system shall include:

    a. Headlights. Two or more sealed-beam headlights with upper and lower driving beams and a foot or hand controlled switch for beam selection. These may be fender or body mounted.

    b. Dual Taillights and Dual Stoplights.

    c. Turn Signals. Front and rear turn signals conforming to SAE Turn Signal Units, Type I Class A having self-cancelling control with a visual and audible indicator and switch to flash all lights.

    d. Spotlight. Six-inch, corrosion resistant spotlight on cab roof or side of the windshield, hand-adjustable type, with controls for beam adjustment inside the vehicle.

    e. Reflectors, markers, and clearance lights installed in conformance with FHWA's Motor Carrier Safety Regulations. The clearance lights should be equipped with lenses of the commercial truck type.

    f. Engine compartment lights arranged to adequately illuminate both sides of the engine(s) with switches located in the engine compartment(s).

    g. Backup Lights. At least two, six-inch backup lights installed at the rear of the vehicle.

39. COMMUNICATIONS EQUIPMENT. An optional provision for installation of two-way radio communications may be made. Details of radio installation are shown in paragraph 67m.

## SECTION 7. OPERATOR'S CAB

40. GENERAL. An all metal or fiberglass constructed fully enclosed cab of the conventional or forward design shall be furnished. The surfaces and floor of the cab shall be insulated. The engine and driver's compartment shall be separated by insulation. The cab roof is to be provided with gutters. The cab shall have a hinged door on each side providing easy access. Running boards, cab steps, and assist handles and bars shall be of ample size and design to insure safety and easy entrance and exit from either side of the cab for persons wearing bulky artic overshoes, mittens and outer garments. All step surfaces on the exterior of the cab shall be of the nonskid, open grated type.

41. CAPACITY. Seating shall be provided for the driver. The driver's seat shall be easily adjustable up and down, fore and aft, a minimum of three inches. If desired, a cab suitable and with seating for two persons may be specified.

42. SEATS. Seats shall be fully upholstered with a good quality upholstery over foam rubber cushions. Approved, properly installed seat belts for the occupants shall be provided. The cab shall be provided with dual sun visors of a type that will afford the occupants sun protection. Cab ventilators shall be screened and shall be located to minimize entry of snow.

43. WINDOWS. All glass shall be of the laminated safety tinted type with the windshield located to minimize blocking by obstructions affecting visibility. The windshield shall be equipped with dual, two speed electric or air wipers or rotary windshield sector(s) similarly controlled and powered which shall sweep a clear view for all occupants. A windshield washer of the one-gallon size shall be provided and properly installed.

44. MIRRORS. Two outside rear view mirrors of the extension arm "westcoast" type, each having an area of not less than 60 square inches, shall be provided. One mirror shall be mounted on each side of the cab with at least three supporting arms per mirror. Heated mirrors are optional.

45. HEATER-DEFROSTER. The vehicle shall be equipped with a heater/defroster system selectable functions which will generate approximately 200 BTU output per cubic foot of cab volume, with blower capacity per minute approximately equal to cab volume. The system shall contain a snow-free, fresh air intake and defroster ducts to the windshield. The heating system shall be able to maintain a cab temperature of $55^{\circ}$ F at ambient temperatures of $-20^{\circ}$ F.

46. INSTRUMENTATION. The cab shall be provided with an instrument panel equipped with instruments and controls located in full view of and for convenient operation by the operator. All instruments and controls shall be labeled in a manner to remain legible for the life of the carrier, to indicate function, and be illuminated by rheostat controlled lighting for night operation. All instuments and controls necessary for proper operation of the snow removal unit and the rotary plowhead drive engine(s) shall be provided and shall, as a minimum, include the following:

    a. Ammeter for carrier and rotary plowhead drive engine(s).

    b. Fuel Level Gauge(s).

c. Lubricating oil pressure gauges for carrier and rotary plowhead drive engine(s).

d. Engine coolant temperature gauges for carrier and rotary plowhead drive engine(s).

e. Speedometer with recording odometer.

f. Tachometer(s) for carrier and rotary plowhead drive engine(s).

g. Brake-air reservoir pressure gauge when required.

h. Low-air pressure warning, visual and audible type when required.

i. Light Switches and Headlight Beam Indicator.

j. Starting controls for carrier and rotary plowhead drive engine(s).

k. Torque converter oil temperature and pressure when required.

l. Cranking system air reservoir pressure gauge (when pneumatic cranking is furnished).

m. Hydraulic oil pressure and temperature gauge (if applicable).

n. Carburetor choke when required.

o. Hydraulic Level Gauge.

p. Audible overheat alarms (hydraulic and engine oil) when required.

## SECTION 8. SHEET METAL COMPONENTS

47. CAB/BODY/ENGINE COMPARTMENTS. The cab/body/engine compartments shall be fabricated from aluminum, fiberglass or steel designed to provide the lightest weight consistent with the strength necessary for maximum durability. Body shall fully enclose all engine(s) and mechanical components. Self tapping bolts shall not be used in construction of sheet metal components. These components shall be of rain, snow and dust proof construction and be equipped with doors having continuous piano-type hinges with brass pins or equivalent, and chrome-plated, snap-type locks with semiflush handles, or similar positive locking devices.

a. Steps shall be located on each side of the cab, and shall be provided as required for ascending or descending from the vehicle. All steps shall be of four-way safety tread design.

b. Walkway. When necessary for access, a walkway of a four-way safety tread design shall extend the distance of the vehicle.

c. Rigidly attached handrails or guardrails of suitable metal tubing not less than 1¼ inches in diameter shall be provided as required for personnel safety at all steps, walkways and stations. Handrails or guardrails of a material other than stainless steel shall be chrome plated or otherwise protected against corrosion.

d. Fenders shall be provided to prevent wheels from throwing snow on windshield.

e. Mudflaps, when necessary to prevent debris throwing, shall be the non-sail type.

f. Drains, plugged or open, shall be provided on all body and compartment locations where free standing water can collect. The open drains shall not drain onto locations anticipated to be occupied by personnel during normal operations.

48. COMPARTMENT DOORS. Doors shall have positive closing mechanisms. Top-hinged compartment doors shall be held in the open position by support arms. They shall be easily opened or closed and shall not rattle during travel. The doors shall be counterbalanced where necessary by means of springs or shall be divided horizontally, if required, to facilitate easy handling.

## SECTION 9. SNOWBLOWER AND COMPONENTS

49. GENERAL. The rotary snowblower may be either a single stage or a two-stage unit and shall be considered as an integral part of the vehicle. (Figure 2, page 30.) The blower unit shall be designed to withstand hard usage, cold climates and the materials, parts, and construction techniques shall conform to the best engineering practices. A blower of proper design shall not depend primarily on vehicle forward motion to pickup and cast snow.

