Table 7-1. Plough selection table

Plough type	Blade angling	Low-speed displacement type	Casting-type high-speed	Swath width	Cost	Rubber edge	Wear
One way	No	Single direction	Single direction	Large	Low	Yes	Acceptable
Reversible	Yes	Both directions	Both directions	Large	Medium	Yes	Acceptable
Roll-over	Yes	No	Excellent both directions	Medium	Medium	No	Minimum
Apron	Yes	Both directions	No	Large	High	No	Acceptable
Large/folding wings	Yes	Both directions	Both directions	Very large	Highest	Yes	Acceptable
Loader bucket	Articulated	Both directions	No	Medium	Medium	No	Minimum

profile. Using earlier technology, the most generally accepted method of accomplishing this was the use of snowblowers and ploughs as a team. This is still a valid concept in many locations today, but in the following circumstances, the use of a casting-type plough alone might be considered:

— low annual snowfall (40 to 50 cm);

— elevated runways (pavements tend to remain clear if runways are elevated);

— high edge lighting (higher lights remain visible longer);

— low traffic counts (more time to clear runway);

— paved or stabilized shoulders (plough closer to lights);

— highly skilled operators (often major judgements can be required); and

— winter prevailing winds (slight prevailing cross-winds tend to blow snow clear of surfaces).

Under these conditions, elimination of a snowblower from the snow removal equipment inventory can reduce costs (see Figure 7-4).

7.5.7 *Plough types.* Figure 7-3 illustrates the different plough types.

a) *Tapered blade, one way, left or right hand.* Designed for high-volume, high-speed runway snowploughing, this snowplough is a conventional, one-way type with a tapered mould-board, operated by hydraulic power with conventional controls.

b) *Power-reversible, with standard or non-metal cutting edge.* This snowplough is intended for high-volume, high-speed runway snowploughing requiring the ability to discharge snow to the right or left at a fixed cutting angle. The unit is not intended for use on areas equipped with in-pavement lighting.

c) *Roll-over, steel edge.* This plough is designed for snow removal operations requiring the ability to discharge snow to the right or left at a fixed cutting angle. The unit is not intended for use on areas equipped with in-pavement lighting.

d) *Levelling wing, left or right hand.* This levelling wing is intended for heavy-duty snow removal operations and will provide blade operation at varying heights for wind-row and snowbank levelling and trimming operations.

