U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: AIRPORT WINTER SAFETY AND OPERATIONS

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Change:

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1. **PURPOSE.** This Advisory Circular (AC) provides guidance to assist airport owners/operators in the development of an acceptable airport snow and ice control program and guidance on appropriate field condition reporting procedures.

2. **CANCELLATION.** AC 150/5200-23A, Airport Snow and Ice Control, dated January 25, 1985, is cancelled.

* 3. **APPLICATION.** The guidance and standards contained in this advisory circular are recommended by the Federal Aviation Administration for winter operations at all civil airports. Guidance is also provided on information which could be included in the Snow and Ice Control Plan required by Federal Aviation Regulation (FAR) Part 139 for certificated airports. At certificated airports, standards for the use of deicing/anti-icing chemicals and abrasives described in paragraphs 34 and 37 provide an acceptable means of compliance with FAR Part 139. *

4. **METRIC UNITS.** To promote an orderly transition to metric (SI) units, this AC contains both English and metric dimensions. The metric conversion may not be exact, and pending an official changeover to this system, the English system governs.

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CHAPTER 1. INTRODUCTION

1. **FOCUS.** Understanding winter operations on aircraft movement areas, ramps and service areas on the airside of airports is important for airport operations and maintenance personnel, air carrier operations personnel, fixed base operators, and contract snow removal agencies.

2. **BACKGROUND.** Snow, ice, drifting snow, and reduced visibility at airports in areas subject to below freezing temperatures can severely affect winter-time operational safety. The presence of snow, ice or slush on airport movement surfaces frequently causes hazardous conditions which contribute to aircraft accidents, incidents, and reduced traffic volumes resulting in delays, diversions, and flight cancellations. Airport management's approach to snow and ice control procedures will largely determine the extent to which these effects can be minimized. *

3. **DEFINITIONS.**

a. **Ice.** The solid form of water consisting of a characteristic hexagonal symmetry of water molecules. Density of pure ice is 57 lb/ft^3 (917 kg/m^3), which is 9 percent less dense than water. Compacted snow becomes ice when the air passages become discontinuous, at a density of about 50 lb/ft^3 (800 kg/m^3).

b. **Slush.** Snow which has a water content exceeding its freely drained condition such that it takes on fluid properties (e.g., flowing and splashing). Water will drain from slush when a handful is picked up.

c. **Snow.** A porous, permeable aggregate of ice grains which can be predominately single crystals or close groupings of several crystals.

(1) **Dry Snow.** Snow which has insufficient free water to cause cohesion between individual particles; generally occurs at temperatures well below 32° F (0° C). An operational test is to make a snowball; if this is futile because it falls apart, the snow is dry.

(2) **Wet Snow.** Snow which has grains coated with liquid water which bonds the mass together, but has no excess water in the pore spaces. A well-compacted solid snowball can be made, but water will not squeeze out.

d. **Eutectic Temperature/Composition.** A deicing chemical melts ice by lowering the freezing point. The extent of this freezing point depression depends on the chemical and the proportions of chemical and water in the system. The limit of the freezing point depression, equivalent to saying the lowest temperature that the chemical will melt ice, occurs with a specific amount of chemical. This temperature is called the eutectic temperature and the amount chemical the eutectic composition. Collectively it is referred to as the eutectic point.

e. **Coefficient of Friction.** The ratio of the tangential force that is needed to maintain uniform relative motion between two contacting surfaces to the perpendicular force holding them in contact. The coefficient is often denoted by the Greek letter mu. It is a simple means of quantifying slipperiness.

4. - 6. **RESERVED.**

(f) **At Other Times.** Finally, airport management may find other times when friction measurement will prove to be useful. Some airports have chosen to integrate friction measurement as a diagnostic tool during snow removal operations. Other airports with friction devices have found that the use of friction measuring devices is seldom required and use the devices only occasionally. An objective decision on how best to utilize friction measuring devices in winter conditions should be made by the airport management at each airport.

(7) **Conducting the Friction Tests.** This section provides a general guideline on the conduct of a typical frictions test. This list may be modified to take into consideration the operational characteristics of each airport.

(a) Calibrate the friction device according to the manufacturer's instructions.

(b) Obtain ATC clearance in accordance with established procedures (at uncontrolled airports, ensure that the runway is clear).

(c) Conduct the test run approximately 10 to 15 feet (3.1 to 4.6 meters) from the centerline of the pavement (or at the location defined in the snow plan).

(d) Advise ATC when clear of runway and taxiways.

(e) Record the test results.

(f) Save the tapes.

f. **Runway Condition Reporting.** Timely dissemination of the airport runway braking action report is very important. The braking action report descriptor should always be determined in the same manner to retain consistency. If friction measurement equipment is available, this information should be provided in a timely manner. This paragraph provides guidance on what information should be reported based upon friction measurements, how the information should be transmitted, and to whom the information should be transmitted. The report format should follow the standardized format of AC 150/5200-28. Runway friction reporting should include the following elements:

(1) **Runway or Ramp Identification.** The need for test site identification in the report is obvious and includes runway, taxiway, and ramp identification. When a runway is identified, only the landing direction of the runway should be named. For example, rather than identifying runway 18/36 in a report, only runway 18 or 36 should be named based on the current active runway. This is important because the runway friction values are averaged and reported by runway thirds from the approach end to the departure end of the takeoff runway. Taxiway and/or ramp identification can be for specific areas or for the entire taxiway or ramp areas depending on the conditions.

(2) **Name of Device.**

(3) **Values Reported.** The values reported should include the average friction value for the first third, second third, and last third of the runway being tested. Any of the friction devices with microcomputers can compute these averages with little programming from the operator. For devices without automatic averaging for each runway third, averaging should be done before the report is released.

(4) **Cause.** The reason for the friction reading should be reported (i.e. snow, ice, patchy snow).

(5) **Time and Date of Observation.** The time of the test needs to be included in the friction report because the conditions are subject to change; and the more recent the observation, the greater the confidence one can have in the report.

(6) **Friction Information Dissemination.** Several methods are available for reporting friction values. The appropriate method will differ between airports and will probably involve a combination of reporting methods.

(7) **Typical Report.** The following is an example of a typical report: RY 12 Tapley 40 45 20 Deiced 01/04/86 1830 CST.

12. **CLEARANCE PRIORITIES.** Since all aircraft movement surfaces cannot be cleared simultaneously, the most critical areas should be attended to first with other areas taken care of in their order of importance. Airport operators should identify and prioritize all areas to be cleared of snow and ice based on safety requirements, flight schedules, and operational routes of traffic. Priority 1 areas normally include the primary instrument runway, its principal taxiways and high-speed turnoffs, designated ramp areas, emergency roads or firefighters' access routes, and NAVAIDs (see subparagraph g) for the active instrument runway(s). Priority 2 areas generally include secondary runways and taxiways, other NAVAIDs, and ramp areas not otherwise classified. Priority 3 areas may include refueling areas and perimeter roads. The face of all signs and all runway lights should be kept clear of snow at all times, and they should be checked frequently during the snow removal operation to ensure that they are both cleared of snow and operational. Roads to the passenger terminal should be considered in a separate category since different equipment and techniques may be employed and timely access and departure by the public rather than operational safety is the objective.

13. **SNOW REMOVAL PRINCIPLES.** Certain principles or objectives form the basis for a snow removal plan. These are discussed below:

a. **Snow Removal.** Snow impedes the passage of wheels by absorbing energy in compaction and displacement. The resulting drag increases as the water content of the snow increases. Wet snow and, in particular, slush will accumulate on all exposed surfaces subject to splashing from the landing gear, degrading flight control effectiveness or possibly preventing retraction of landing gear. Engine flameout can also be caused by wet snow. Even dry snow will accumulate on the landing gear and underside of the fuselage because of engine heat and the use of reverse thrust. A slush-covered pavement will reduce friction coefficient and can also cause hydroplaning. It is therefore necessary to remove snow from Priority 1 (active) runways as soon as possible after snowfall begins. Dry snow falling on a cold dry pavement will generally not adhere and may be blown off by wind or aircraft operations. Under these circumstances, only brooming may be needed to prevent compacted snow tracks from forming. Wet snow cannot blow off the pavement and will readily compact and bond to it upon the passage of wheels.

b. **Height of Snow on Shoulders.** Snow plowed off the runways must be reduced in height sufficient to provide clearance for wings, engines, and propellers [see Chapter 4, paragraph 30b(6)]; eliminating windrows at the runway edge will also reduce the formation of drifts onto the runway. The latter are frequently in the form of "finger drifts," intermittent long, possibly narrow drifts which taper in width and height, which can cause loss of aircraft directional control. Furthermore, snow cleared from the runways should not be deposited within a NAVAID critical area, especially a reflecting plane area (see Figures 4-6a and 4-6b).

c. **Ice and Bonded Snow Prevention.** Proper application of a liquid chemical on the pavement prior to or during the very early stages of a snowfall will reduce the likelihood of compacted snow bonding to the pavement and will also reduce the effort needed by either mechanical or chemical means of removing the snow. Chemicals should not be used where they may cause dry blowing snow to stick and become slush. A solid deicing chemical may be used under conditions such that it will be retained. Care should be taken to avoid creating problems by applying chemicals, either liquid or solid, to a cold dry runway where bonding of snow would be unlikely.

d. **Response to Freezing Rain.** Freezing rain, on the other hand, will bond to a cold pavement surface, so this type of precipitation requires special measures depending on the pavement surface temperature (see subparagraph c above). If the pavement surface is below freezing, chemical application may be the most effective control measure. If the pavement surface temperature is above freezing, any accumulation of frozen rain (slush) can normally be broomed off the runways and taxiway.

e. **Effect of Chemicals on Friction.** Deicing chemicals can degrade the coefficient of friction when first applied as a result of the concentrated chemical film on either the pavement or the surface of the compacted snow or ice. This is especially true with liquid deicing chemicals. Application of chemicals should be followed by mechanical * removal of the slush or melt, using either brooms or blade plows. Cleanup operations should also remove remaining snow/ice masses prior to aircraft operations. When equipment is available, friction measurements should be made * prior to reopening the runway.

f. **Communications Equipment.** Two-way radios provide the primary communication between snow and ice control elements: i-e., snow control center, supervisory vehicles, and often times with snowplows, brooms, and other equipment. All units operating on runways and taxiways should be able to communicate on the appropriate airport advisory frequency or be under the control of a radio-equipped vehicle. Methods of signaling to indicate to the operators the necessity for clearing the runway or changing the snow and ice control plan should be worked out in advance. Some airports use a flashing beacon on supervisory vehicles as a signal. This signal beacon is separate and distinct from the flashing beacon that should be operating whenever vehicles are in an aircraft maneuvering area. High noise levels in snow and ice control equipment may justify providing all units with radios equipped with headsets and noise cancelling microphones.

g. **Clearance around NAVAIDs.** Snow removal around FAA localizer, glide slope installations, transmissometers, etc., should commence in conjunction with runway/taxiway/ramp snow control based upon the snow and ice control plan and ILS snow depth criteria agreed to with the FAA airway facilities sector manager or designee. Prior to starting removal and after finishing removal, the air traffic control tower, Flight Service Station, UNICOM, or appropriate facilities should be contacted. No equipment should be moved into the NAVAID area until all aircraft approaches are completed. In addition, the local Airway Facilities office should be contacted before beginning removal actions unless the glide slope has been NOTAMED out of service. Clearance around non-Federal NAVAIDs should be accomplished according to the facility's operations/maintenance manual. Properly designed and sited snow fences can minimize snow accumulation around these facilities. The nearest FAA Airway Facilities office should be contacted prior to erection of any snow fence for technical guidance and determination of the effect such structures will have on the proper functioning of the NAVAIDs. Failure to remove the snow in areas adjacent to the NAVAID may result in the restriction or shutdown of the facility. Also see paragraphs 30b(4) and (6). The airport sponsor should have an agreement with Airway Facilities related to the conditions for which snow removal must be undertaken and the limits of the required snow removal to preclude restriction of the facility.