50. TWO-STAGE BLOWER. This type blower may be of any suitable design, either the single solid auger, the dual solid auger, or the helical ribbon auger type. The first-stage auger acts to cut and force snow from auger ends into the center of the blower where the second stage impeller buckets force the snow into a snow casting chute. Figure 5, page 33.

a. Rotary-Head box shall be fabricated of heavy gauge welded alloy steel suitable for the type of expected service. Provisions on the box shall be made for vehicle mounts, shoe or caster brackets, scraper blades and associated hardware, drives, controls, auger and impeller bearing mounts and other mechanical hardware.

b. Auger (Solid) single or dual type shall have a minimum of two bearing supports, one at each end of each auger shaft. The flights shall be high tensile steel, welded to the auger shaft and may be equipped with hardened edges for increased service. The auger shall be balanced to ensure minimum vibration.

c. Auger (helical ribbon) type shall have a minimum of two bearing supports, one at each end of the auger shaft. The ribbon flights on each reel shall be removable and mounted on the reel shaft by the necessary number of mounts to ensure maximum rigidity. A minimum of clearance shall exist between the rotary head box and the reel to reduce snow plowing and carryover. Teeth may be provided on reels.

d. Impeller System. The impeller system shall be designed to be consistent with the capacity of the in-putting augers. The opening, blade diameter and speed ratio shall ensure proper snow flow and discharge to the casting chute. The impeller blades may be replaceable and the assembly shall contain not less than four blades. All blades shall be of high tensile steel and constructed and balanced to be resistant to vibration and shock damage caused by high speed ingestion of foreign objects.

e. Blower/Impeller Drive. Auger reel and impeller shall be driven by either hydrostatic or mechanical means with the rate controllable by a single operator inside the control cab. The blower drive may input on either side or in the middle of the auger. A reduction gear system shall be provided between the impeller and the auger to ensure a proper ratio of impeller speed to auger speed, ensuring correct snow flow. The impeller reduction unit may be either a mechanical or hydrostatic system.

f. Scraper blade shall be fitted to the lower leading edge of the rotary head box. The blade shall run the entire box width and be a removable blade of high carbon steel.

51. SINGLE-STAGE BLOWER. The single-stage blower may be of any suitable design, with either single or dual turbine fans and with or without moveable or fixed blower side extension wings. Each turbine fan shall be equipped with a pre-cutter propeller bar on the fan shaft extension. The pre-cutter bar shall be sufficiently rugged to breakup ice and ice-encrusted snow into pieces small enough to be ingested by the turbine fans. (Figure 6, page 34.) A blower of proper design shall not require vehicle forward motion to ingest and blow snow.

a. The turbine fan box shall be fabricated of heavy gauge welded alloy steel suitable for the type of expected service. Provisions shall be made for vehicle mounts, shoe or caster brackets, wings and associated hardware, drives, controls, shaft bearing supports and other mechanical hardware when so equipped.

b. Propeller turbine fans shall be supported on one end by bearings of adequate size for maximum expected loads and velocities. The turbine fans shall contain a minimum of four blades and shall be fitted with a pre-cutter propeller on shaft extensions.

c. Turbine Drive. The turbine assembly shall be driven by either hydraulic or mechanical means, with turbine rate controllable by a single operator inside the control cab. The blower drive shall input behind the blower face, and be fully accessible from the rear of the blower box.

d. Wings and Swath Extenders. The blower box may be fitted with alloy steel wings as desired to achieve greater removal swath. The wings may be fixed or hydraulically actuated. All blower swath extenders shall be easily removable.

52. STANDARD BLOWER EQUIPMENT (SINGLE AND TWO-STAGE).

a. The snow casting assembly consists of a controllable chute, impeller or turbine snow collector and a control system. The system shall be designed to accept the maximum output volume of the impeller or fan assembly, with an interior free from sharp bends or obstructions. The casting chute assembly shall rotate in a vertical or horizontal plane as required to cast snow to the left or right side of the vehicle for distances from zero to maximum cast for the class of blower. The assembly shall be able to flat cast. The snow casting assembly shall be fully controllable by a single operator in the control cab. The snow casting chute and assembly shall be designed to provide maximum operator visibility during all operations. A spot casting chute may be provided as desired for loading trucks or stockpiling snow.

b. Adjustable, replaceable alloy steel shoes shall be fitted on the rotary head box sides. The shoes shall be of suitable size to adequately control pavement surface contact.

c. Caster wheels may be provided if the blower head design requires casters as primary or secondary pavement clearance devices, rubber pneumatic tires shall be fitted to caster wheels.

d. The rotary head assembly shall have a provision for raising the head from the pavement. Hydraulic or mechanical actuators fully operable from the control cab shall be provided. Minimum ground clearance shall be eight inches when rotary head is at maximum height. Rotary head drive system shall not bind, rub or vibrate excessively when head is raised to maximum height.

e. Drive Protection System. The snowblower drive engine, if dual engine, shall have the same protection system and instrumentation as required for the vehicle engine (para. 15). The auger and impeller assemblies shall be protected against sudden stoppage or damage from foreign objects, by automatic clutches, release overrides and/or shear fasteners. If design considerations permit, preferred shear devices shall be accessible and replaceable from behind intake face of blower to eliminate removing snow from blower intake to replace pins.

f. Blower Accessibility. Provisions of carrier vehicle, page 10 shall apply.

g. Engine. If dual engine, the provisions of carrier vehicle engine, page 7 shall apply.

h. Drive Train, Transmissions, Transfer Assemblies. Drive shafts, universal joints and mechanical units shall not depart from driveline rotation planes at excessive angles (greater than $15^0$) during normal lifting or tilting operations of the blower head. Provisions of the carrier vehicle, page 11, shall apply to all driveline components.

## SECTION 10. MISCELLANEOUS RECOMMENDATIONS

53. PAINT AND ANTI-CORROSION TREATMENT.

a. The vehicle shall be cleaned, treated and painted in accordance with the best commercial practice.

b. The cab, blower compartments and all accessories not covered above shall be cleaned, primed, puttied, sanded and painted with not less than two coats of solid chrome yellow enamel or a substitute color as desired by the sponsor.

c. The finished paint shall be free of "fisheye", "orange peel", chips or runs and other imperfections that detract from the vehicle's appearance.