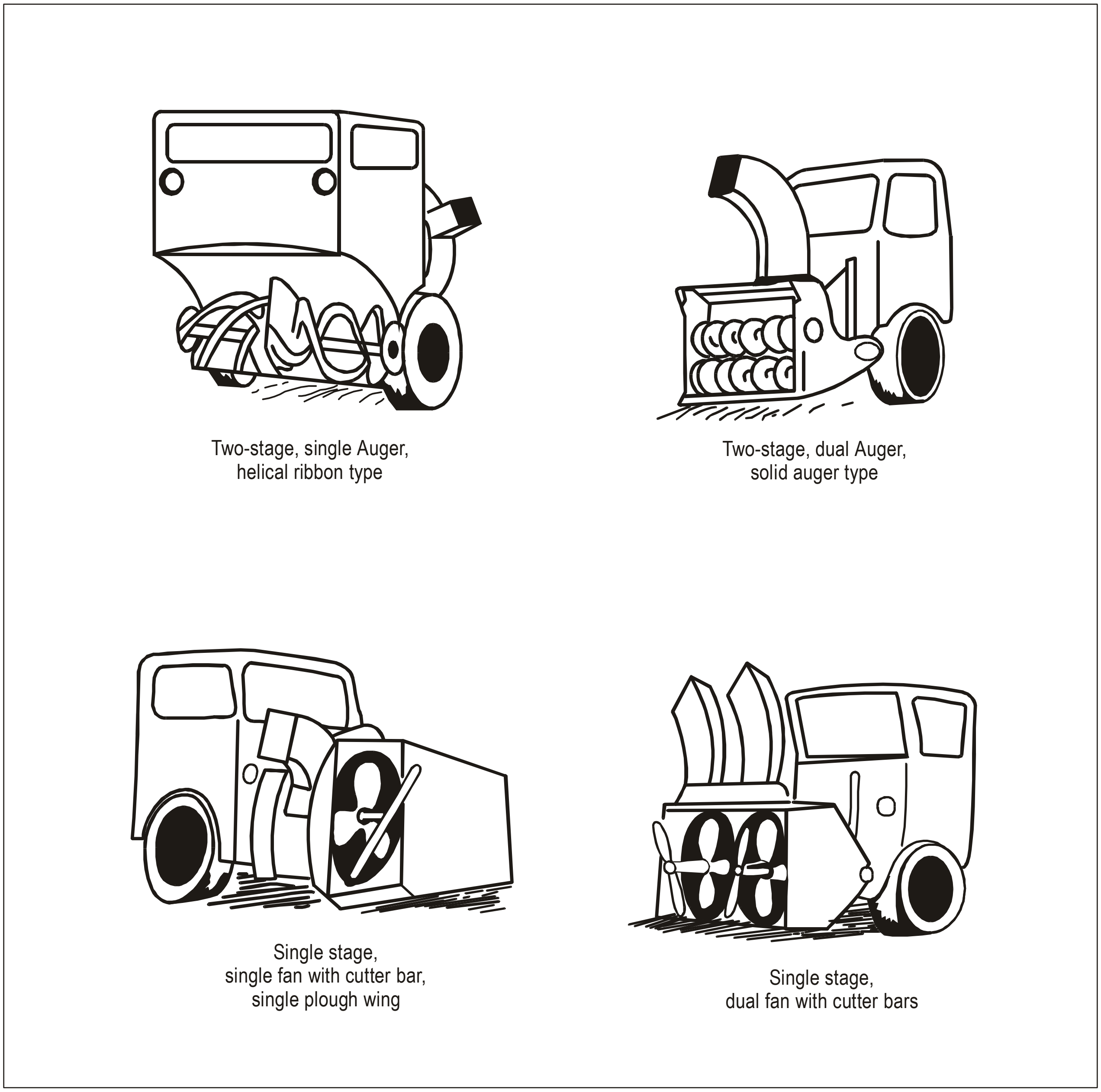


Figure 7-2. Typical snowblower types

e) *Extension plough.* This extension plough operates on the right or left side of the vehicle in combination with the front-mounted snowplough to increase the width of cut.

f) *Wide-swath, large push plough, reversible with folding wings.* This plough is designed for wide-swath operations, either high speed or low speed.

g) *Underbody scraper.* This plough is designed for maximum manoeuvrability in restricted areas and for packed ice and snow.

h) *Apron snow blade.* This plough is designed for wide-swath operations in confined apron areas. This unit is suitable for pushing snow and slush away from terminal buildings, aeroplane stands and apron areas and is not intended for use on areas with in-pavement lighting.

i) *Snow buckets (general purpose).* Snow buckets are for use in snow-loading operations and should function similarly to a standard bucket. The snow bucket is intended for use on front-end, loader-type vehicles in lieu of a standard bucket.