* 14. **STORAGE OF ICE CONTROL MATERIALS.** Enclosed shelters are recommended for storing ice control materials. Storage of chemicals, i.e., deicing/anti-icing chemicals, reduces the prospect of product degradation due to the environment. In addition, storage of abrasives reduces the potential for leaching of the chemicals that lower the abrasive's freezing point. Storage prevents absorbtion of moisture which may freeze the stockpile during cold weather. Storage also permits preheating an abrasive prior to application. AC 150/5220-15, Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials, provides specific layout and functional recommendations for the storage of ice control materials. *

15. **EQUIPMENT MAINTENANCE AND STORAGE.** Whenever possible, snow and ice control equipment should be housed in heated structures during the winter to prolong the useful life of the equipment and to enable rapid response to operational needs. Repair facilities should be available for on-site equipment maintenance and repair during the winter season. Equipment should be inspected after each use to determine whether maintenance or repair is appropriate. AC 150/5220-15 provides specific layout and functional recommendations for the storage of equipment.

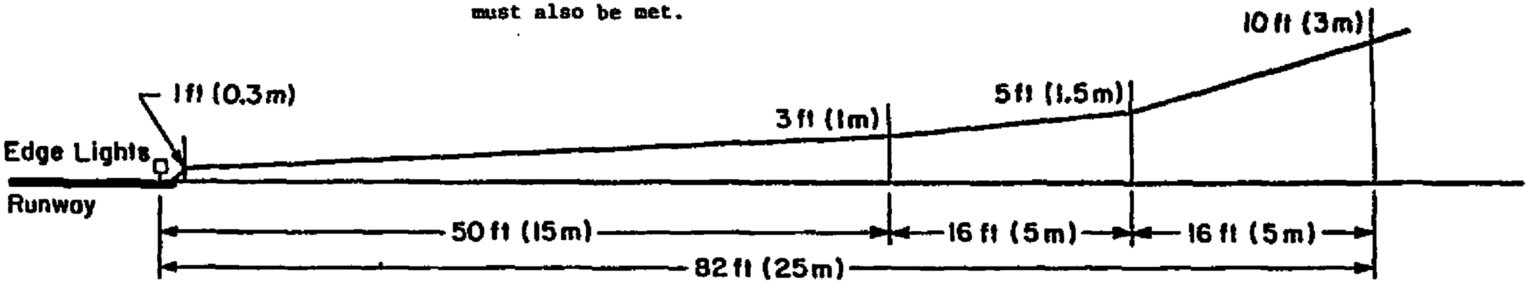
16. **FUTURE DEVELOPMENTS.**

a. **Equipment.** The efficiency of both displacement and rotary plows is being improved significantly to reduce power requirements and the size of vehicle carriers. Research is underway as part of a major highway snow and ice control research program, using modern techniques of computer-aided design, combined with new knowledge of the mechanics of fluidized snow, to improve the efficiency of displacement plows. Rotary plow improvements involving optimization of power distribution between disaggregator and impeller by computer monitoring and control are being investigated by manufacturers and research laboratories in other countries and may be available in a few years.

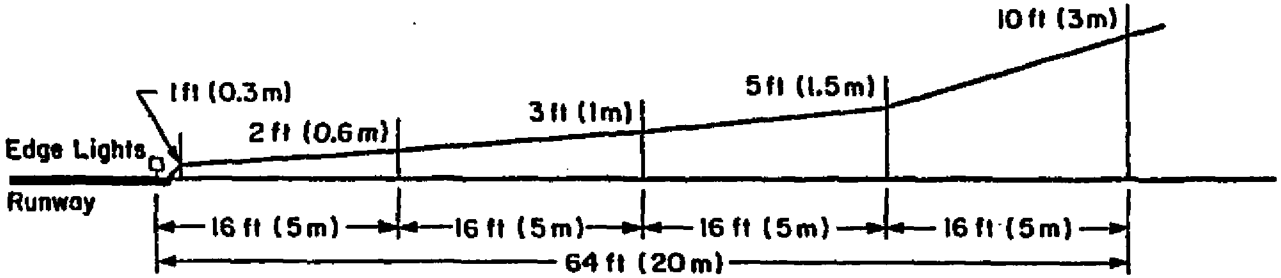
* b. **Chemicals.** Studies continue to try to find solid and liquid deicing/anti-icing chemicals which are compatible with aircraft and airport facilities, e.g., pavements. Chemicals under study include acetamide and various mixtures of urea, ethylene and/or propylene glycol. When effective and compatible chemicals are identified, they will be listed in this document as an approved airside deicing/anti-icing chemical. *

17. - 18. **RESERVED.**

NOTE: Snowbank heights as shown in Figure 4-6a and 4-6b must also be met.



a. Runways and Taxiways Used by Airplanes in Design Groups V and VI.*



b. Runways and Taxiways Used by Airplanes in Design Groups I, II, III, and IV.*

* As defined in AC 150/5300-12, current edition

Figure 4-5. Snowbank Heights Generally Acceptable to Clear Engines and Wingtips with the Airplane Wheels on Full Strength Pavement

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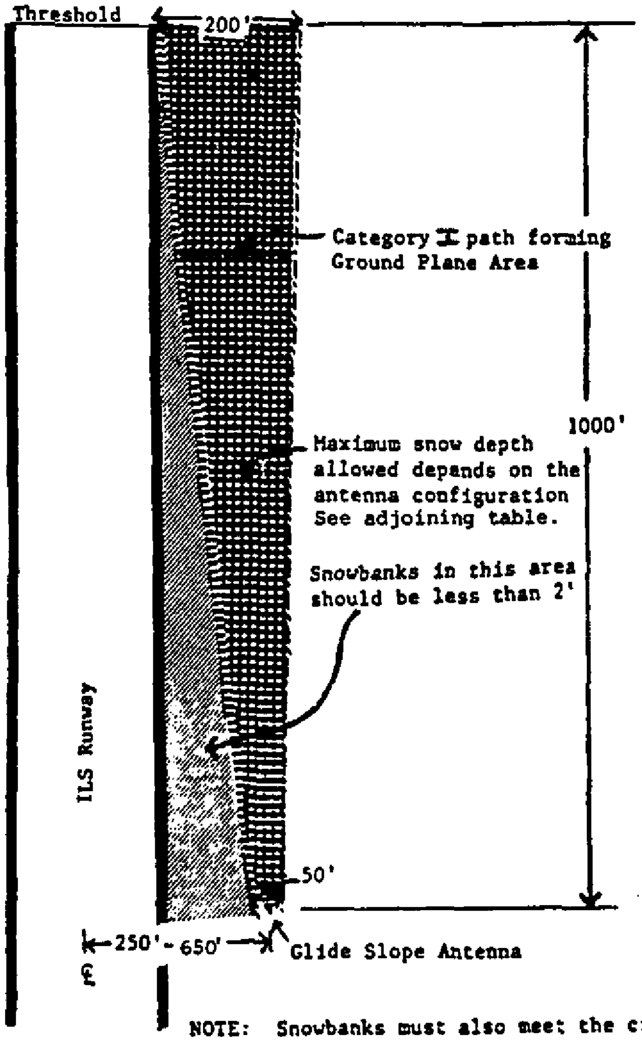

NOTE: Snowbanks must also meet the criteria in Figure 4-5.

SNOW DEPTH

ACTION TAKEN	SBR < 6 in NR,CEGS < 18 in	SBR 6 - 8 in NR,CEGS 18 - 24 in	SBR > 8 in NR,CEGS > 24 in
Snow is removed	Removal not required. Full CAT I service.	Remove snow 50 ft wide at mast widening to 200 ft wide at 1000 ft towards middle marker.	
Snow is not removed	Full CAT I service.	Category D aircraft minima raised to localizer only.	CAT I approach restricted to localizer only minima.

Antenna configurations: SBR sideband reference
NR null reference
CEGS capture-effect glide slope

Figure 4-6a. CAT I Snow Critical Areas to be Kept Clear of Snow Accumulation *

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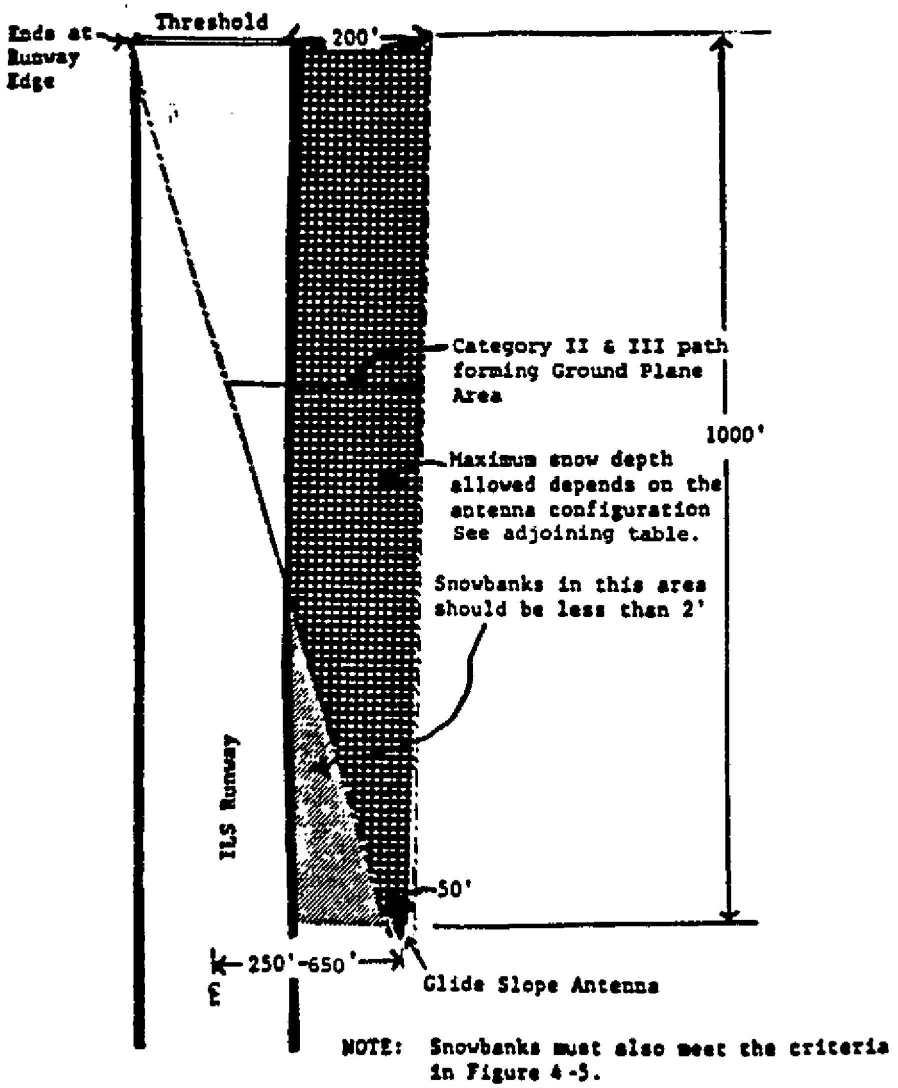


SNOW DEPTH

ACTION TAKEN	SBR < 6 in NR,CEGS < 18 in	SBR 6 - 8 in NR,CEGS 18 - 24 in	SBR > 8 in NR,CEGS > 24 in
Snow is removed	Removal not required. Full CAT II & III services.	Remove snow 50 ft wide at mast widening to 200 ft wide at 1000 ft towards middle marker plus widen the area to include the line from the mast to the far edge of the runway threshold.	
Snow is not removed	Full CAT II & III services.	Both CAT II & III restore to CAT I service. Category D aircraft minima raised to localizer only.	Landing minima raised to localizer only minima.

Antenna configurations: SBR sideband reference
NR null reference
CEGS capture-effect glide slope

Figure 4-6b. CAT II & III Snow Critical Areas to be Kept Clear of Snow Accumulation *

(11) Centerline and touchdown zone (TDZ) lights inset in the pavement tend to form "igloos" of ice or compacted snow surrounding them. Heat from lamps will melt even cold dry snow which will refreeze and adhere to the pavement and then accumulate around the lights. Methods of control or removal are described in paragraphs 23c and 33. To prevent damage to these lights, use rubber or plastic cutting edges or shoes and casters on plow moldboards and the front of rotary plows.

(12) Striated pavement markings are useful in reducing ice build up.

31. **SNOW DISPOSAL.** Some means of disposing of snow must be provided when there is insufficient space for storage adjacent to cleared areas. This will entail loading trucks and hauling to a disposal site, pushing the snow into melting pits sited near the areas being cleared, or portable snow melting pits set up over catch basins. Although melting pits eliminate long hauls and may reduce truck traffic in the ramp area, an economic analysis should be made to determine the benefit of constructing and operating them. Calculation of the thermal energy required is based on the heat of fusion of ice, 144 Btu/lb (335 kJ/kg) and the specific heat of ice, 0.5 Btu/lb-°F (2.1 kJ/kg-°C). Submerged combustion burners have been developed and are commercially available. A typical 10 x 8 x 8 ft (3 x 2.4 x 2.4 m) deep melting pit containing two burners can melt 120 tons of snow per hour (30 kg/s) consuming 60 gal (0.23 m^3) of No. 2 fuel oil per burner.