54. VEHICLE IDENTIFICATION. A revolving yellow beacon of a size (normally 10 inches minimum) appropriate to the size of vehicle is to be mounted on the uppermost part of each vehicle and must have:

a. Three hundred and sixty degrees azimuth coverage;

b. Effective intensity in the horizontal plane not less than 40 or more than 400 candles;

c. The beam spread measured to 1/10 peak intensity extending from 10 degrees to 15 degrees above the horizontal; and

d. Sixty to ninety flashes per minute.

55. NAMEPLATES AND INSTRUCTION PLATES. All nameplates and instruction plates shall be metal or plastic with the information engraved, stamped, or etched thereon. If metal, they shall be made of a noncorrosive material. These plates shall be mounted in a conspicuous place with screws, bolts, rivets or exterior type pressure sensitive tape.

a. Plastic plates shall not be used in exposed positions where they are subject to weathering.

b. Nameplates shall show make, model, serial number, and other such data as to positively identify the item.

56. HOURMETERS. Hourmeters with a zero to 9999 range shall be provided to record hours of each engine operation. The hourmeters shall be so mounted on the truck that they can be conveniently and easily read by personnel servicing the truck.

57. HOT WEATHER ROADABILITY. At an ambient temperature of 70° F., the vehicle shall have the capability of being driven a minimum of three miles at a speed of 20 miles per hour, without any component exceeding its normal operating temperature.

58. TECHNICAL PUBLICATIONS. The contractor shall furnish two sets of the following publications in accordance with standard commercial practices applicable to the vehicle furnished under the contract. Each set shall be composed of one copy each of:

a. An operator's manual with lubrication charts.

b. A Parts Manual. All parts not of original fabrication by the snowblower manufacturer shall be listed by the original manufacturer's name and number as well as the snowblower manufacturer's number.

c. A maintenance and service manual shall include specifications and procedures to ensure that routine maintenance service can be performed by nonspecialist service personnel.

59. TOOLS. Any tools peculiar to the servicing of the vehicle, blower and any of the auxiliary equipment shall be furnished with the vehicle.

60. ACCESSORIES. The vehicle shall be equipped with the following accessories installed in a built-in or permanently affixed, readily accessible compartment with lock:

a. Tire tools and lug wrench;

b. A jack with a capacity consistent with the vehicle's gross weight;

c. Shear pins, if applicable; and

d. Other tools specific for the operation or maintenance of the particular vehicle supplied.

61. INSTRUCTION AND TRAINING. The contractor shall, at no additional cost, furnish trained personnel at the time of delivery to place the equipment into operation and provide a minimum of twenty-four (24) hours of training for airport personnel in its operation and maintenance.

## CHAPTER 3. QUALITY ASSURANCE PROVISION

62. GENERAL. The contractor shall be responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the contractor may utilize his own or any other inspection facilities and services. Records of inspections and tests shall be maintained by the contractor. Copies of these records shall be provided the purchaser. The purchaser shall perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure contractor compliance with the specification requirements.

63. INSPECTIONS AND TEST PROCEDURES. These tests will be conducted at the purchaser's location by the vehicle manufacturer's representative.

a. Operational Tests. During these tests, the functioning of the engine, power train, blower system, hydraulic system, brakes, steering, lighting system, controls, and instruments shall be observed. The vehicle shall be fully loaded to its GVW and shall be operated as follows:

(1) 15 miles over hard surfaced roads at maximum speeds not less than 30 mph. (All wheel drive.)

(2) One hour at not more than five mph over types of terrain encountered at airports.

b. Capacity tests shall be conducted in accordance with AC 150/5200-23, Appendix 2.

c. Spot casting ability shall be tested by casting snow through the complete range at the minimum and maximum casting distances to determine spillage.

d. Brake Tests.

(1) Using service brakes only, bring the vehicle at GVW to five complete, successive stops within 50 feet from 20 mph on dry hard pavement free from loose material.

(2) Using hand brakes only, bring the fully loaded vehicle to a complete stop from 20 mph and hold the vehicle on the maximum grades at the airport.

e. Radio Interference. Vehicle shall have appropriate ignition and electrical shielding and shall not produce radio interference that disturbs normal airport navigation/communication capabilities.

f. Comply with hot weather roadability requirements in paragraph 57, page 23.

64. FIRE EXTINGUISHER. When specified, fire extinguisher(s) shall be provided. Such extinguisher(s) shall be mounted so as to be readily accessible to the operator. Type, size and quantity of extinguisher(s) shall be as specified by the sponsor.

65. PREPARATION FOR DELIVERY.

a. Domestic Shipment. The vehicle, blower and its accessories, spare parts and tools shall be packed in such a manner as to ensure acceptance and safe delivery to the designated point.

b. Marking. Marking for shipment shall be in accordance with instructions issued by the purchaser.

66. AUXILIARY EQUIPMENT. When the blower system is mounted on the vehicle as a nonintegral component, the blower engine (if dual engine) shall be easily demountable. The blower head shall be mounted on vehicle front using standard quick disconnect components. When the snowblower is removed from the vehicle, the blower drive system shall not interfere with normal operation of the carrier vehicle.

67. OPTIONS. The following options may be included if the purchaser's requirements so warrant these items.

a. Low Temperature Options.

(1) Engine-jacket water heater (750 or 1,000 watt unit).

(2) Engine oil pan heater (750 or 1,000 watt unit).

(3) Battery warmer pad (250 or 500 watt unit).

b. Battery Charger (built in and installed on carrier charge type) 0 - 1 amps at 12 volts or equivalent.

c. Tow chain 20 foot length 1/2 inch link.

d. Spot Casting Chute.

e. Bostrom "T" seat, or equivalent, on driver's side.

f. Bostrom "T" seat, or equivalent, on the passenger's side.

g. Windshields.

(1) Heated windshield (left hand or right hand or both sides).

(2) Non-tinted windshields.

h. Backup Alarm.

i. Systems (special start).

(1) Cold starting system (ether).

(2) Dual battery system.

j. Extra leaf springs to accommodate snow wing.

k. Heated Outside Rear View Mirrors.

l. Air Horn.

m. Radio transceiver, two way VHF for radio communications on appropriate ground control, unicom, flight service station, and maintenance base, complete with antenna and remote speaker. COMCO 730 (3 channels or equal). Additional radios may be installed as required.

n. Left-Hand and Right-Hand Door Lights.

o. Rotating or strobe beacon if different from recommended standard beacon.

p. Windows.

(1) Extra windows to improve driver visibility on either side of cab.

(2) Sliding windows.

(3) Heated rear windows.

q. Larger radiator, frontal area, core size.

r. Larger alternator or generator, specify type drive, amperes ____ voltage ____.

s. Fuel Tanks.