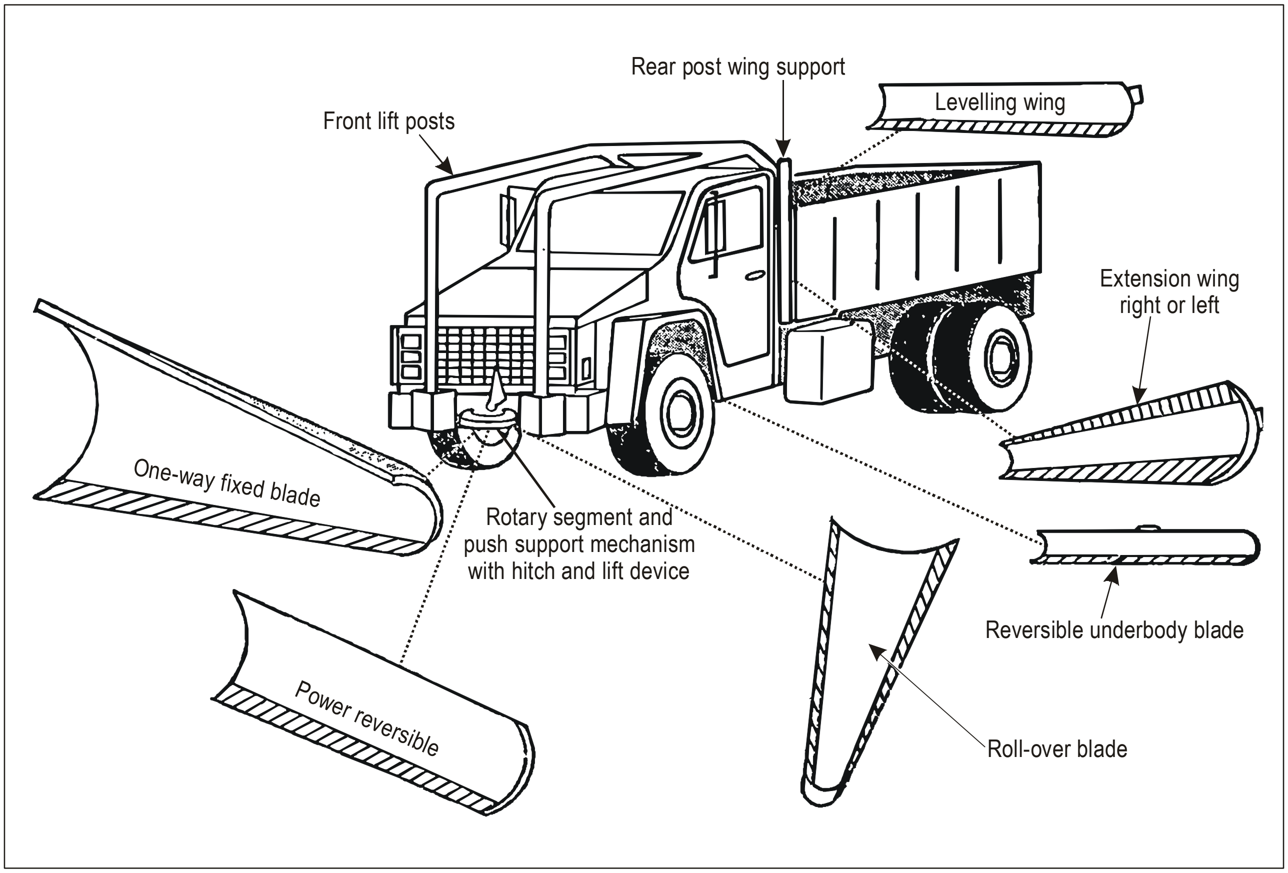


Figure 7-3. Blade types

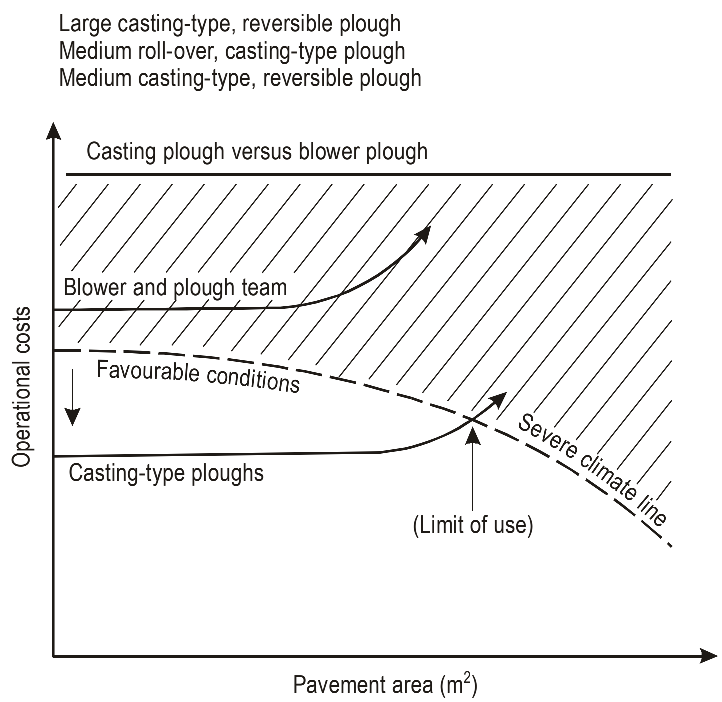


Figure 7-4. Casting-type ploughs (in any single or combination)

j) *Snow basket.* This basket is for use in snow-loading operations and is to function similarly to a standard bucket. It is intended for use on front-end, loader-type vehicles in lieu of a standard bucket.

7.5.8 Another savings on equipment could be realized by an airport analysing the use of front-end loaders versus plough/truck combinations. On tight apron areas in particular, the highly controllable and mobile articulated loader with good visibility performs better than any other equipment. The speed limitation in this type of vehicle is primarily due to its lack of suspension and its low-speed tires. In general, this type of vehicle should not be used constantly at more than 8-16 km/h, with the lower figure preferred, since the higher speeds produce bounce and internal tire heating and eventual tread separation. Figure 7-5 graphically illustrates the increased costs associated with the longer hauls and time requirements. When the areas to be cleared are large and time becomes an important factor, consideration must be given to a conventional plough/truck combination.

7.5.9 Plough vehicle power and fuel requirements may be reduced when using polycarbonate plough blades. There are many indications that fuel costs may be reduced considerably by the use of this newer blade material. Polycarbonate blades offer the same durable qualities expected from conventional steel blades, but with three major improvements:

a) lighter in mass — Inertia of the plough is reduced, lowering ploughing power requirements.

b) friction reduction — The friction coefficient of polycarbonate is less than steel and plough/snow skin friction is decreased, producing less drag; thus, less ploughing power is required.

c) corrosion-free material — The polycarbonate mould-board will not rust or corrode, and the portion of the ploughing assembly made of steel is generally protected by the polycarbonate mould-board.

7.5.10 *Sander/spreader vehicles.* These multi-purpose ice control vehicles used for spreading sand and urea are necessary at many snow-belt airports. Generally, urea can be used to melt ice when the temperature is above –9°C; heated sand is used when the temperature is below –9°C. The system is self-contained, has a hopper with positive feed and a spread swatch control device, and usually mounts on a plough truck. The vehicles are large 8- or 10-wheel trucks and may have such extra features as heated beds, automatic speed controls, and wetting devices for the urea to ensure a positive surface adhesion (see Figure 7-6).

7.5.11 *Snow sweepers.* These devices are either pushed or towed and have a directional air blast for clearing and vectoring packed snow. They are used to clear light snow, slush, and residual sand and to clear around in-pavement lighting.

a) *Pushed-type sweepers.* These may be of any suitable design and may be pushed by either a conventional or