32. **MECHANICAL METHODS FOR CONTROLLING ICE.** Ice near the freezing point is soft and may be scraped off the pavement. Cold, hard ice bonds much more tenaciously and is difficult to remove by mechanical means. Scraping is not very effective, and attempts to lift the ice from the pavement by penetration with a wedge parallel to the pavement have only been partially successful. Cutting edges attached to plow moldboards are operated in contact with the pavement in the attempt to remove ice. At plowing speeds above about 10 mph (16 km/hr), front-mounted plows tend to bounce and leave ice on the pavement. Slower speeds, heavier plows, or plows which can be downloaded can reduce this "porpoising" or bouncing. Application of downward force also helps to penetrate and scrape the ice. Although down pressure can be applied by hydraulic cylinders on front-mounted plows, underbody blades can apply greater pressure without reducing steering control. All blades or cutting edges or the moldboards to which they are attached should have trip mechanisms to release the blade upon striking an obstacle in order to prevent damage to the blade, truck, pavement insert, or pavement. Carbon steel cutting edges run in contact with pavement wear rapidly and require frequent replacement. Tungsten carbide cutting edges are extremely tough and can last for thousands of miles. They are brittle, however, and can chip upon striking metal or other very hard projections. Serrated cutting edges which cut grooves in hard ice are sometimes used and will facilitate retention of chemicals and abrasives which might otherwise be blown off. Centerline or flush lights should not be plowed with metal cutting edges contacting the pavement; rubber or polymer cutting edges will help prevent damage to the lights. Slush or very soft ice can also be removed effectively by rubber cutting edges which squeegee the pavement.

33. **ANTI-ICING VS. DEICING.** The most difficult task in winter maintenance occurs when snow or ice bond to the pavement. Thus, the primary effort should be directed at bond prevention. Though dry snow will not readily form a strong bond even under heavy and frequent wheel passes, wet snow and ice will develop such a strong bond that mechanical removal is difficult, slow, or damaging to the pavement. Ice removal after formation is called deicing; preventing the bond from forming is called anti-icing or bond prevention. Anti-icing, recommended over deicing whenever possible, is accomplished by concentrating either thermal or chemical energy at the pavement surface. Because of the high cost of installing pavement heating systems and the large amounts of energy required to maintain the surface above freezing prior to the onset of precipitation, anti-icing/deicing with approved airside chemicals is generally more economical. Chemical application is in either solid (includes pre-wetted) or liquid form. Chemicals in liquid form are most effective for uniform anti-icing treatment of pavements. All deicing/anti-icing chemicals should be applied based on pavement temperature rather than air temperature (see AC 150/5220-13, Runway Surface Condition Sensor - Specification Guide, latest edition).

* a. **Deicing Chemicals.** Deicing chemicals should be applied on ice 1/16 inch (1.5 mm) or less in thickness. Thicker layers of ice require an extended period of time to obtain ice-free pavement. However, solar radiation from even a cloudy sky enhances melting action to such an extent that elimination of ice thicknesses greater than 1/16 inch (1.5 mm) are possible.

b. **Anti-Icing Chemicals.** The recommended chemical form for anti-icing is liquid (including solid chemicals in solution). A dry solid chemical applied to a cold dry surface may not adhere and may be blown off or scattered by either surface winds or aircraft movements. Wetting a dry anti-icing chemical, either during distribution or before or after loading into the application vehicle, improves the ability to achieve uniform distribution and improved adhesion.

34. **CHEMICALS.** Any water-soluble substance will lower the freezing point of water and thus, promote the melting of ice. Theoretically, the lower the molecular weight and the more individual particles (ions) the substance disassociates into, the more effective the product is as an ice control chemical, assuming its solubility still remains high at the freezing temperature. For the purpose of shared information, airport operators should advise the airlines before using any chemicals on the airside.

a. **Approved Airside Chemicals.** Airside chemicals approved for nonaircraft applications are urea, ethylene glycol, calcium magnesium acetate (CMA), and magnesium calcium acetate (MCA). The Society of Automotive Engineers (SAE) through Aerospace Material Specifications (AMS) and the military (MIL) provide specifications for airside chemicals and sand. Airport operators should obtain certification that chemicals meet the applicable specification. Approved airside chemical specifications are as follows:

(1) **Urea (also called carbamide).** The applicable specifications are SAE AMS 1730A, Urea Compound - Shotted, SAE AMS 1731A, Urea Compound - Powder, and MIL SPEC DOD-U-10866D, Urea-Technical. Urea produced for agricultural use is not acceptable. Production of this nontoxic solid white chemical, chemical formula $(NH_2)_2CO$, is in either powder or "shotted" ("prilled") form. The latter form's shape is small spheres of about 1/16 inch (1.5 mm) diameter. Both forms are primarily for deicing where powdered urea is frequently mixed with sand. Hot mixtures of powder or "shotted" urea and sand serve two purposes: (1) immediate increase in braking action and; (2) retention of chemical over the pavement area until it initially dissolves some of the ice and then melts the remainder. The urea deicing function is practical only at temperatures above approximately 15° F (-10° C) because of the decreasing melting rates below this temperature value. The decreasing melting rate is a result of urea's eutectic temperature, defined in paragraph 4(d), which is approximately 11.3° F (-11.5° C). However, the presence of solar radiation assists urea in the melting action. Pavement surface temperature and ice thickness determine the urea application rate.

Application Rate of Urea (lb/ft^2)

Ice Thickness (inch)	Temp (°F)		
	30°	25°	20°
less than 1/32	.016	.023	.06
1/32 - 1/8	.03	.06	.125
1/8 - 1/4	.125	.175	.275

(2) **Ethylene Glycol.** The applicable specifications are SAE AMS 1426A, Deicing/Anti-icing Fluid - Runways and Taxiways, and MIL-D-83411A, Deicer/Anti-icer Fluid (for Runways and Taxiways). This is a liquid, chemical formula $(CH_2)_2(OH)_2$, with a freezing point of approximately 8.6° F (-13° C) for the pure liquid and a eutectic temperature of approximately -58° F (-50° C) for an aqueous solution of 58-78 weight percent of ethylene glycol. *

* Composition of proprietary solutions meeting these specfications varies with the manufacturer, though the ethylene glycol content is usually approximately 50 percent. While specifications for runway use only require a eutectic temperature of -10° F (-23° C) or less, proprietary products are available with eutectic temperatures as low as -75° F (-59° C). Application rates of glycol-based liquids range from 1-2 gal/1000 ft^2 for deicing and from 0.2-0.5 gal/1000 ft^2 for anti-icing.

(3) **Calcium Magnesium Acetate (CMA) and Magnesium Calcium Acetate (MCA).** Appendix 4 contains the applicable "interim specification" for these products. Currently, the SAE is in the process of writing a generic solid specification which may replace the specification in appendix 4. Both products function only as pavement surface deiciers/anti-iciers. Proprietary products are available having eutectic temperatures lower than that specified for ethylene glycol. Product application rates are provided by manufacturers.

b. **Landside Chemicals.** The most effective landside chemicals used for deicing/anti-icing based on both cost and freezing point depression are from the chloride family, e.g., sodium chloride (rock salt), calcium chloride, and lithium chloride. <u>Prohibited on the airside are products that contain salts, particularly salts of the chloride family, or any other product known to be corrosive to aircraft.</u> After landside application, precautions should be taken that vehicles do not transport any nonapproved airside products onto the airside.

35. **ENVIRONMENTAL ASPECTS OF DEICING CHEMICALS.** All freezing point depressants may cause scaling of portland cement concrete (PCC) by physical action related to the chemical concentration gradient in the pavement. Deleterious effects on PCC can be reduced by ensuring sufficient cover over reinforcing steel (minimum of 2 inches (5 cm)), using air-entraining additives, and avoiding applications of chemicals for a year after placement. Concrete meeting the compressive strength outlined in ASTM C 672, Scale Resistance of Concrete Surfaces Exposed to Deicing Chemicals, or concrete receiving a prior application of commercial concrete sealer such as boiled linseed oil will perform very well when subjected to chemical deicers. No surface degradation of asphalt concrete has been observed due to deicing chemicals. Both deicing chemicals commonly used on airfields, urea and ethylene glycol, rapidly biodegrade in the environment although biological oxygen demand is high. Low temperatures and dilution from heavy runoff during periods of use tend to minimize this. Urea decomposes to ammonia which is quickly dissipated.

36. **RUNWAY FRICTION IMPROVEMENT.** Since snow and ice degrade the coefficient of friction between rubber tires and pavement and could pose an unsafe condition for aircraft, it is important to clear to bare pavement whenever possible. There are situations where complete removal is difficult or impossible to achieve within a required span of time; at temperatures approaching the eutectic temperature of a deicing chemical, for instance, it may require an hour or more for the chemical to go into solution and melt the ice. There are two techniques for modifying the frictional coefficient of a pavement covered with ice or compacted snow, one by building in a texture on the surface and the other by surface treatment of the ice or snow. It should be emphasized, however, that an abrasive is not a deicing chemical and will not remove ice or compacted snow--in fact, heavy applications of abrasives can insulate the ice and prolong its presence.

a. **Pavement Surface Modification.** These two modifications by themselves will not increase the coefficient of friction of ice formed on the surface but both will enhance the response of chemical treatment.

(1) **Pavement Grooving.** Grooves cut into the pavement will trap deicing chemical, reduce loss, and prolong its action. Grooves also assist in draining melt water and avoiding its refreezing. There is empirical evidence that grooves and porous friction courses modify the thermal characteristics of a pavement surface, probably by reducing the radiant heat loss, and delay the formation of ice. There do not appear to be any negative effects from grooved pavements.

(2) **Porous Friction Course (PFC).** PFC has generally the same benefits as grooving. Open graded asphalt concrete is less effective in improving coefficient of friction under icing conditions because the open spaces will fill with compacted snow, and to a lesser extent with ice in the case of freezing rain. Most maintenance personnel have found that chemical treatment rates must be increased on this type of pavement compared to dense graded asphalt concrete because of drainage of the chemical. The drainage characteristics also change as abrasives accumulate in the voids and plug them.

b. **Surface Treatment.** This is the approach taken to rapidly increase the frictional coefficient of an ice surface. Two methods are available: application of coarse granular material ("abrasives") and scarifying the ice surface with a serrated blade. A friction value measured below 0.27 (mu equivalent), as discussed in paragraph 11e, indicates that surface treatment should be initiated.

(1) **Abrasives.** Granular material provides a roughened surface on ice and thereby improves aircraft directional control and braking performance. Use of abrasives must be controlled carefully on turbojet movement areas to reduce engine erosion. If the granules do not embed or adhere to the ice, not only are they likely to be ingested in engines but they can be blown away by wind or scattered by traffic action and serve no useful function. This is particularly the case with ice or compacted snow is at temperatures below about 20° F (-6.7° C) since no water film exists on the surface to act as an adhesive. There are three approaches to reducing loss of abrasives: (1) they can be heated to enhance embedding into the cold surface; (2) the granules can be coated with a non-corrosive deicing chemical in the stockpile or in the distributing truck hopper; (3) or water or dilute deicing chemical can be sprayed on the granules or the pavement at the time of spreading. If stockpiles are kept in a heated enclosure and spread promptly after truck loading, sufficient heat may remain for embedding without the necessity for any further treatment. One method of setting the sand, though difficult to implement, is to apply heat after the sand has been spread by using weed burners or other open flame sources. Maintenance personnel should make a test on an unused pavement covered with ice or compacted snow to determine if bonding is adequate to prevent loss. When the slippery condition giving rise to the requirement for abrasives has passed, treated pavements must be swept to remove the residue to prevent engine damage. Abrasives should be used when the friction measurement, as discussed in paragraph 11e, is below 0.27 (mu equivalent). Other factors to consider when deciding to apply abrasives are pavement and air temperature and frequency of operations.

(2) **Ice Scarifying.** Directional control of vehicles on an ice or compacted snow surface can be improved dramatically by cutting longitudinal grooves in the ice. However, no improvement in braking effectiveness results from grooving, so this approach is only an expedient to be employed when very low temperatures prevent rapid chemical action or mechanical removal. The grooves formed trap abrasives or chemicals and hence contribute to improving the surface friction characteristics or melting action.