(1) 50 gallon left-hand or right-hand installation;

(2) 60 gallon left-hand or right-hand installation;

(3) 75 gallon left-hand or right-hand installation; or

(4) 100 gallon left-hand or right-hand installation.

Separate fuel gauges and cross connections to tanks may also be provided.

t. Mud or anti-splash flaps, if different from standard.

u. Rotary Windshield.

v. Manual override feature on radiator shutters.

w. Warning signal plus indicator light on dashboard when parking brake is in use.

x. Vehicle chassis and accessory options.

(1) All-wheel steering, power assisted type with operator selectable wheel steering lockout.

(2) Attachments or provisions for integral, towed or pushed power sweep brooms and plow blades.

(3) Articulated blower carrier vehicle such as front end loader types. All vehicle specifications in the foregoing list shall apply.

(4) Reversible operator position including operators seat and controls necessary to reverse vehicle operation direction.

(5) Tire chains.

(6) Vertical corner guide vanes.

(7) Pneumatic casters with head float.

(8) Rollover cab protection.

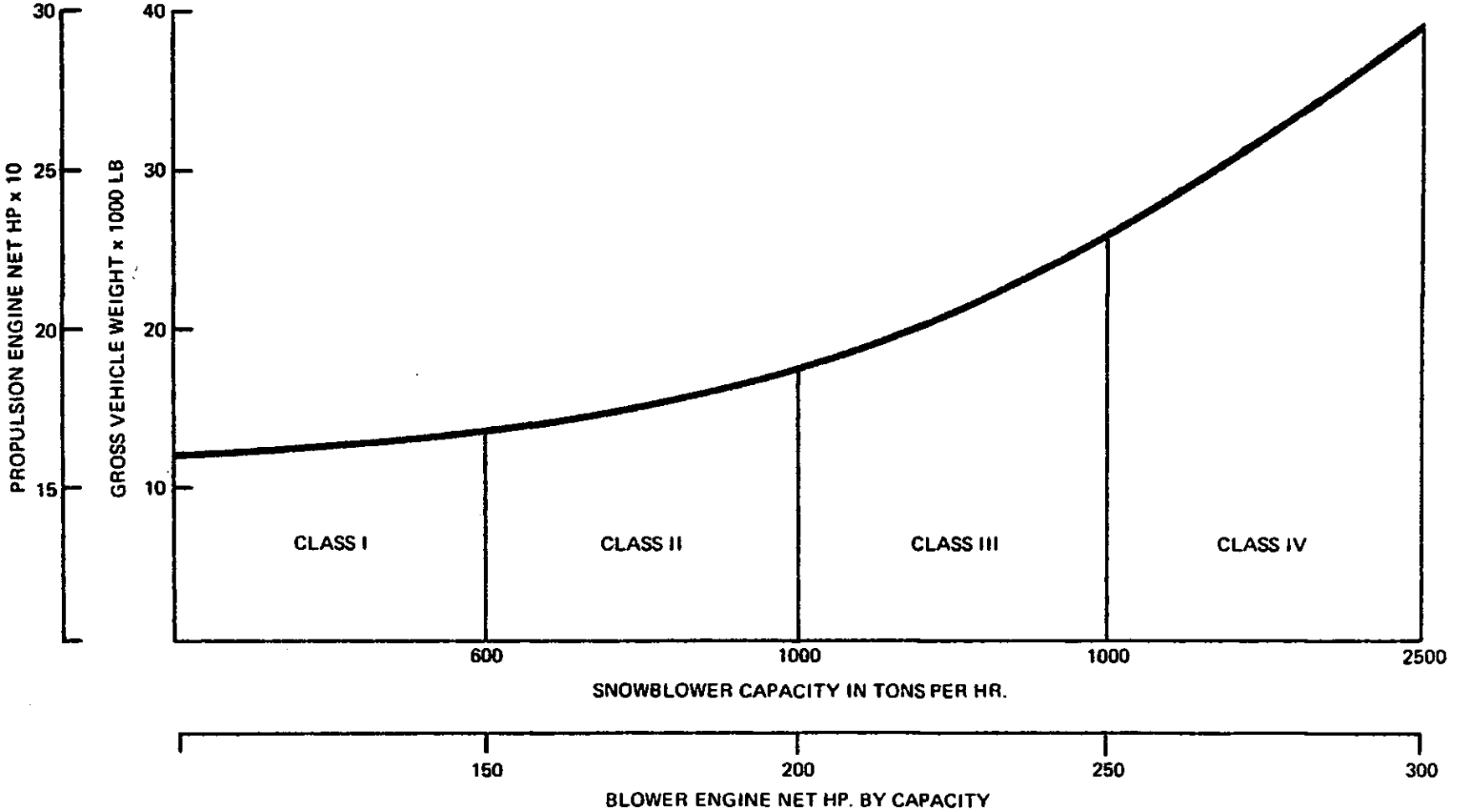
(9) 6 x 6 chassis design, with 33 percent or vehicle weight in front and 67 percent in rear.

68. WARRANTY. The manufacturer, contractor, or bidder must guarantee in writing that for a period of time that includes one full season of snow removal operations but not less than one year from the date of delivery he will, at his own expense and without expense to the purchaser, replace all failed parts and make all repairs that may be required by reason of defective design, workmanship or material in any part of the assembly of the snowblower, vehicle and associated components. Tires, batteries, electric lamps and other devices subject to normal deterioration shall not be included in this warranty.

NOTE: Due to the possibility of tire chain injestion damage to turbojet engines, snowblowers using the tire chain option, paragraph 67x(5), should periodically inspect chains for security, loss, and damage during operation and whenever possible avoid chain usage entirely in turbojet operational areas.

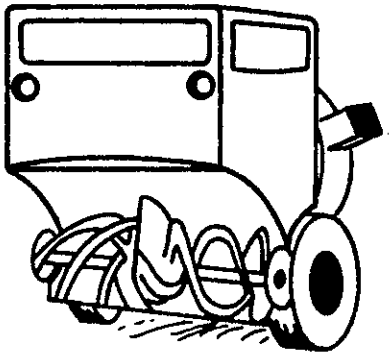
FIG. 1 - VEHICLE GVW AND HORSEPOWER RATING

Gross Vehicle Weight. The gross vehicle weight (GVW), including weight of the complete chassis and cab with all attachments, accessories, and equipment required by this specification; body; rated payload; and full complement of fuel, lubricants, coolant, and operating personnel (525 pounds), shall be as shown for each class vehicle shown below. The gross vehicle weight rating shall not exceed the sum of the axle manufacturer's certified load ratings for the axles used. The manufacturer's advertised gross vehicle weight rating shall not be arbitrarily raised to meet the requirements of this specification. The horsepower ratings should be used as general guidelines only, some machines are inherently more efficient than others. Capacity and casting distance should be the primary vehicle selection criteria.