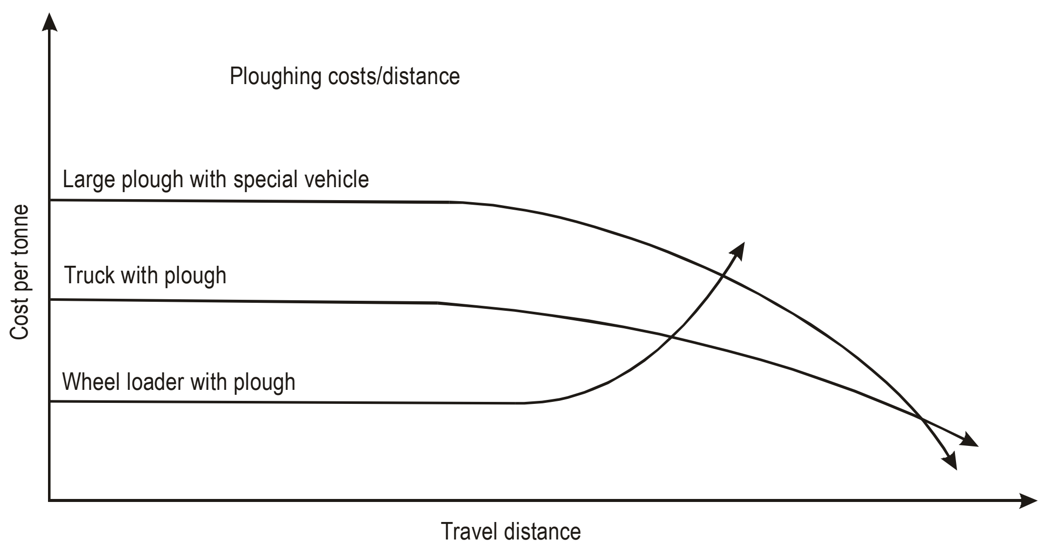


Figure 7-5. Ploughing costs/distance

a raised cab propulsion vehicle. The sweeper may have either one, two, or four castor wheels, and dual or single engine(s) and may incorporate an engine-driven air blower. This type of unit is placed in front of the vehicle and allows the operator to directly observe the area being swept, though in strong wind conditions, visibility from the cab can be seriously affected (see Figure 7-7).

b) *Towed-type sweepers.* These are pulled by a conventional cab propulsion vehicle. These machines are capable of sweeping a 3 m swath at speeds of up to 40 km/h and, when a number are used in echelon formation, can be most effective in sweeping runways quickly (see Figure 7-7).

7.5.12 *Liquid de-icer tankers.* These are large and usually custom-built vehicles that can spray up to a 25 m swath. Fluid anti-icing can perform effectively at lower temperatures than urea and does not blow away in the wind as urea does. It is also easier to tank and store. These vehicles are useful on larger airports where runway ice is a constant winter problem. They operate on two principles. The liquid can be pressurized and sprayed out through a spray bar (as shown in Figure 7-8). The amount of chemical dispensed is then dependent upon the pressure of the liquid, the size of the spray holds and the speed of the vehicle. Up-to-date machines spread the liquid from spinners in up to 25 m swaths, either symmetrically behind the vehicle or offset (to throw the liquid under parked aeroplanes). The rate of spread can be preset and is not dependent upon vehicle speed (up to 32 km/h).

7.5.13 *Solid de-icing chemical dispenser.* These are vehicles that dispense urea by spinners in 25 m swaths — either symmetrically behind the vehicle or offset (to throw the urea prills under parked aeroplanes). In order to make the urea prills stick to dry surfaces, they are passed through a water or liquid de-icer spray just prior to being spread. The rate of spread can be preset and the vehicle speed is automatically compensated for (see Figure 7-9).

7.5.14 *Front-end loader.* This loader, which is very useful for apron work, snow stockpiling, and loading sand