37. **ABRASIVES.**

a. **Materials.** The airlines should be consulted about the material used on the runways. *The following is the standard for abrasives.* Friction improving materials applied to airport movement surfaces shall consist of washed granular particles free of stones, clay, debris, and chloride salts or other corrosive substances. The pH of the water solution containing the material shall be approximately neutral (pH 7). Material shall meet the following gradation using U.S.A. Standard Sieves conforming to ASTM E 11-81.

Sieve Designation	Percent by Weight Passing
4	100
8	97-100
16	30-60
50	0-10
80	0-2

b. **Application.** Sharp, hard silica sand provides the greatest increase in traction and remains effective the longest because of its resistance to fracturing and rounding compared to softer materials, but it is also very abrasive. Limestone is softer and may be used where available if abrasion must be reduced. Tests have shown that application rates of 0.1-0.2 lb/ft^2 (0.49-0.98 kg/m^2) of sand will substantially increase friction coefficient. The greater amount is required at temperatures approaching 32° F (0° C), the amount decreasing as the temperature drops.

* c. **Chemically-treated Abrasives.** Granular particles are treated with approved airside chemicals to make them adhere to cold ice to prevent loss of material. At temperatures above 18° F (-7.8° C) a solution of urea is used; below this temperature ethylene glycol will be effective. Approximately 8-10 gal. (.003 - .004 m^3) of liquid are required to coat a ton of sand. The most effective method of applying liquid chemical is to spray it on the granules as they drop onto the spinner since wetting is more thorough than when the liquid is poured onto the stockpile or the hopper load. Below 0° F (-17.8° C) heated sand can be more effective because of more rapid adhesion of the granules to ice.

APPENDIX 2. TYPICAL SNOW PLAN

The Snow Plan that follows provides a guide for preparation of the Plan. An actual Plan should be tailored to the unique requirements and conditions that exist at your airport. See paragraph 12 for a list of items that should be considered for inclusion in a Snow Plan.

MUNCHO AIRPORT

SNOW AND ICE CONTROL PLAN

1. Responsibilities and Supervision.

a. The airport manager or his designated representative is responsible for the following (*include if possible who is authorized to make decisions and their phone numbers*):

(1) Determining when snow removal or anti-icing operations shall begin. This will be based on his evaluation of existing field conditions, and present and forecast weather.

(2) Maintaining a constant check of runway conditions during snow or ice storms to determine presence of snow, ice, or slush and their depth, and to determine the coefficient of friction by use of our SAAB.

(3) Keeping all NAVAID snow clearance areas within snow depth limits for the specific type of glide slope antenna configuration and notifying the local Airway Facilities (AF) Sector Office at 887-0500 immediately upon engaging the snow removal plan. *

(4) Disseminating airport information through the Notice to Airmen (NOTAM) system by calling 887-6532 prior to commencing snow removal or ice control operations, when low friction measurement readings are recorded, when ridges or windrows of snow remain on or adjacent to movement areas, when any hazard to aircraft operations exists, or when conditions change from those reported by a previous NOTAM.

(5) Informing the airport traffic control tower at 887-8765, air carrier operations office (United 887-6565, Delta 887-6546), and other airport users (Joe at 887-1212, etc.) of the current airport surface conditions.

b. All fixed base operators will be responsible for snow removal and ice control on their designated ramp areas.

c. All supervisors (i.e. Chief Maintenance Engineer) involved in snow removal and ice control are responsible for the efficient operation of snow and ice removal equipment. All equipment must be inspected by supervisors to ensure proper operation. Equipment should be properly sheltered to ensure complete, prompt readiness for use. A 72-hour supply of gasoline and diesel fuel must be kept on hand in the event that a prolonged storm occurs. The equipment must be inspected for damage and/or maintenance needs after each snow and ice removal event.

2. Vehicles.

a. All snow removal and ice control vehicles operating on aircraft movement areas must be equipped with a two-way radio or be under the direct control of a vehicle so equipped. Radios must be capable of monitoring the ground control frequency (or such other frequency assigned by the airport traffic control tower) at all times.

b. All outside contractors employed for snow and ice control operations (currently XYZ Construction) will be subject to all airport regulations. They will operate under the supervision of the airport manager or his representative and get clearance from the airport traffic control tower prior to entering movement areas. At no time will contractors be permitted to operate equipment beyond the limits of the ramp areas without being cleared by the appropriate authorities and without being accompanied by a radio-equipped vehicle. All vehicles must be equipped with the necessary lights and warning signals for night operation in accordance with Advisory Circular 150/5210-5, Painting, Marking, and Lighting of Vehicles Used on an Airport, current edition.

c. The following airport-owned equipment and authorized operators will be utilized for snow and ice control on movement areas.

Vehicle No.	Type	Plow	Operator	Home Phone
1	4X4 Truck	14' Blade	J. Doe	123-4567
2	4x2 Truck	Rotary	R. Jones	999-0001
3	(list continued)			

Another possibility is to list personnel and equipment separately so that there is more flexibility and efficiency--this is a function of airport size and organization. May refer to list of current personnel kept in specific location at airport.

d. XYZ Construction Company is the contractor for providing equipment and trained personnel for emergency snow removal operations on an as-needed basis. Equipment available from the contractor: three graders, two front-end loaders, and four 4x4 trucks equipped with 12 ft. (3.7 m) reversible plows. The contractor will furnish driver/operators and all maintenance support.

Contacts with XYZ Construction Company

Day: 222-1492
Night: 111-1895 (Sam Foreman)

Requests for contractor support must be approved by the airport manager (Jim) or his representative (operations officer).

3. Snow Removal Operations.

The following principles regarding snow removal shall be adhered to in maintaining safe operating conditions on airport movement areas.

Drifted or windrowed snow will be removed completely and promptly from runway, taxiway, and ramp surfaces.

* *In the event of heavy snow accumulation, the height of snowbanks alongside usable runway, taxiway, and ramp surfaces must be such that (1) all aircraft propellors, engine pods, rotors and wingtips, will clear each snowdrift and snowbank when the aircraft's landing gear traverses any full strength portion of the movement area, and (2) the permissible snow heights of glide slope snow clearance areas are maintained.*

In the event that the snow removal crew is unable to comply promptly with the requirements stated above, the airport manager or his representative will utilize the Notice to Airmen system to describe the conditions and will promptly notify the air carrier operations offices, airport control tower, and other airport users.

a. Snow removal operations are to commence when snow begins to accumulate on the movement surface. The runway will be closed for aircraft use, if it has more than 1/2" (1.3 cm) of slush or 2" (5.1 cm) of dry snow.

b. The active runway, associated parallel taxiway, and taxiways connecting the active runway to the parking ramp are designated Priority 1. This will usually be the shaded areas in Figure 1. Standard procedure will consist of:

(1) Dispatching brooms to maintain the centerline clear.

(2) Utilizing displacement plows to move the snow cast by the brooms along the edge lights, and

(3) Displacement plows will be utilized to create a windrow and rotary plows will be utilized to cast the snow beyond the edge lights.

c. Snow removal operations will commence concurrently on the aircraft rescue and firefighting (ARFF) access roads and/or emergency airport access gates, the aircraft parking ramp, the cross-wind runway and its associated taxiways, as shaded in Figure 1. While work is progressing on these areas, the condition of the active runway will be monitored by the crew chief. If continuing snowfall requires replowing, work in all other areas will be suspended and all necessary equipment diverted to maintaining the active runway.

d. Maximum allowable snowbank height is defined in the graphic on the next page (Figure 2) and should be checked frequently by the crew chief. Snowbank heights should be lower than this if possible.

e. Signs and lights should be frequently checked by the crew chief for visibility and should be cleared as appropriate.

f. Snow removal operations on the airport access roads, auto parking lots, and service areas will receive lowest priority. The equipment dedicated to their maintenance will be used, but they will be plowed only after drivers are available. Because of the importance of the safe movement of passengers and visitors on the airport properties, access roads, parking areas, and sidewalks should be properly plowed and deiced. This requires different pieces of equipment and different chemicals than used on aircraft movement surfaces and will normally be the responsibility of facilities maintenance crews.

* g. The glide slope snow clearance area for the "capture-effect" antenna configuration should be evaluated by the crew chief and cleared as shown on Figure 3. Contact should be made with the Airway Facilities Manager or his designee at 887-6532 and the air traffic control tower at 887-8765 before moving equipment into the ground plane area. *

4. Ice Control. Icing conditions occur most frequently at air temperatures between 28° and 34° F (-2° and 1° C), though there have been instances as low as 5° F (-15° C) and as high as 40° F (4° C). Frequent contact should be made by operations staff with the National Weather Service or contract weather service when the air temperature falls in the most probable icing range. Runway sensors which are monitored by operations division employees are important tools in determining when icing conditions may occur.

* (a) Runways, taxiways and ramps. It is the policy of this airport to apply X-7V liquid deicing chemical meeting SAE specification AMS 1426A to all priority 1 movement areas as soon as the pavement surfaces become wet and the temperature is close to 32° F (0° C) as an anti-icing treatment. In the event that ice forms on movement areas, the standard procedure will be to apply prilled (solid) urea at the rate of 0.1 lb/ft^2 (0.49 kg/m^2) when the temperature is above 20° F (6.7° C) and sand wetted with X-7V at temperatures below this. *Absolutely no chloride salts or other corrosive chemicals are to be used on aircraft movement areas.* *

(b) Access roads and parking areas. Sodium chloride and calcium chloride are permissible on automobile roadways. Sand used in these areas may be treated with these chemicals to assist in adhering to the ice and to prevent stockpiles from freezing. Bridges must receive special attention since icing frequently occurs on those surfaces prior to the adjoining pavement because of cooling from underneath.

5. Cleanup. All snow windrows must be removed as soon as possible after a storm ends. Sand will be removed from runways as soon as the surface is dry and braking action has been restored. The crew chief and/or operations staff will ensure that this is done. The airfield should be checked for broken or damaged lights and signs and repairs should be made.

Note: It is useful to append lists of personnel with their phone numbers, maps showing routing of equipment teams, radio frequencies or channels assigned to snow and ice control equipment, and other special local conditions affecting operations.