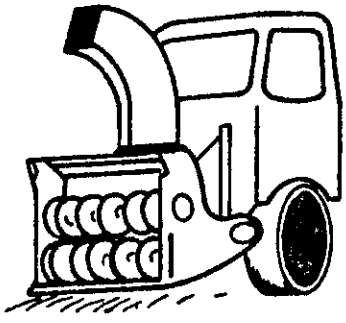



NOTE: HORSEPOWER OF SINGLE ENGINE VEHICLES SHOULD EQUAL PROPULSION & BLOWER HP. FOR THE CLASS OF VEHICLE CONSIDERED.

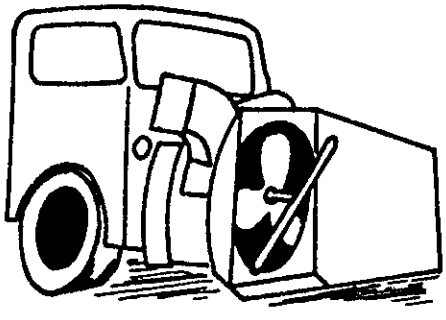
FIG.2- TYPICAL SNOWBLOWER TYPES



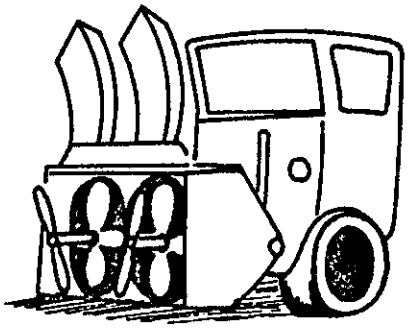
2 STAGE SINGLE AUGER
HELICAL RIBBON TYPE



2 STAGE DUAL AUGER
SOLID AUGER TYPE



SINGLE STAGE
SINGLE FAN WITH CUTTER BAR
SINGLE PLOW WING



SINGLE STAGE
DUAL FAN WITH
CUTTER BARS

FIG. 3 – FAMILY OF BLOWER CLASS PERFORMANCE CURVES – REQUIRED RATED CAPACITY AND PREDICTED TOTAL PERFORMANCE BEYOND MANDATORY VALUES

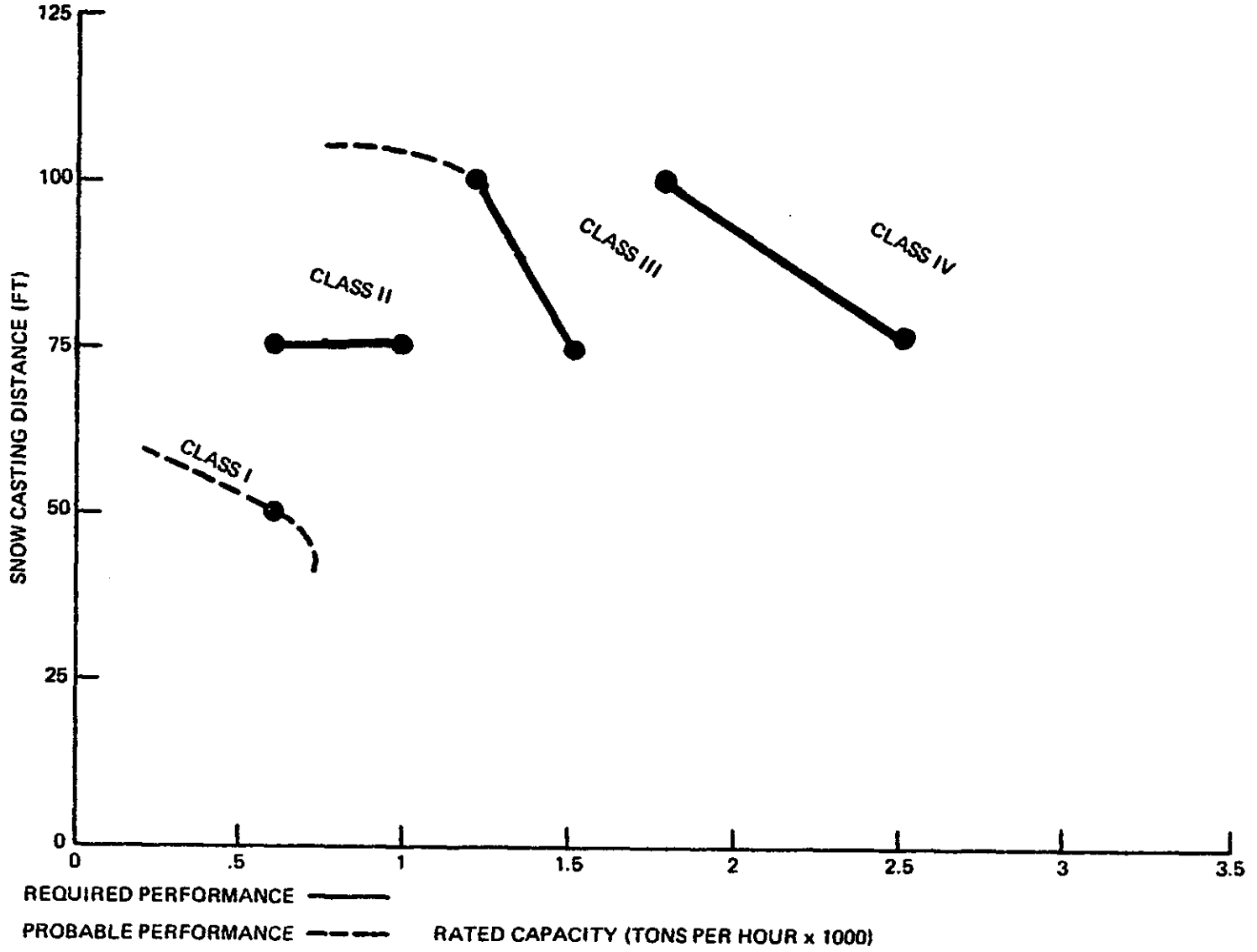
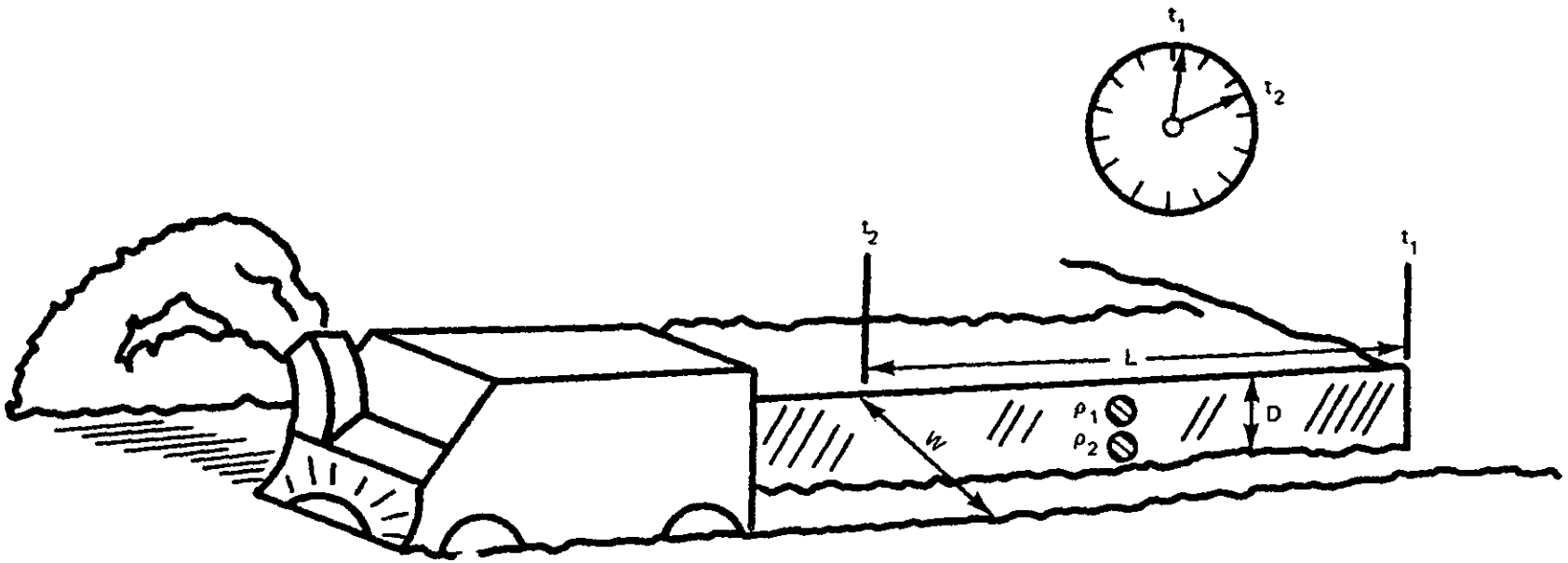