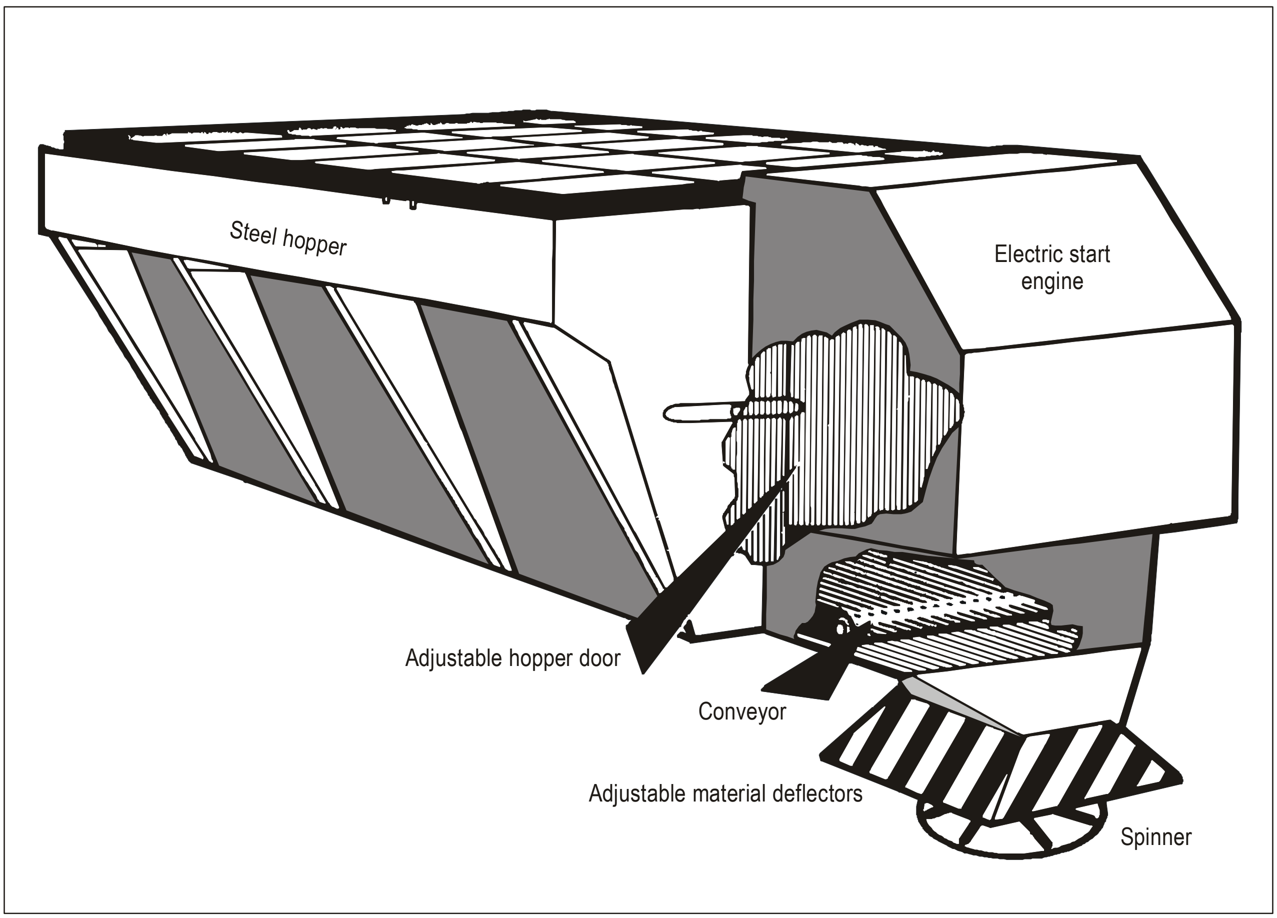
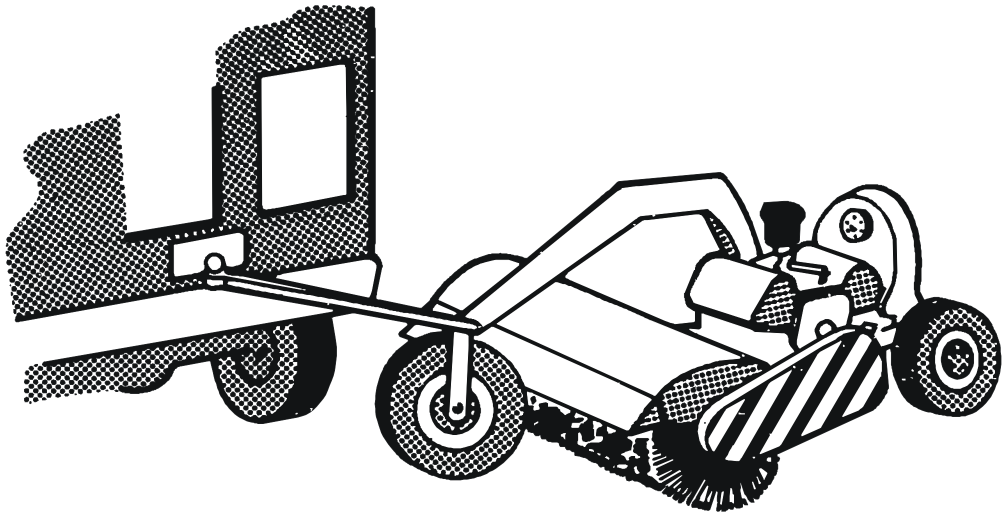
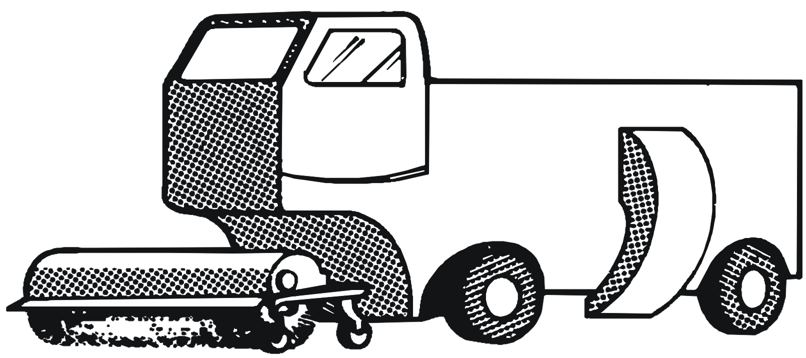


Figure 7-6. Sander/spreader device



Small swath, light duty — 3.6 m — swath towed type with integral blower



Large swath, heavy duty — over 3.6 m — pushed type with integral engine and rear blower — raised cab

Large swath, heavy duty — over 3.6 m — pushed type with two engines, front blower — conventional cab