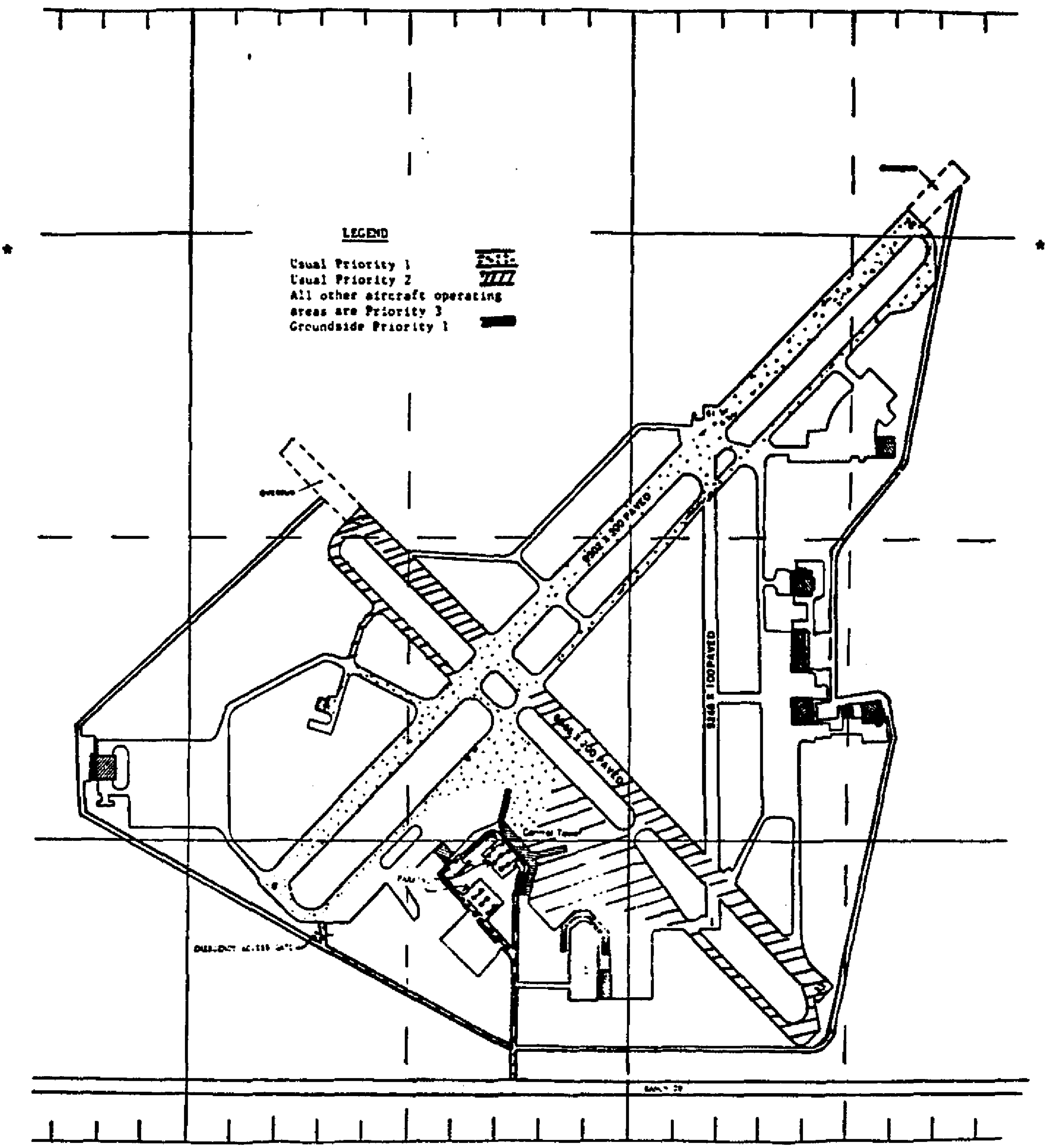
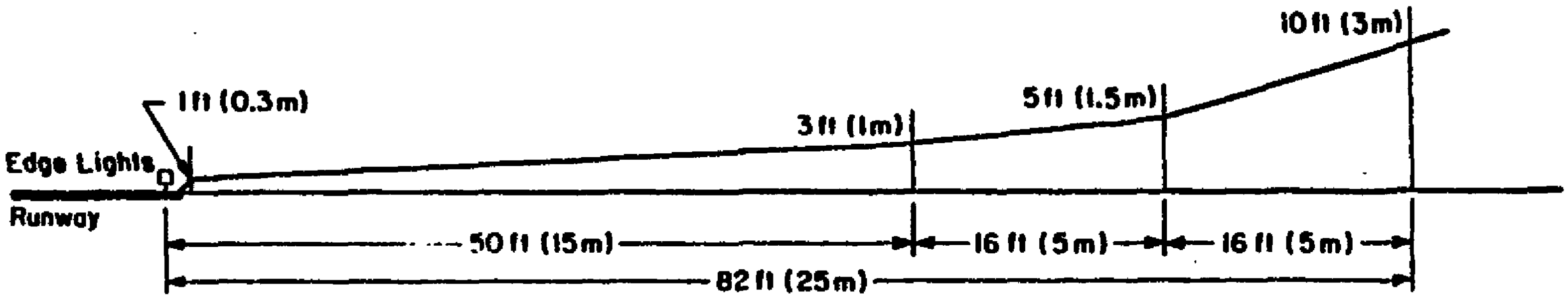


Figure 1. Priority Areas for Snow Control at Muncho Airport

*

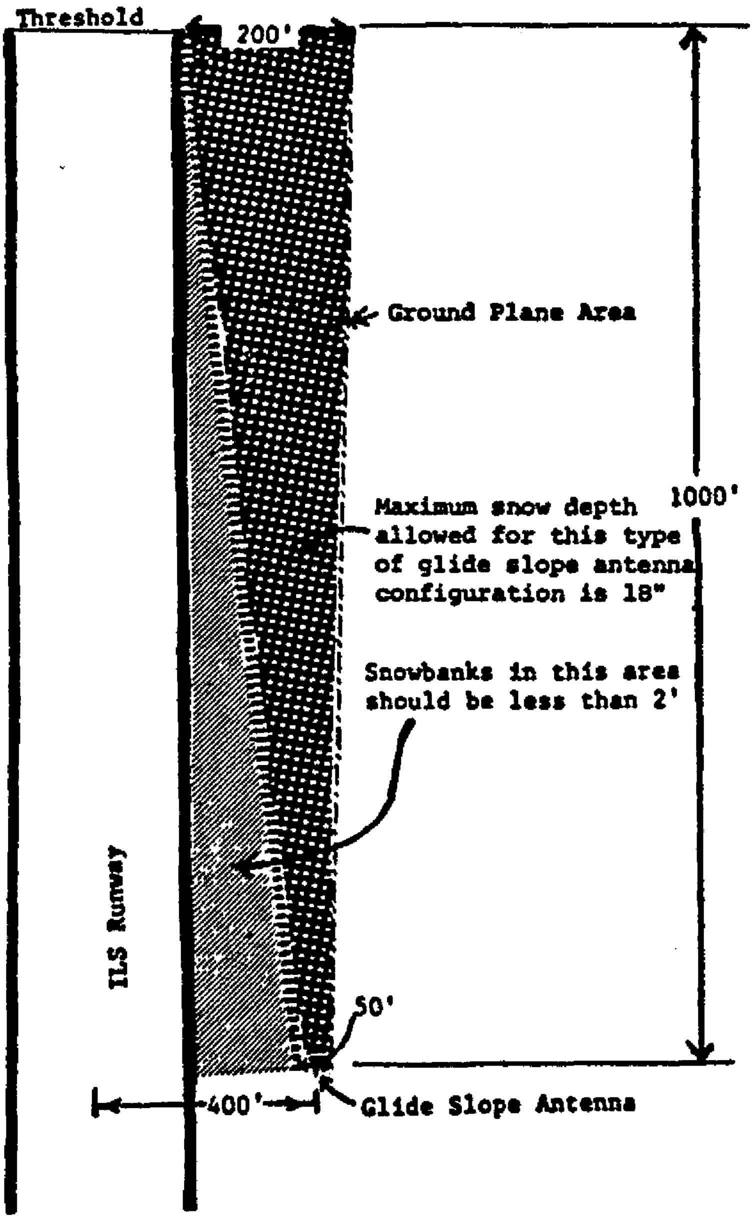


Note: Figure 3 may take precedence near a glide slope antenna. Other glide slope antenna configurations exist that restrict the height of snow even more than this example.

*

Figure 2. Snowbank Profiles Allowed Along Runways and Taxiways

*



Note #1. A Sideband Reference GS requires less than 6 inches in the GS snow clearance area.

#2. Snowbank heights defined in Figure 2 must also be met *

Figure 3. Snow Critical Areas to be Kept Clear of Snow Accumulation

* # APPENDIX 4 - INTERIM SPECIFICATION FOR CMA/MCA

The sponsor of a certificated airport may not use a CMA/MCA deicing/anti-icing chemical unless the chemical meets the interim specifications of this appendix. Although this appendix uses the term "vendor", the appendix does not create directly any obligations on vendors. The appendix is written to assist the airport sponsor in acquiring these chemicals by providing the sponsor with specifications that can be readily attached to a procurement contract.

1. **SCOPE:**

1.1 **Form:** This interim specification covers a deicing/anti-icing chemical in the form of a solid.

1.2 **Application:** Primarily for use in deicing/anti-icing aircraft maneuvering areas, such as airport aprons, runways, and taxiways, but not aircraft.

1.3 **Precautions:** This product is a stable, relatively nontoxic chemical as described by the Material Safety Data Sheet of paragraph 4.5.1. However, purchaser should take necessary precautionary measures to ensure the health and safety of all personnel involved with the product. For example, avoid product contact with eyes and skin and breathing of product dust.

2. **APPLICABLE DOCUMENTS:** The below referenced publications, Aerospace Material Specifications (AMS) and American Public Health Association (APHA), form a part of this specification to the extent specified herein. The latest issues shall apply.

a. AMS 1426A - Deicing/Anti-icing Fluid - Runways and Taxiways.

b. AMS 1730A - Urea Product, Shotted.

c. APHA - Standard Methods for Examination of Water and Wastewater.

3. **TECHNICAL REQUIREMENTS:**

3.1 **Composition:** The product shall be a calcium magnesium acetate product complying with the following chemical requirement. The level of soluble chloride shall be no greater than 250 ppm, determined in accordance with either Method 112A of APHA Standard Methods for Examination of Water and Wastewater or with a recognized analytical practice.

3.1.1 **Moisture:** Shall be reported and determined in accordance with American Society for Testing and Materials ASTM E 203.

3.1.2 **Insolubles Level in Aqueous Solution:** The level of product insolubles in a 10% by weight solution of product in ASTM D1193, Type IV water shall not exceed 0.5% as determined in 3.1.2.1

3.1.2.1 30 grams of product diluted to 200 ml shall be freshly made and maintained at 37° C (100° F) with agitation for one hour. Prior to filtering, the solution should be allowed to cool to room temperature. The insoluble matter shall be collected with the aid of a vacuum filtering apparatus consisting of a water tap filter pump, a 2,000 ml filter flask, a size 4 (126 millimeter I.D.). Use a Buchner funnel and a piece of 12.6 centimeter diameter (126 mm) Whatman No. 5 filter paper, or equivalent. The filter paper shall be dried at 60° C (140° F) for 30 minutes in a gravity convection oven, cooled for three minutes in a desiccator, and weighed to the nearest 0.1 mg. The filter paper shall be placed in the Buchner funnel so that its circumference coincides with the filter paper wetted with

* approximately 10 cc of distilled water in order to secure it properly in place. The test sample shall be rinsed with 25 cc of distilled water from a wash bottle, and the rinse transferred to the funnel, ensuring that any remaining insoluble matter is completely transferred with the rinse. When all the initial liquid and the rinse have been transferred through the filter, the sides of the funnel shall be washed with 25 cc of distilled water from a wash bottle and the rinse allowed to filter. The vacuum of the flask shall be relieved and the filter paper removed from the funnel. The filter paper shall be dried for 1 hour at 60° C (140° F) in a gravity convection oven, cooled for three minutes in a dessicator, and weighed to the nearest 0.1 mg. The percent insolubles (INS%) shall be calculated as follows:

$$INS\% = \frac{(\text{Final filter paper weight} - \text{Initial filter paper weight}) \times 100}{\text{Weight of Sample}}$$

Care shall be exercised throughout the final drying and weighing cycle to maintain the flat surface of the filter paper in a horizontal position in order that no insolubles will be lost. Insoluble matter determinations shall be made on a minimum of two samples.

3.2 **Solid Particle Shape:** Report the shape of the product.

3.3 **Eutectic Point:** Shall not be higher than -23° C (-10° F), determined in accordance with ASTM D 1177.

3.4 **Properties:** The product shall conform to the following requirements and performed tests shall be in accordance with specified test methods on either the product supplied or at the specified dilution concentrations of paragraph 3.4.2:

3.4.1 **On Concentrated Product:**

3.4.1.1 **Temperature Stability:** In accordance with AMS 1730A, paragraph 3.2.1.1.

3.4.1.2 **Storage Stability:** In accordance with AMS 1730A, paragraph 3.2.1.3, using ASTM F1104, Test Method for Preparing Aircraft Cleaning Compounds, Liquid Type, Water Base, for Storage Stability Testing.

3.4.2 **On Diluted Product:** Performed test shall be at dilutions of both 5% and 15% concentrations, unless otherwise specified, in ASTM D1193, Type IV water:

3.4.2.1 **pH of Aqueous Solution:** A 15% by weight solution of the product in ASTM D1193, Type IV water shall exhibit a pH in the range 7.0 - 9.5, determined in accordance with ASTM E70.

3.4.2.2 **Residue:** In accordance with AMS 1730A, paragraph 3.2.2.1.1 except substitute "water ASTM D1193, Type IV" for "methyl ethyl ketone" as the rinsing agent.

3.4.2.3 **Effect on Painted and Unpainted Surfaces:** In accordance with AMS 1426A, paragraphs 3.2.8 and 3.2.9.

3.4.2.4 **Effect on Transparent Plastics:** In accordance with AMS 1730A, paragraph 3.2.2.4.

3.4.2.5 **Corrosion of Metal Surfaces:** In accordance with all three subparagraphs of AMS 1426A, paragraph 3.2.5, with subparagraph 3.2.5.1 limited to a rating not worse than 2 in accordance with ASTM F1110, Standard Test Method for Sandwich Corrosion Test and subparagraph 3.2.5.3 determined in accordance with ASTM F1111, Corrosion of Low-Embrittling Cadmium Plate by Aircraft Maintenance Chemicals.