FIG. 4 - METHOD OF CAPACITY MEASUREMENT




Q = CAPACITY RATE IN TONS PER HOUR

$$Q = (\rho) \times (\frac{1}{t}) \times (K) \times (V)$$

WHERE: $\rho$ = SNOW DENSITY IN LB/FT$^3$ = $\frac{\rho_1 + \rho_2}{2}$

$t = t_2 - t_1$ IN SECONDS

$K = \frac{3600 \text{ SEC/HR}}{2000 \text{ LB/TON}} = 1.8$

V = VOLUME = $L^{FT} \times W^{FT} \times D^{FT}$

FIG. 5 - TWO-STAGE BLOWER

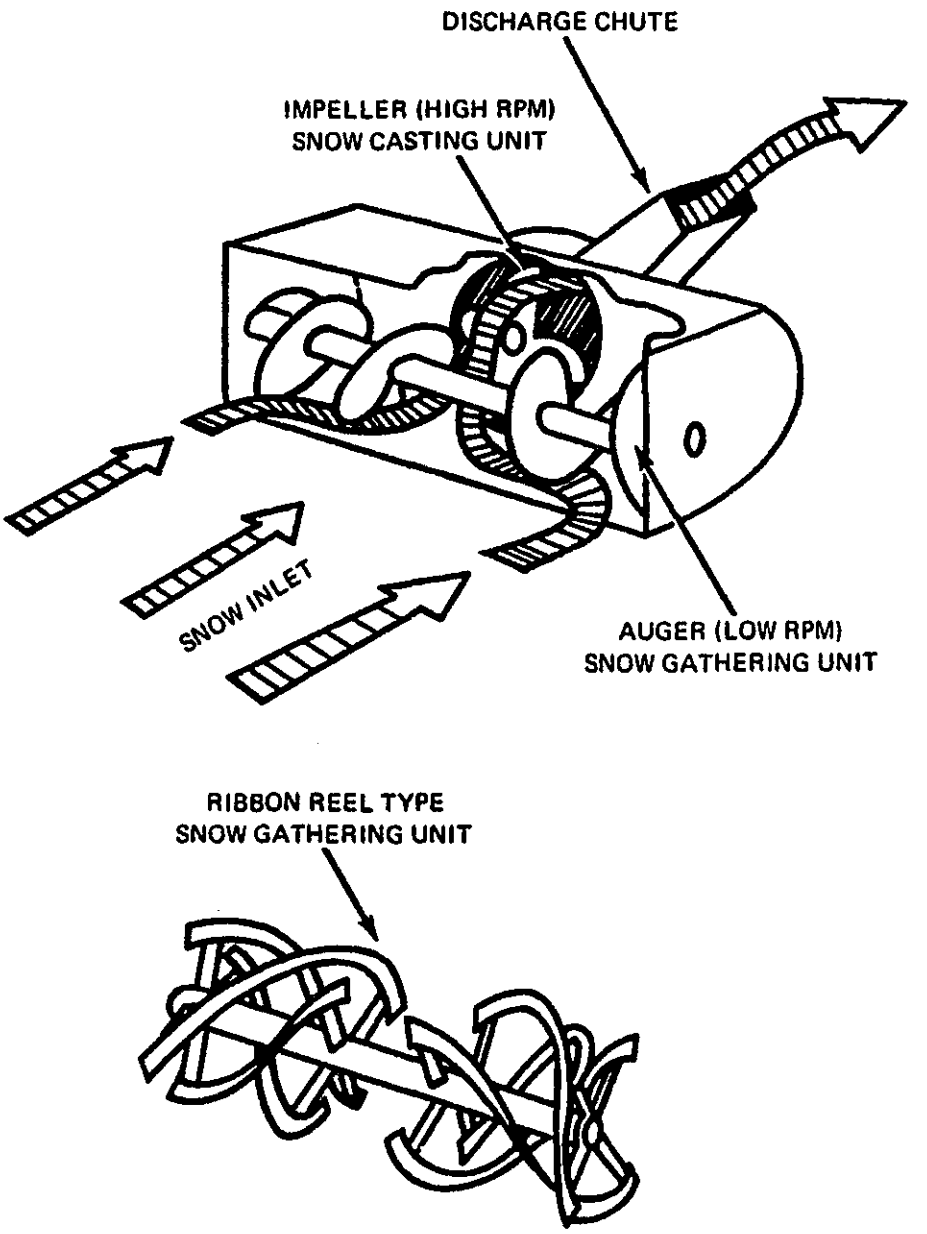


FIG. 6 - SINGLE-STAGE BLOWER

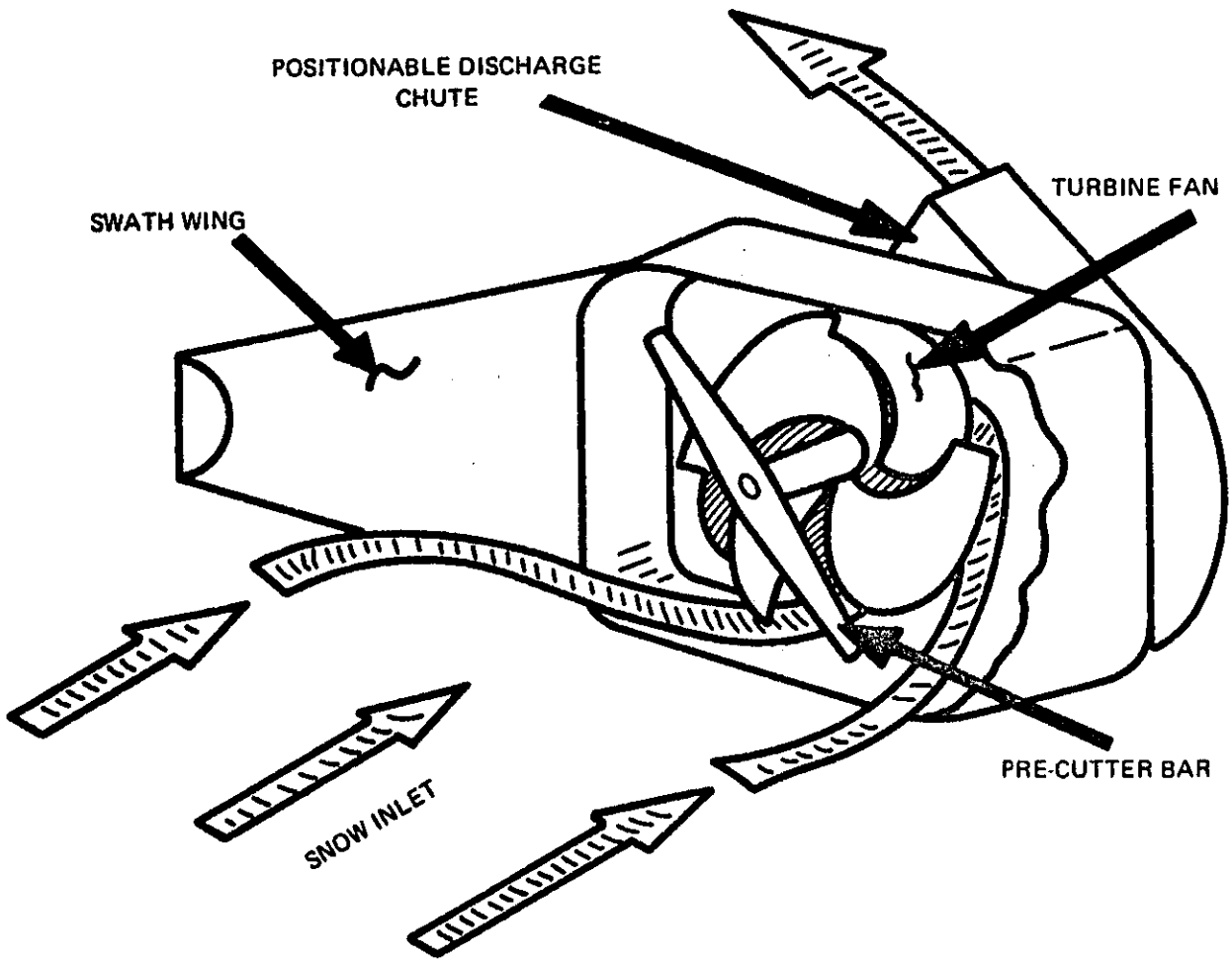
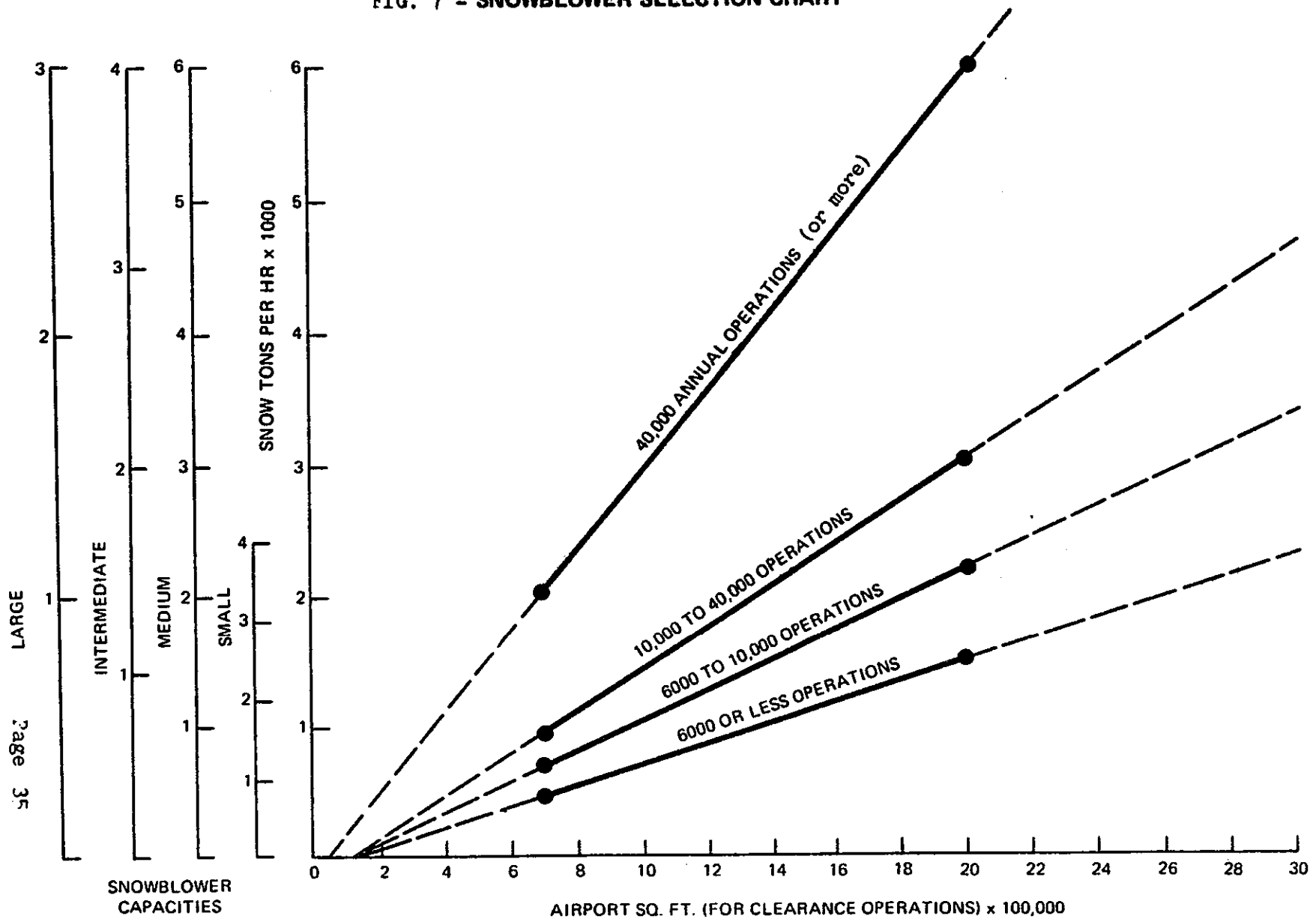