Figure 7-7. Typical sweeper types

Figure 7-8. Liquid de-icer tanker

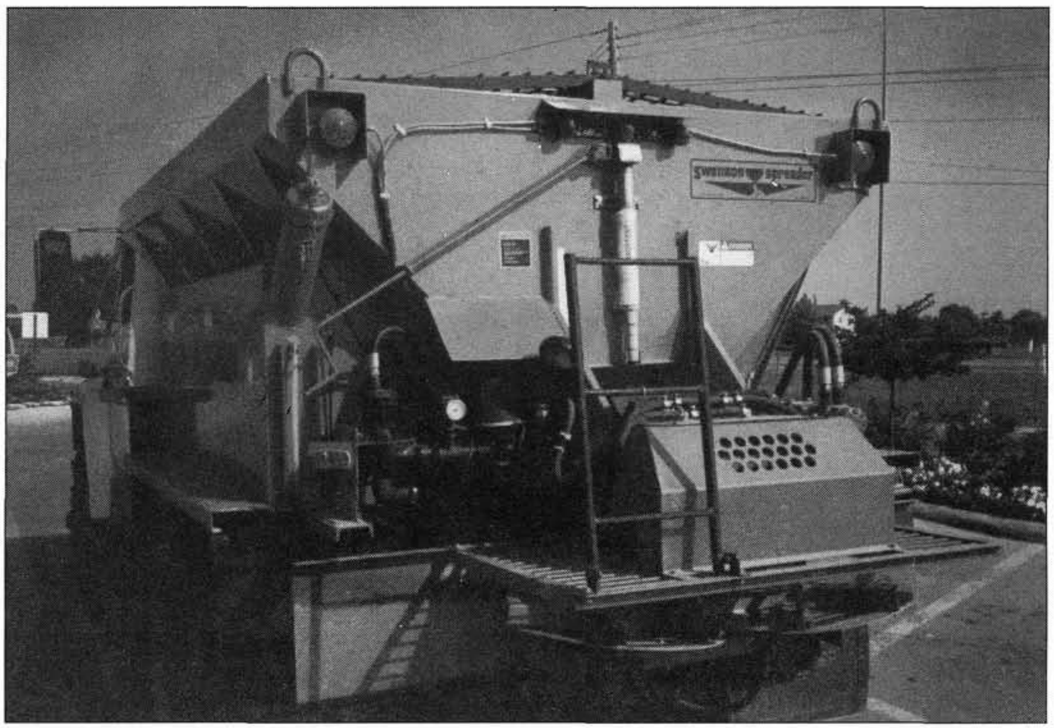


Figure 7-9. Solid de-icing chemical dispenser

and urea, can also be used to plough taxiways and aprons. It is available with a variety of attachments and buckets (see Figure 7-10).

7.5.15 *Grader*. The grader is very good for breaking ice and cleaning gravel runways. It has a low speed but can also be used for summer airport maintenance. These machines are often useful for maintenance of shoulders and access roads (see Figure 7-11).

7.5.16 *Airport maintenance, storage and snow removal equipment structures*. Constant surface management to prevent hazardous snow and ice accumulations requires the on-hand availability of snow and ice removal equipment, materials, and other associated equipment. To help achieve this all-weather availability, maintenance and storage facilities for this equipment are considered essential.

Runway surface condition sensor

7.5.17 The spreading of ice control materials prior to ice formation is the safest, most effective ice control method. A sensor that can both anticipate and display real-time conditions occurring on the runway is also a very effective tool. The pavement condition detection system contains three basic functional elements: the input head(s), signal processor unit(s), and a data display console unit. The system displays can be formatted to any end-user, e.g. pilots and air traffic or maintenance personnel (see Figure 7-12).

7.5.18 The system measures and displays information as described below:

a) runway surface temperature (actual temperature of pavement at detection site);

b) dry pavement condition (no perceptible moisture);

c) wet pavement condition (visible moisture on the surface);

d) ice prediction mode (advance alert of incipient ice formation); i.e. ice should form on the sensor detector head prior to formation on the pavement; warning time is dependent on temperature drop rate;

e) pavement ice formation (perceptible ice exists on pavement);

f) ambient air temperature, wind speed and wind direction near runway;

g) precipitation falling, all types;

h) relative humidity and dew-point temperature; and

i) chemical factor (an indication of the relative concentration of anti-icing chemicals still remaining in solution on the pavement surface).

7.5.19 The system works automatically 24 hours a day, permitting the detection of changing conditions before other methods.

7.5.20 Depending on the number of input heads in the pavement surface, the system can detect varying and rapidly changing conditions. Accordingly, rapid formation of ice will be detected electronically on a wet runway even if the air temperature remains above freezing. It is to be noted that airport personnel would not be alerted to the problem by conventional means.

7.5.21 Maintenance personnel time is better spent in preventing ice traction problems rather than continuously measuring them.

7.5.22 A continuous system provides more current information since the most recent dynamic friction measurement or pilot report may quickly become invalid when climatic conditions are rapidly changing. The task of reporting SNOWTAM data may be less complex and more rapid during manual data entry on the system's video display. The previous SNOWTAM data will remain until changed; only the automatic functions will continuously update. The display data can show a history, trends, graphics, or any format programme the user selects, and all or any portion of it may be sent to any geographic location over standard telephone lines. The display unit can also present the current status of other field conditions or operational safety data entered manually or by radio link.

7.5.23 Experience has shown that the system provides the following benefits:

a) safety — Advance warning of incipient icing conditions allows ice control materials to be applied prior to the formation of runway ice. Anti-icing opposed to de-icing provides better runway friction characteristics, improves runway utilization, and reduces the use of abrasives;

b) cost — Use of chemicals and abrasives only when the sensors indicate a need and the use of lighter anti-icing applications when an advance warning is provided will result in substantial reduction of ice control materials.

7.5.24 Selection of the correct number of sensors in each runway is dependent on many factors. These factors are presented in Figure 7-13.