3.4.2.6 **Hydrogen Embrittlement:** In accordance with AMS 1730A, paragraph 3.2.2.3.

3.4.2.7 **Stress-Corrosion Resistance of Titanium Alloys:** In accordance with ASTM F945, Method A.

3.4.3 Pavement Compatibility:

* 3.4.3.1 **Scaling Resistance:** In accordance with AMS 1426A, paragraph 3.2.11.1 except that a 20% by weight solution of the deicer/anti-icer in tap water shall be substituted for calcium chloride (section 7.1 of ASTM C672).

3.4.4 **Performance:** The product, used in accordance with manufacturer's recommendations, shall prevent ice formation (anti-icing) and remove normally accumulated deposits of frost and ice (deicing) from aircraft maneuvering areas.

3.4.5 **Quality:** Product, as received by purchaser, shall be uniform, uncoated, and free from foreign materials detrimental to usage of the product.

4. QUALITY ASSURANCE PROVISIONS:

4.1 **Responsibility for Inspection:** The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by section 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this interim specification.

4.2 Classification of Tests:

4.2.1 **Acceptance Tests:** Tests to determine conformance to requirements for composition (3.1), pH (3.4.2.1), total immersion test of only AMS 4049 aluminum alloy - corrosion of metal surfaces (3.4.2.5), hydrogen embrittlement (3.4.2.6), and effect on transparent plastics (3.4.2.4) are classified as acceptance tests and shall be performed on each lot.

4.2.2 **Periodic Tests:** Tests to determine conformance to requirements for eutectic point (3.3), temperature stability (3.4.1.1), effect on painted and unpainted surfaces (3.4.2.3), residue (3.4.2.2), corrosion of metal surfaces except the total immersion test for AMS 4049 aluminum alloy (3.4.2.5), scaling resistance (3.4.3.1), stress-corrosion resistance of titanium alloys (3.4.2.7), and delivery containers (5.2.1) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser. In all cases, periodic tests must be performed at least once every three years.

4.2.3 **Preproduction Tests:** Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests, and shall be performed prior to or on the initial shipment of the product to a purchaser, when a change in ingredients, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 **Sampling:** Shall be in accordance with all applicable requirements of ASTM D1568 and Military Standard MIL-STD-105, Level S-2. A lot shall consist of all the product produced in one continuous manufacturing operation from the same lots of raw materials and presented for vendor's inspection at one time. In the event the process is a batch operation (see 4.3.1), each batch shall constitute a lot.

4.3.1 A batch is defined as the quantity of materials which has been manufactured by some unit chemical process or subjected to some physical mixing operation intended to make the final product substantially uniform.

4.3.2 When a statistical sampling plan and acceptance quality level (AQL) have been agreed upon by purchaser and vendors, sampling shall be in accordance with such plan in lieu of sampling as in 4.3, and the report specified in 4.5 shall state that such plan was used.

4.4 Approval:

4.4.1 Sample product shall be approved by purchaser before the product for production use is supplied, unless such approval is waived by purchaser. Results of tests on product production shall be essentially equivalent to those on the approved sample. *

* 4.4.2 Vendor shall use ingredients, manufacturing procedures, and methods of inspection on production product which are essentially the same as those used on the approved sample product. If necessary to make any change in ingredients or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in materials, processing, or both and, when requested, product sample. Production product made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 **Reports:** The vendor of the product shall furnish with each shipment a report certifying the results of tests to determine conformance to the acceptance test requirements and, when performed, to the periodic test requirements and stating that the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, manufacturer's identification, lot number, quantity, and product designation (CMA or MCA).

4.5.1 **Material Safety Data Sheet:** A material safety data sheet (MSDS) conforming to AMS 2825, Material Safety Data Sheet, or equivalent, shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing is waived by purchaser, concurrent with the first shipment of product for production use. Each request for modification of product formulation shall be accompanied by a revised data sheet for the proposed formulation.

4.6 **Resampling and Retesting:** If any sample used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional samples for each original nonconforming sample. Failure of any retest sample to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. **PREPARATION FOR DELIVERY:**

5.1 **Identification:** Each container shall be legibly marked with not less than the vendor's identification, purchase order number, lot or batch number, quantity, and product designation (CMA or MCA).

5.2 **Packaging:**

5.2.1 The product shall be packed in containers of a type and size agreed upon by purchaser and vendor or delivered in bulk. Containers used for delivery to purchaser shall be thoroughly cleaned and emptied of any foreign particles or materials.

5.2.2 Containers of the product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packing, and transportation of the product to ensure carrier acceptance and safe delivery. Packing shall conform to carrier rules and regulations applicable to the mode of transportation.

6. **ACKNOWLEDGMENT:** A vendor shall reference this advisory circular and appendix 4 in all quotations and when acknowledging purchase orders.

7. **REJECTIONS:** Product not conforming to this interim specification or to modifications authorized by purchaser will be subject to rejection.

8. **DIMENSIONS AND PROPERTIES:** Inch/pound units and the Celsius temperatures are primary units. For information, SI units and the Fahrenheit temperatures are approximate equivalents of the primary units.

U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: AIRPORT WINTER SAFETY AND OPERATIONS

Date: 4/20/88
Initiated by: AAS-100

AC No: 150/5200-30
Change:

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1. PURPOSE. This advisory circular (AC) was developed to provide guidance to assist airport owners/operators in the development of an acceptable airport snow and ice control program and to provide guidance on appropriate field condition reporting procedures.

2. CANCELLATION. AC 150/5200-23A, Airport Snow and Ice Control, dated January 25, 1985, is cancelled.

3. METRIC UNITS. To promote an orderly transition to metric (SI) units, this AC contains both English and metric dimensions. The metric conversions may not be exact, and pending an official changeover to this system, the English system governs.

Leonard E. Mudd

LEONARD E. MUDD
Director, Office of Airport Standards

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CHAPTER 1. INTRODUCTION

1. FOCUS. Understanding winter operations on aircraft movement areas, ramps, and service areas on the airside of airports is important for airport operations and maintenance personnel, air carrier operations personnel, fixed base operators, and contract snow removal agencies.

2. APPLICATION. This advisory circular provides guidance on materials, equipment, and techniques for snow and ice control and runway condition reporting procedures. Guidance is also provided on information which could be included in the snow and ice control plan required by FAR Part 139 for certificated airports. While the guidelines and standards contained in this AC are recommendations for winter operations at all airports, standards for the use of deicing chemicals and abrasives contained in paragraphs 34 and 37 provide *an acceptable means of compliance with FAR Part 139 at certificated airports.*

3. BACKGROUND. Snow, ice, drifting snow, and reduced visibility at airports in areas subject to below freezing temperatures can severely affect winter-time operational safety. The presence of snow, ice, or slush on airport movement surfaces frequently causes hazardous conditions which contribute to aircraft accidents, incidents, and reduced traffic volumes resulting in delays, diversions, and flight cancellations. Airport management's approach to snow and ice control procedures will largely determine the extent to which these effects can be minimized.

4. DEFINITIONS.

a. Ice. The solid form of water consisting of a characteristic hexagonal symmetry of water molecules. Density of pure ice is 57 lb/ft^3 (917 kg/m^3), which is 9 percent less dense than water. Compacted snow becomes ice when the air passages become discontinuous, at a density of about 50 lb/ft^3 (800 kg/m^3).

b. Slush. Snow which has a water content exceeding its freely drained condition such that it takes on fluid properties (e.g., flowing and splashing). Water will drain from slush when a handfull is picked up.

c. Snow. A porous, permeable aggregate of ice grains which can be predominately single crystals or close groupings of several crystals.

(1) Dry Snow. Snow which has insufficient free water to cause cohesion between individual particles; generally occurs at temperatures well below 32°F (0°C). An operational test is to make a snowball; if this is futile because it falls apart, the snow is dry.

(2) Wet Snow. Snow which has grains coated with liquid water which bonds the mass together, but has no excess water in the pore spaces. A well-compacted solid snowball can be made, but water will not squeeze out.

d. Eutectic Temperature/Composition. A deicing chemical melts ice by lowering the freezing point. The extent of this freezing point depression depends on the chemical and the proportions of chemical and water in the system. The limit of freezing point depression, equivalent to saying the lowest temperature that the chemical will melt ice, occurs with a specific amount of chemical. This temperature is called the eutectic temperature and the amount of chemical the eutectic composition. Collectively it is referred to as the eutectic point.

e. Coefficient of Friction. The ratio of the tangential force that is needed to maintain uniform relative motion between two contacting surfaces to the perpendicular force holding them in contact. The coefficient is often denoted by the Greek letter mu. It is a simple means of quantifying slipperiness.

5. - 6. RESERVED.

CHAPTER 2. WINTER OPERATIONS ON AIRPORTS

7. SAFETY REQUIREMENTS. Snow, ice, and slush should be removed as expeditiously as possible to maintain runways, high speed turnoffs, and taxiways, in a "no worse than wet" condition. Surface friction can be improved by application of abrasive material when unusual conditions prevent prompt and complete removal of slush, snow, or ice. Operations of snow removal equipment and support vehicles must be conducted to prevent interference and conflict with aircraft operations. This responsibility is shared by both airport personnel and aircraft operators. The reduced hours of daylight during the winter and frequent low visibility conditions resulting from fog, blowing snow, or precipitation require extra care during field operations and greater attention to enhancing visibility of equipment performing winter maintenance (i.e., snow removal, friction enhancement, etc.).

a. Airport Operator. An operator has a major duty to ensure the safety of operations at his facility. This involves performance according to accepted principles, ensuring a high standard of care, and providing state-of-the-art standards in equipment and techniques. Care should be taken that the snow and ice removal plan in the airport's certification manual is current, complete, and customized to the local conditions. All airport leases and agreements should be clear and specific and cover the duties and responsibilities of lessees to carry out their snow and ice control duties. Airport operators, however, have the duty to warn of any change in published procedure or change in the physical facility. As an example, an operator should give timely or proper notice of pavement or visual aids which may have been damaged by a snow plow. Complete documentation of compliance with the certification manual should be kept.

b. Snow and Ice Control Contractors. The principles of ensuring safety of operations also apply to contractors. In particular, agreements should be clear and specific regarding duties, procedures for snow and ice control, responsibilities for communications and control, and contingencies. Contractors should be given a copy of the airport certification manual as well as the snow plan.

8. WINTER OPERATIONS CONCERNS. Snow, ice, and slush on aircraft movement surfaces can degrade the coefficient of friction and reduce aircraft braking and directional control to the point where life and equipment are endangered.

a. On Runways. Snow, ice, slush, and standing water impede aircraft acceleration. Although acceptable limits vary by aircraft, most jet aircraft flight manuals limit the aircraft to landing with one inch or less of slush or standing water on the runway and to taking off with one-half inch or less of slush or standing water on the runway. AC 91-6, Water, Slush, and Snow on the Runway, current edition, provides additional information concerning the operation of turbojet aircraft when water, slush, and snow are on the runway.

b. Runways, Taxiway and Holding Aprons. Other winter operation safety concerns include:

(1) Obscured Visual Aids. In-pavement and edge lights, taxiway lights, runway markings, airport guidance signs, and visual approach slope indicators need to be maintained free of snow and ice.

(2) Obstructions. Hazardous snow banks, drifts, windrows, ice ridges, which could come into contact with any of the aircraft wing or nacelle surfaces should be prevented or eliminated.

(3) Navigational Aids. Any snow or ice which affects the signal of electronic navigation aids must be removed.

c. On Parking Ramps. Snow, ice, and slush accumulations on ramps and parking or holding areas create safety hazards. Three effects of such accumulations are:

(1) Slick Surfaces. Equipment and personnel operating on a slick or icy pavement surface may not have sufficient traction to start, stop, or remain in place when encountering exhaust blast as pilots apply power. Also, there is a potential for an aircraft to have poor directional control.

(2) Increased Power Needed. Pilots of parked or holding aircraft (especially turbojet aircraft) must apply more than normal power to break away, maneuver, and taxi the aircraft. The resultant blast may damage other aircraft or ramp support equipment, or injure ramp personnel.

(3) **Obscured Visual Aids.** The absence of visible painted markings or signs makes maneuvering in ramp areas very difficult. Pilots, without being able to see these visual aids, are hard pressed to accurately judge clearance from obstacles or other aircraft.