FIG. 7 - SNOWBLOWER SELECTION CHART



# APPENDIX 1

## SNOWBLOWER SELECTION CALCULATIONS

1. The selection guide, figure 7, page 35, was developed from the following calculations. (Either the selection guide or these calculations may assist in airport snowblower selection.)

   a. Determine the total square footage of all essential airport operational areas using AC 150/5200-23A. Assume removal operations begin when one inch of snow is on the runway.

   b. Determine removal time frame from total operations. For example, 40,000 or more annual operations of air carrier aircraft requires snow removal time frame of 1/2 hour.

   c. For purposes of calculation, snow density shall be 25 $lb/ft^3$.

   d. The mean temperature is $25^{\circ}$ F, wind zero. The standardized values of temperature and wind velocity (1d) do not appear explicitly in the calculations. Zero wind velocity ensures no blowing snow conditions exist, thus not introducing another parameter into the calculations. The temperature of $25^{\circ}$ F tends to ensure the snow density will remain approximately uniform at 25 $lb/ft^3$ and not change to slush or ice.

   e. The vehicle efficiency factor is 70 percent. The vehicle efficiency factor is essentially a lumped parameter that accounts for the difference between theoretical snow removal efficiencies and actual team efficiencies in the field. Variable blowing snow, variable snow densities, poor operator visibilities, wheel slippage, turnaround problems, team formation problems, minor mechanical problems and vehicle efficiencies are all accounted for by the single efficiency factor. Based on operator and manufacturer's experiences, this efficiency factor of 70 percent is considered a reasonable value.

2. Using the above information, snowblower selection calculations may proceed as follows.

   a. Convert runway square footage to cubic feet.

   b. Multiply by density to get snow weight in pounds.

   c. Divide by vehicle efficiency factor.

   d. Divide by time factor. (Time allowed based on yearly air carrier operations.)

   e. Convert to tons per hour.

   f. Select minimum number of blowers to equal required removal capacity.

3. For purposes of illustration, a sample calculation is shown below:

| Step 1. Determination of Operational Area | SQUARE FEET |
|---|---|
| Main runway = 9,000 x 150 feet = | 1,350,000 |
| Taxiway (parallel and connectors) = | 187,000 |
| Fillets = | 20,000 |
| Crash, fire rescue vehicle apron and access = | 20,000 |
| Apron (25 percent of 160,000 square feet parking) = | 40,000 |
| Blast pads (2 at 150 x 200 feet) = | 60,000 |
| Miscellaneous = | 20,500 |
| TOTAL AREA TO BE CLEARED = | 1,697,500 $ft^2$ |

NOTE: The total area may be rounded off to 1,700,000 for calculation purposes.

Step 2. The following parameters are incorporated in the calculations:

Area = 1,700,000 $ft^2$

Time Frame = 1/2 hour (corresponds to 40,000 or more annual air carrier operations at the airport)

Temperature = 25° F. (Standard)

Wind velocity = Zero Miles Per Hour (Standard)

Snow density = 25 $lb/ft^3$ (an industry accepted standard)

Snowblower efficiency = .7 (based on mechanical efficiency standards)

Depth of snow = 1/12 feet (FAA critical)

Step 3. Calculation of airport snow removal rate.

| | | |
|---|---|---|
| Cubic feet = | 1,700,000 x 1/12 | = 141,666 cubic feet |
| Weight = | 141,666 x 25 | = 3,541,665 pounds |
| Efficiency = | 3,541,665 ÷ 0.7 | = 5,059,521 pounds |
| Pounds per hour = | 5,059,521 ÷ 1/2 | = 10,119,042 lb/hr |
| Tons per hour = | 10,119,042 ÷ 2,000 | = 5,059 tons/hr |

Removal requirements are approximately 5,000 tons per hour and it can be seen that one 3,000 tons/hr snowblower and one 2,000 ton/hr snowblower can satisfy airport requirements. The same results can be obtained from Figure 7, page 35, without calculation, assuming square footage to be cleared is known.

In general, the current team concept of snow removal indicates the desireability of using the larger snowblowers to meet capacity requirements, i.e., if an airport has a snow removal capacity requirement of 2,000 tons per hour one large snowblower should be selected instead of three small snowblowers. This also reduces equipment outlay since each snowblower is normally supported by two plows.

## MEASUREMENT CONVERSION TABLE

| U. S. | | METRIC |
|---|---|---|
| 1 Foot | = | .3 Meters |
| 1 Cubic Foot | = | .028 Cubic Meters |
| 1 Inch | = | 2.5 Centimeters |
| 1 Cubic Inch | = | 16 Cubic Centimeters |
| 1 MPH | = | 1.6 KM/HR |
| 1 $LB/FT^3$ | = | 16 $KG/M^3$ |
| 1 Ton | = | .93 Metric Tons |
| 1 Ton/Hr | = | .93 Metric Tons/Hr |
| 1 Gallon | = | 3.8 Liters |
| $(^oF)-32 \times 5/9$ | = | $^oC$ |

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