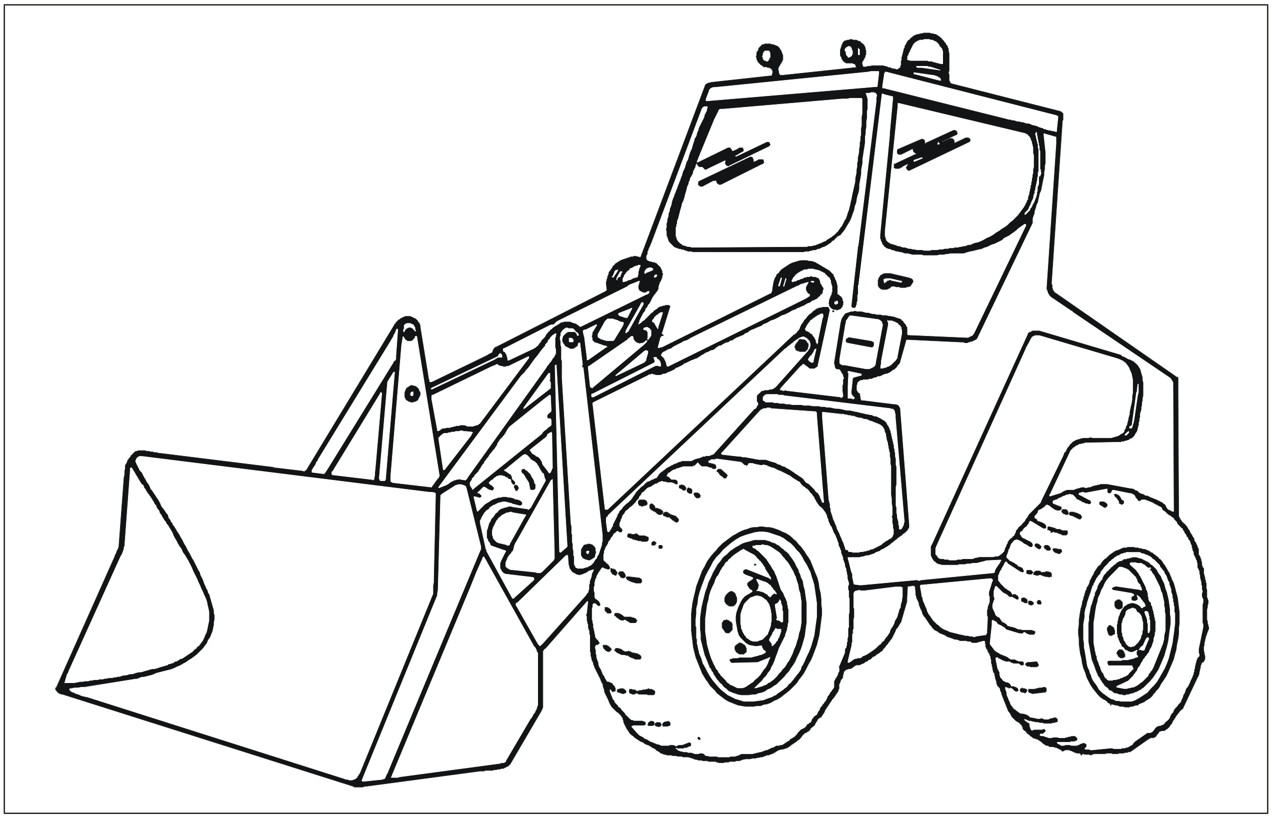


Figure 7-10. Front-end loader

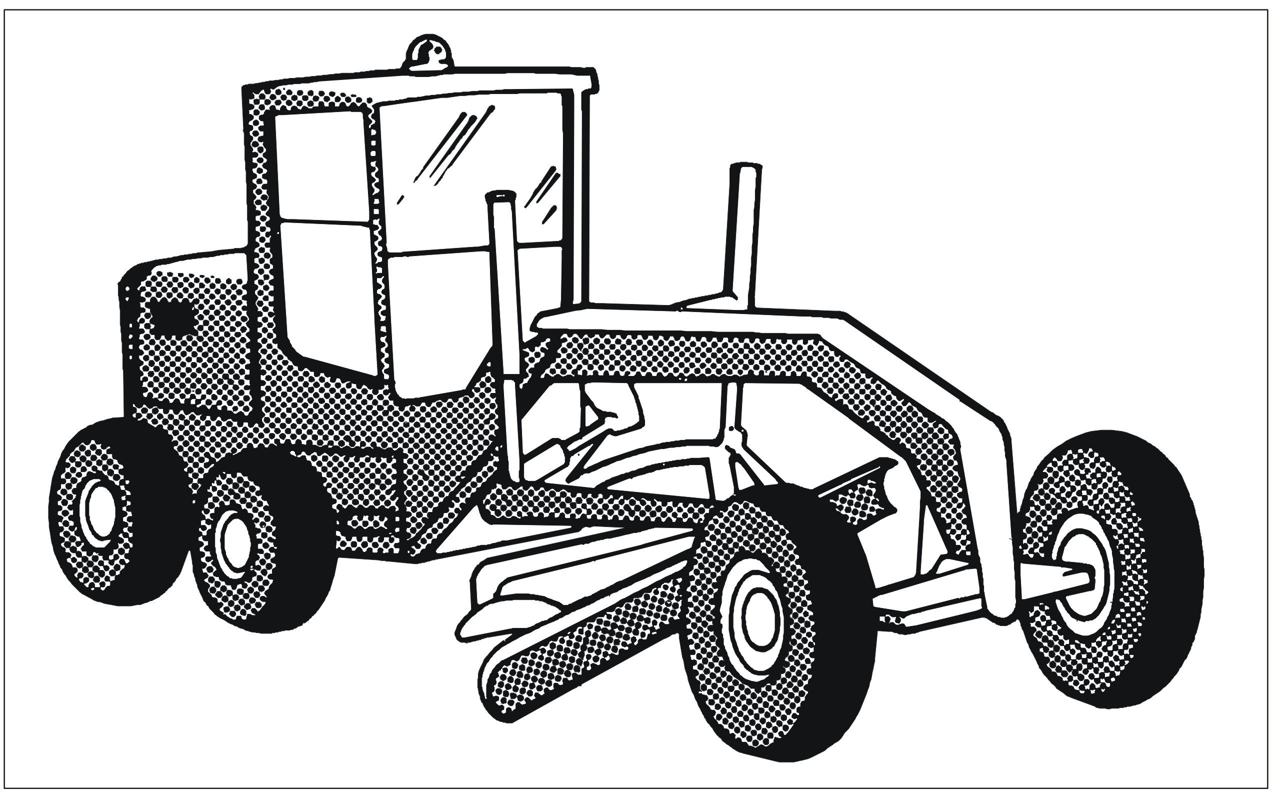


Figure 7-11. Motor grader