9. OPERATIONS.

a. **Snow Committee.** All airports subject to annual snowfall of several inches or more or icing conditions should have a snow committee. The committee size and function will vary depending on the frequency and amount of anticipated snowfall and the size of the airport. The formally constituted snow committee expedites decisionmaking, reduces the response time for keeping runways, taxiways, and ramp areas operational, and improves the safety evaluation process which determines when or if a runway should be closed. A committee may be composed of representatives of airport management and operational staffs, airline Flight Operations Departments and/or Fixed-Base Operators, the air traffic control tower, the Flight Service Station, FAA Airway Facilities, the National Weather Service and other meteorological services, if used, and any other interested or concerned parties. Airlines normally provide information on aircraft operational limitations and assist in evaluating pavement surface conditions. Snow committees are generally chaired by the airport manager or his representative. Committees have proved useful not only in day to day operations (because communications are enabled) but in identifying long-range equipment needs and selecting and applying ice control chemicals. Snow committees normally critique past season's activities. Many snow committees also critique responses after each storm event.

b. **Snow Control Center.** Airports in frequent or heavy snowfall areas should set up a special facility for all snow and ice control activities (i.e., a "Snow Desk" or "Snow Control Center"). The snow desk or snow control center will normally inform air carriers and ATC of expected runway opening and closing times and serve as a prime source of field condition information. The size and complexity of this facility will depend on the size of the airport, local climate conditions, and the personnel available. Communication between the tower, snow and ice control equipment and/or supervisors' vehicles, and other support elements needs to be provided. Status boards are often used for displaying the type, identification number, status, and location of each piece of equipment. A status board is also useful for recording the condition and inspections of airport surfaces and visual aids. The snow control center can keep an equipment checklist to supplement the status board and a visual inspection to ensure that all equipment has cleared runways prior to resumption of aircraft operations.

c. **Snow Removal Plan.** Every airport where snowfall is likely should have a written plan which states the procedures, equipment, and materials to be used by the airport in removing snow and ice. It should set out maintenance objectives and the priorities assigned to the airport movement areas, establish and define areas of responsibility (including who can close a runway), establish operational requirements and procedures, and define relationships with contractors if used. The plan should also address any unique environmental, climatic, and physical conditions affecting the airport. Elements that should be in this plan are preseason preparation, snow committee composition, snow desk or snow control center location, equipment, personnel training, weather reports, field condition reports, clearance criteria, clearance priorities, supervision, and communications. The snow plan should be flexible enough to allow snow and ice removal operations to change with changing weather and operational procedures. The snow committee at the airport can be charged with helping the airport operator keep the snow plan up to date. The sophistication or detail included in a snow plan will necessarily increase with the increasing size and complexity of the airport. A sample snow plan is included in Appendix 2.

10. PRESEASON PREPARATIONS. Preparation for the next winter season should begin as soon as the previous winter season ends. A review of the past winter's experiences and problems should be made as soon as possible while the experience is still fresh in mind.

a. **Equipment and Supplies.** The operational condition of the airport snow control equipment should be determined, repairs scheduled, and replacement parts not in stock ordered. Ice control chemicals and abrasives should be ordered to ensure their being on hand before the first snowfall of the following winter season. Chemical and abrasive spreading equipment should be calibrated to ensure application of a known, controlled amount of material. The correct spread rate should be based on the prevailing conditions and the guidance provided in Chapter 4.

b. Training and Communications. Crews should be trained in the operation of the equipment and practice runs should be made with the equipment in typical operational scenarios. Also, the crews should be taught general maintenance and repair techniques for the vehicles and be trained in communication procedures and terminology, as well as be completely familiarized with airport layout, marking, signs, and lighting. A complete check of communication equipment should be made. Operator training on the use and repair of specific pieces of equipment is extremely important as it allows more efficient use of the equipment and less likelihood of breakdowns during operation.

c. Installation of Snow Fences. Immediately prior to the onset of a winter season, snow fences should be installed at locations where prior observation has shown they will be effective in minimizing accumulation (e.g., around NAVAIDs). Persistent drifts onto the runway may be eliminated or reduced by properly siting snow fences. Snow fences are discussed further in Chapter 4.

d. Identification of Disposal Areas. If there is insufficient storage space for snow near the areas to be cleared and no melting or flushing means are available, hauling to a disposal site may be necessary. In that case, a site should be selected before winter in an area where the snow pile will not interfere with aircraft operations, will be readily accessible, and will not interfere with the airports' NAVAIDs. The disposal site selection should be coordinated with the local Airway Facilities (AF) Sector Office. Careful consideration must be given to drainage in selecting a land disposal site as the ground will remain snow-covered or wet long after all other snow has melted and seasonal vegetative growth will be delayed. If large quantities of snow must be handled, a tracked bulldozer may be necessary to push the snow from the truck dumping point into a pile. This will reduce the area occupied by the snow and prevent haul trucks from becoming stuck in the dumped snow. Debris remaining after the spring melt will need to be cleaned up. Disposal by use of melting devices is discussed in Chapter 4.

11. WEATHER AND SURFACE CONDITIONS.

a. Weather Reports. Rapid response to a snow or ice removal event requires adequate warning of an approaching storm and a prediction of the effect on airport surfaces. Not only will the snow or ice removal task be reduced and money be saved by prompt response to a storm warning, but unnecessary call-outs and other mobilization costs will be eliminated by accurate storm forecasts. In many areas, good forecasts can be obtained from the National Weather Service (NWS). Where these are very general, both with regard to space and time of the precipitation event, contract weather services often are available and can provide local specific forecasts and short-time warnings. Some airports have installed color weather radar monitors on which views of precipitation cells can be called up from local or distant radars. Another option may be procurement of a weather radar system including x-band radar (designed specifically for snow and low-level precipitation conditions like "lake effect storms"). At smaller airports, a telephone network with outlying areas (possibly county or state highway offices) can be used to improve weather forecasts.

b. Field Condition Assessment. The snow control center must be aware of the surface conditions of all movement areas in order to properly plan and carry out appropriate maintenance actions. Runway condition reports received from pilot reports, "snow team" personnel, friction measurements (subparagraph e below), or pavement condition sensors can be used to assess the surface state. This same information forms the basis for field condition reports.

c. Pavement Condition Reporting. Pavement condition reports should be furnished to all airport users whenever there is a significant change in runway surface condition due to snow or ice or when runways are closed (or are scheduled to close) for snow or ice removal. The condition information should fully but concisely describe type of contaminant (wet snow, dry snow, slush), depth of contaminant, partial/full coverage, snow banks exceeding height standards, pavement temperature, readings of runway friction measurement devices, runway braking action reports, chemical or abrasive treatments, proposed runway closing time and duration of closure, and obscuration of any centerline, touchdown zone, or edge lights. AC 150/5200-28, Notices to Airmen (NOTAMS) for Airport Operators, current edition, provides details of format and abbreviations for use in reporting (within the NOTAM system) winter conditions on aircraft movement areas.

d. Pavement Surface Condition Sensors. Sensors embedded in the pavement to measure surface conditions serve two functions: (1) they provide a precise measure of the pavement temperature and they indicate the presence of water, ice, or other contaminant; and (2) they transmit this information to the snow control center to provide an important part of the information necessary for selecting the most appropriate snow and ice control strategy. Many factors influence pavement temperature: surface color and composition, wind, humidity, solar radiation, traffic, and the presence of residual deicing chemicals or other contaminants. Since pavement temperature lags behind air temperature, use of air temperature to infer the condition of the pavement surface is imprecise and can be very misleading. Ice will not form unless the pavement temperature reaches the freezing point; therefore, knowledge of the direction and rate of change of pavement temperature will provide a predictive capability for the formation of ice. Sensors are particularly valuable in the timing of anti-icing applications of chemicals (see Chapter 4). If ice or compacted snow have accumulated on pavements, knowledge of the pavement temperature will guide selection of chemical and application rate to achieve clearance within a specified time with the minimum amount of material.

e. **Friction Measurement.** With the introduction of turbojet aircraft, braking performance on snow-and/or ice-covered runways has become more critical. Under certain conditions, difficulties in stopping and controlling the aircraft on snow-and/or ice-covered runways can occur with potentially serious results. Pilot braking action reports have been found to vary significantly and are sometimes not representative of the actual runway braking condition. For this reason, many airports throughout the world utilize runway friction measuring devices to provide an indication of the available friction on runways contaminated by snow or ice during aircraft operations and during snow removal operations. Correct usage of friction measuring devices requires that the device be calibrated for accuracy, the operators be trained and familiar with the equipment, and the limitations of each device be understood. AC 150/5320-12, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces, current edition, has more detailed information on runway friction measurement.

(1) **Operational Limitations.** Operators must be aware of measurement parameters and the manufacturer's operational limitations and restrictions to assure quality and accuracy of friction measurements. Friction measuring equipment gives valid results only on compacted snow or ice covered pavements and should not be used on loose snow or slush.

(a) **Decelerometers.** Some devices have specific limitations which the operator should be aware of. For example, decelerometers (Tapley Meter, Bowmonk, or James Brake) work well on hard-packed snow or ice but are not for use on wet pavements. In order to develop an accurate picture of the runway conditions, numerous tests should be made down the runway and then averaged for each third of the runway.

(b) **Towed Vehicles.** Some towed vehicles can be unstable on rough runways with patchy snow and ice and require reduced speeds under these conditions.

(2) **Optimal Speed for Measuring.** When friction tests are required, a speed consistent with safety should be used. For decelerometers, 20 mph is the optimum speed, while for continuous measuring devices, the fastest speed consistent with safety up to 40 mph should be used. Slower speeds on the taxiway and ramps are acceptable since the aircraft will be taxiing at slow speeds.

(3) **Friction Vehicle Correlation.** Although various devices use different operating principles, the values generated by each device are closely related but are not always equivalent. Hence, the type of friction measuring device should be reported until additional experience with the machines and better correlations have been developed. It is expected that a scale will eventually be developed to allow a single friction number to be reported for all friction measuring devices, thereby minimizing confusion and misinterpretation by users.

(4) **Data Elements.** When a friction test is conducted, the following information should be recorded:

(a) Time and date

(b) Personnel taking reading

(c) Runway and direction, or ramp and taxiway identification

(d) Type of friction measuring device

(e) Vehicle speed

(f) Friction values (average values for runway thirds or ramp and/or taxiway area)

(g) Description of runway/taxiway/ramp conditions influencing friction readings

A standard form for recording this data is shown in Figure 2-1.

(5) **Friction Test Integration.** Runway friction measurements take time, and while the tests are being conducted, the runway will be unusable for air traffic. Airport operations management should work closely with air traffic control (ATC), if available, Fixed Base Operators (FBO's), and/or airlines to minimize interruption to normal traffic flow. Close coordination among all parties concerned is critical if personnel safety, traffic management, and timely friction measurement objectives are to be met. The airport operator should coordinate with the tower and ask for a three-minute period (or other appropriate period) of time to check the runway. At a high density airport, friction measurements may have to be made in segments to reduce occupancy times. Upon request, Air Traffic Control (ATC) personnel generally can plan a break in arrival and departure traffic to permit a friction measurement test run. Through such planning, the friction measurement team can be in position adjacent to the runway when ATC gives the go-ahead. In this way, disruptions to traffic flow can be minimized. There may be occasions where the benefit from a friction test would not justify the disruption to the traffic flow, but safety of aircraft operations should take precedence. It is recommended that a letter of agreement or memorandum of understanding with the ATC facility should identify the means and responsibilities for coordination.

(6) **Friction Tests: When They Should Be Done.** The decision of when to conduct a friction test is based on airport user needs. Each airport has unique characteristics that make it different from other airports. The airport operator needs to take these factors into consideration when deciding to utilize friction measurement. It is recommended, however, that friction tests be conducted in the following situations:

(a) **Upon any major change in surface conditions.** A friction measurement after runway treatment gives the airport operator an idea of the effectiveness of the snow removal operation. For example, application of glycol-based deicers to a runway covered with hard-packed snow and ice may cause a decrease in friction until the snow removal equipment follows up and completes snow and ice removal. A runway friction test would identify this potential problem. A runway friction test after the runway has been treated and prior to opening provides incoming flights objective information on runway surface conditions.

(b) **Before the First Flight.** During periods of freezing and inclement weather, a runway friction test should be conducted before the first flight of the day as runway conditions could and may have changed overnight. Snow- and ice-covered runways, even if only partially covered, can begin to melt slightly in the afternoon sun even if the temperature remains below freezing. This water will refreeze quickly during the night to form a thin layer of glare ice on the surface, reducing the friction available to very low values. A friction test will identify this problem to airport management who can take corrective action.

(c) **Based Upon Braking Action.** When pilot braking action reportsindicate a worsening of surface friction characteristics, it is prudent for airport management to utilize the friction measuring device to assess the amount of change. Based on this and other information, appropriate corrective actions can be taken.

(d) **After an Incident or Accident.** If a runway accident or incident occurs where braking action might be less than normal, a friction test should be conducted. This will provide an objective record for airport management. Having equipment which provides a paper record of the results is advantageous for this use.

(e) **At Periodic Intervals.** Utilizing the friction measurement equipment at periodic intervals will allow the airport operations personnel to keep track of surface conditions and to plan ahead for corrective action if needed. The use of the friction measuring device as a management tool can prove to be extremely beneficial in managing the resources of the airport in winter weather conditions. A one-hour interval is recommended for those times when snow, ice, or slush is on the runway and precipitation is occurring. This frequency is recommended to ensure that worsening trends are identified before they create problems. A three-hour interval is recommended for those times when the conditions appear to have stabilized.

			AIRCRAFT DATA		FRICTION DATA					
DATE	TIME	RUNWAY	PILOT REPORT TO TOWER ON AIRCRAFT BRAKING ACTION ON RUNWAY SURFACE	TYPE OF AIRCRAFT OPERATING ON THE RUNWAY SURFACE	TYPE OF FRICTION EQUIPMENT USED ON RUNWAY SURFACE	FRICTION AVERAGE FOR ONE-THIRD SEGMENT OF RUNWAY			FRICTION AVERAGE FOR ENTIRE RUNWAY LENGTH	OBSERVERS REPORT ON RUNWAY SURFACE CONDITIONS DURING CONDUCT OF FRICTION SURVEY
						TOUCH DOWN ZONE	MID POINT ZONE	ROLL OUT ZONE		

Figure 2-1. Friction Data Form

(f) **At Other Times.** Finally, airport management may find other times when friction measurement will prove to be useful. Some airports have chosen to integrate friction measurement as a diagnostic tool during snow removal operations. Other airports with friction devices have found that the use of friction measuring devices is seldom required and use the devices only occasionally. An objective decision on how best to utilize friction measuring devices in winter conditions should be made by the airport management at each airport.

(7) **Conducting the Friction Tests.** This section provides a general guideline on the conduct of a typical friction test. This list may be modified to take into consideration the operational characteristics of each airport.

(a) Calibrate the friction device according to the manufacturer's instructions.

(b) Obtain ATC clearance in accordance with established procedures (at uncontrolled airports, ensure that the runway is clear).

(c) Conduct the test run approximately 10 to 15 feet (3.1 to 4.6 meters) from the centerline of the pavement (or at the location defined in the snow plan).

(d) Advise ATC when clear of runway and taxiways.

(e) Record the test results.

(f) Save the tapes.

f. Runway Condition Reporting. Timely dissemination of the airport runway braking action report is very important. The braking action report descriptor should always be determined in the same manner to retain consistency. If friction measurement equipment is available, this information should be provided in a timely manner. This paragraph provides guidance on what information should be reported based upon friction measurements, how the information should be transmitted, and to whom the information should be transmitted. The report format should follow the standardized format of AC 150/5200-28. Runway friction reporting should include the following elements:

(1) **Runway or Ramp Identification.** The need for test site identification in the report is obvious and includes runway, taxiway, and ramp identification. When a runway is identified, only the landing direction of the runway should be named. For example, rather than identifying runway 18/36 in a report, only runway 18 *or* 36 should be named based on the current active runway. This is important because the runway friction values are averaged and reported by runway thirds from the approach end to the departure end of the takeoff runway. Taxiway and or ramp identification can be for specific areas or for the entire taxiway or ramp areas depending on the conditions.

(2) **Name of Device.**

(3) **Values Reported.** The values reported should include the average friction value for the first third, second third, and last third of the runway being tested. Any of the friction devices with microcomputers can compute these averages with little programming from the operator. For devices without automatic averaging for each runway third, averaging should be done before the report is released.

(4) **Cause.** The reason for the friction reading should be reported (i.e. snow, ice, patchy snow).

(5) **Time and Date of Observation.** The time of the test needs to be included in the friction report because the conditions are subject to change; and the more recent the observation, the greater the confidence one can have in the report.

(6) **Friction Information Dissemination.** Several methods are available for reporting friction values. The appropriate method will differ between airports and will probably involve a combination of reporting methods.

(7) **Typical Report.** The following is an example of a typical report: RY 12 Tapley 40 45 20 Deiced 01/04/86 1830 CST.

12. CLEARANCE PRIORITIES. Since all aircraft movement surfaces cannot be cleared simultaneously, the most critical areas should be attended to first with other areas taken care of in their order of importance.

Airport operators should identify and prioritize all areas to be cleared of snow and ice based on safety requirements, flight schedules, and operational routes of traffic. Priority 1 areas normally include the primary instrument runway, its principal taxiways and high-speed turnoffs, designated ramp areas, emergency roads or firefighters' access routes, and NAVAID's (see subparagraph g) for the active instrument runway(s). Priority 2 areas generally include secondary runways and taxiways, other NAVAID's, and ramp areas not otherwise classified. Priority 3 areas may include refueling areas and perimeter roads. The face of all signs and all runway lights should be kept clear of snow at all times, and they should be checked frequently during the snow removal operation to ensure that they are both cleared of snow and operational. Roads to the passenger terminal should be considered in a separate category since different equipment and techniques may be employed and timely access and departure by the public rather than operational safety is the objective.

13. SNOW REMOVAL PRINCIPALS. Certain principals or objectives form the basis for a snow removal plan. These are discussed below:

a. Snow Removal. Snow impedes the passage of wheels by absorbing energy in compaction and displacement. The resulting drag increases as the water content of the snow increases. Wet snow and, in particular, slush will accumulate on all exposed surfaces subject to splashing from the landing gear, degrading flight control effectiveness or possibly preventing retraction of landing gear. Engine flameout can also be caused by wet snow. Even dry snow will accumulate on the landing gear and underside of the fuselage because of engine heat and the use of reverse thrust. A slush-covered pavement will reduce friction coefficient and can also cause hydroplaning. It is therefore necessary to remove snow from Priority 1 (active) runways as soon as possible after snowfall begins. Dry snow falling on a cold dry pavement will generally not adhere and may be blown off by wind or aircraft operations. Under these circumstances, only brooming may be needed to prevent compacted snow tracks from forming. Wet snow cannot blow off the pavement and will readily compact and bond to it upon the passage of wheels.

b. Height of Snow on Shoulders. Snow plowed off the runways must be reduced in height sufficient to provide clearance for wings, engines, and propellers [see Chapter 4, paragraph 30b(6)]; eliminating windrows at the runway edge will also reduce the formation of drifts onto the runway. The latter are frequently in the form of "finger drifts," intermittent long, possibly narrow drifts which taper in width and height, which can cause loss of aircraft directional control. Furthermore, snow cleared from the runways should not be deposited within a NAVAID critical area, especially a reflecting plane area (see Figures 4-6a and 4-6b).

c. Ice and Bonded Snow Prevention. Proper application of a liquid chemical on the pavement prior to or during the very early stages of a snowfall will reduce the likelihood of compacted snow bonding to the pavement and will also reduce the effort needed by either mechanical or chemical means of removing the snow. Chemicals should not be used where they may cause dry blowing snow to stick and become slush. A solid deicing chemical may be used under conditions such that it will be retained. Care should be taken to avoid creating problems by applying chemicals, either liquid or solid, to a cold dry runway where bonding of snow would be unlikely.

d. Response to Freezing Rain. Freezing rain, on the other hand, will bond to a cold pavement surface, so this type of precipitation requires special measures depending on the pavement surface temperature (see subparagraph c above). If the pavement surface is below freezing, chemical application may be the most effective control measure. If the pavement surface temperature is above freezing, any accumulation of frozen rain (slush) can normally be broomed off the runways and taxiways.

e. Effect of Chemicals on Friction. Deicing chemicals can degrade the coefficient of friction when first applied as a result of the concentrated chemical film on either the pavement or the surface of the compacted snow or ice. This is especially true with liquid deicing chemicals. Application of chemicals should be followed by mechanical removal of the slush or melt, using either brooms or blade plows. When equipment is available, friction measurements should be made prior to reopening the runway.

f. Communications Equipment. Two-way radios provide the primary communication between snow and ice control elements: i.e., snow control center, supervisory vehicles, and often times with snowplows, brooms, and other equipment. All units operating on runways and taxiways should be able to communicate on the appropriate airport advisory frequency or be under the control of a radio-equipped vehicle. Methods of signaling to indicate to the operators the necessity for clearing the runway or changing the removal plan should be worked out in advance. Some airports use a flashing beacon on supervisory vehicles as a signal. This signal beacon is separate and distinct from the flashing beacon that should be operating whenever vehicles are in an aircraft movement area. High noise levels in snow and ice control equipment may justify providing all units with radios equipped with headsets and noise-cancelling microphones.

g. **Clearance around NAVAID's.** Snow removal around FAA localizer, glide slope installations, transmissometers, etc., should commence in conjunction with runway/taxiway/ramp snow control based upon the snow plan and ILS snow depth criteria agreed to with the FAA airway facilities sector manager or designee. Prior to starting removal and after finishing removal, the air traffic control tower, Flight Service Station, UNICOM, or appropriate facilities should be contacted. No equipment should be moved into the NAVAID areas until all aircraft approaches are completed. In addition, the local Airway Facilities office should be contacted before beginning removal actions unless the glide slope has been NOTAMED out of service. Clearance around non-Federal NAVAID's should be accomplished according to the facility's operations/maintenance manual. Properly designed and sited snow fences can minimize snow accumulation around these facilities. The nearest FAA Airway Facilities office should be contacted prior to erection of any snow fence for technical guidance and determination of the effect such structures will have on the proper functioning of the NAVAID's. Failure to remove the snow in areas adjacent to the NAVAID may result in the restriction or shutdown of the facility. Also see paragraph 30b(4) and (6). The airport sponsor should have an agreement with Airway Facilities related to the conditions for which snow removal must be undertaken and the limits of the required snow removal to preclude restriction of the facility.

14. MATERIALS STORAGE. Deicing chemicals should be stored in enclosed shelters to prevent rain or snow from dissolving the chemicals. Abrasives should also be stored under cover to prevent water from entering the stockpile and subsequently freezing. If a deicing chemical is mixed with abrasives at the time of storage, the freezing of exposed piles will be reduced, but rain will leach the chemical from the pile. This can result in the loss of the chemical and possibly cause local pollution (due to runoff). The enclosures where abrasives are stored may be heated using infrared lamps, space heaters, heated floors, or combinations of these. An advantage is gained by application of a warm abrasive in as much as heated sand bonds to cold dry ice and reduces material loss. Specific information on functional requirements for and layouts of vehicle storage buildings may be found in AC 150/5220-15, Buildings for Storage and Maintenance of Airport Snow Removal and Ice Control Equipment Guide, current edition.

15. EQUIPMENT MAINTENANCE AND STORAGE. Whenever possible, snow and ice control equipment should be housed in heated garages during the winter to prolong the useful life of the equipment and to enable rapid response to operational needs. Repair facilities should be available for on-site equipment maintenance and repair during the winter season. Equipment should be reviewed after each call out to determine whether additional maintenance or repair is appropriate.

16. FUTURE DEVELOPMENTS.

a. **Equipment.** The efficiency of both displacement and rotary plows is being improved significantly to reduce power requirements and the size of carriers. Research is underway as part of a major highway snow and ice control research program, using modern techniques of computer-aided design, combined with new knowledge of the mechanics of fluidized snow, to improve the efficiency of displacement plows. Rotary plow improvements, involving optimization of power distribution between disaggregator and impeller by computer monitoring and control, are being investigated by manufacturers and research laboratories in other countries and may be available in a few years.

b. **Chemical.** Efforts to find an effective, nontoxic, and noncorrosive deicing chemical for use on highways have concentrated on calcium magnesium acetate (CMA). Tests made on metals and pavement materials have shown low corrosion or degradation in an alkaline environment, though environmental tests are continuing and effects on aircraft materials have not been investigated completely as yet. CMA is a mixture of calcium acetate and magnesium acetate. The eutectic temperature depends on composition, ranging from -17° to -30°C (1.4° to -22°F). CMA and urea are about the same in melting effectiveness on a weight basis. Testing and development of other chemicals, including sodium formate, is also ongoing.

17. - 18. RESERVED.