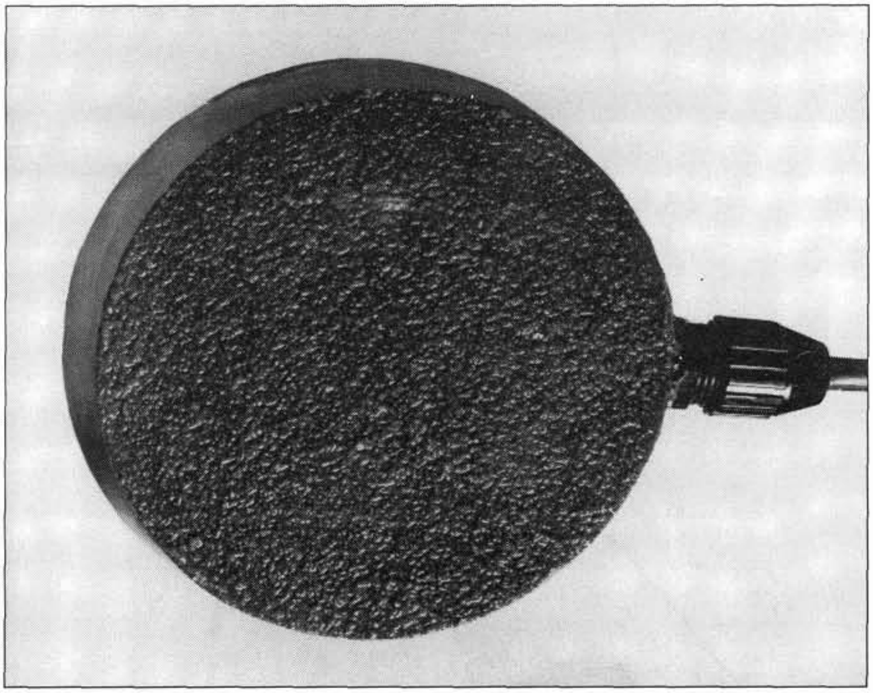


Figure 7-12. Runway surface condition sensor

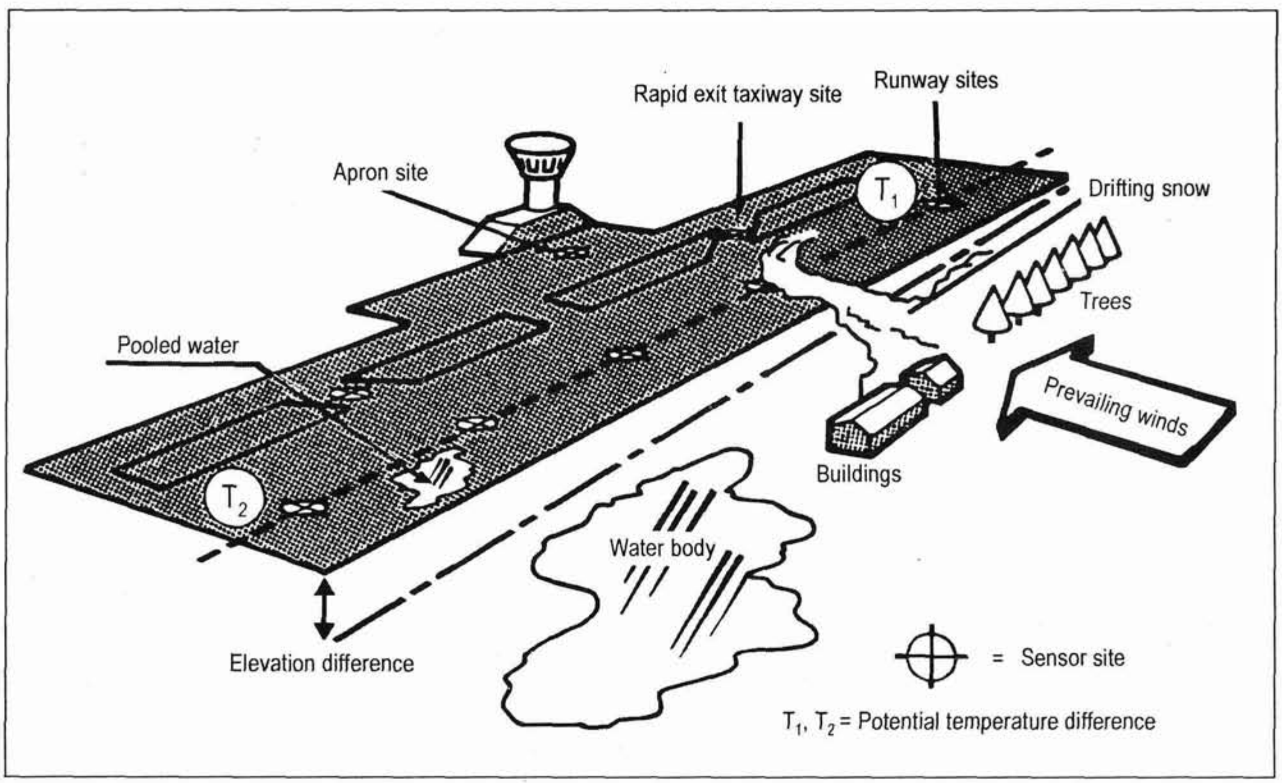


Figure 7-13. Factors affecting sensor location