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ADVISORY CIRCULAR

AIRPORT SNOW AND ICE CONTROL

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AAS-100

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: AIRPORT SNOW AND ICE CONTROL **Date:** 1/25/85 **Initiated by:** AAS-100 **AC No:** 150/5200-23A **Change:**

1. PURPOSE. This advisory circular (AC) was developed to provide guidance to assist airport owners/operators to establish or improve airport snow and ice control programs.

2. CANCELLATION. AC 150/5200-23, Airport Snow and Ice Control, dated November 1, 1976, is cancelled.

3. RELATED READING MATERIAL.

a. FAA-RD-71-20, An Analysis of Airport Snow Removal and Ice Control.

b. AC 91-6A, Water, Slush, and Snow on the Runway.

c. AFCEC-TR-74-4, Liquid Ice Prevention and Control Chemicals for Use on Airfield Pavements, Interim Report for Period January 1970 to December 1973.

d. Military Specification MIL-D-83411A and QPL-83411, Deicer/Anti-Icer (For Runways and Taxiways).

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

f. AC 150/5340-1E, Marking of Paved Areas on Airports.

g. Local Climatological Data, Annual Summary with Comparative Data.

h. FAA Air Traffic Activity.

4. HOW TO ORDER.

a. The following documents may be ordered from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161. When ordering, refer to the Order Number cited.

(1) FAA-RD-71-20, An Analysis of Airport Snow Removal and Ice Control, Order Number AD-728-594.

(2) AFCEC-TR-74-4, Liquid Ice Prevention and Control Chemicals for Use on Airfield Pavements, Interim Report for Period January 1970 to December 1973, and Military Specification MIL-D-83411A and QPL-83411, Deicer/Anti-Icer (For Runways and Taxiways), Order Number AD-785-319/5GI.

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CHAPTER I. INTRODUCTION

1. BACKGROUND. An important seasonal factor which influences airport safety is the approach airport management takes concerning the removal of snow, slush and ice on the airport's operational surfaces (runways, taxiways and aircraft parking areas). The presence of snow, slush and ice on the airport operational surfaces often results in hazardous conditions contributing to aircraft accidents, incidents and reduced traffic volumes including delays, diversions and flight cancellations.

2. SAFETY. The percentage of aircraft accidents in the United States in which snow, slush and ice have played a part has been significant, especially when the number of months and regions in which they could occur are considered. Civil Aeronautics Board (CAB) statistics for a recent 5-year period reported 6.4 percent of all U.S. air carrier accidents involved snow, slush and/or ice. In 1972 and 1973, the National Transporation Safety Board statistics reported 317 general aviation accidents that had snow, slush or ice on the airport operational surfaces as a causal factor. There have also been a number of incidents caused by snow, slush and ice at airports, which, while they did not cause damage to the aircraft or personal injury, did create some expense, delay or other inconveniences. Prompt and complete snow, slush and ice removal could possibly have prevented many of these accidents, incidents and delays.

CHAPTER 2. SNOW, SLUSH AND ICE CONTROL

3. GENERAL CONSIDERATIONS.

a. Effective snow, slush and ice control begins long before the onset of winter. One of the more important considerations for effective control of snow, slush and ice is the formulation and implementation of a good airport snow removal plan. Suggested items for inclusion in the snow removal plan should include the person(s) responsible for the snow removal operations, which runways and taxiways are to receive the highest priority, when to start the snow removal operation, notifying the airport users on a frequent and continuing basis of the existing conditions, a listing of available snow removal equipment and equipment obtainable in emergencies, etc. A sample snow removal plan is included in Appendix 1 for use at Basic and General Transport Airports as defined in AC 150/5300-12, Airport Design Standards--Transport Airports. The formulation of a snow removal plan should not be construed as mandatory, but only a suggested tool to assist in the control of snow, slush and ice on the airport.

b. Today, at many airports, Snow Committees have been formed and have demonstrated their effectiveness in snow removal efforts, especially with regard to insuring that selected runways, taxiways and ramp areas are kept operational. Snow committees generally operate under the direction of the airport manager. At airports having Airline Flight Operations Departments and/or Fixed Base Operators, considerable technical and meteorological expertise can be made available through organized "Snow Committees." Such committees are not only valuable in day-to-day snow removal efforts, but may be of considerable assistance in evaluating long-range equipment requirements and specifications, including selection and use of chemicals for anti-icing/deicing purposes. Prior to the onset of winter, a meeting of the Snow Committee should be convened to brief all concerned parties of the planned snow and ice control operations for the ensuing winter and to critique the past winter's operations. This meeting should include such persons as representatives from airport management, Fixed Base Operators, Airline Flight Operations Departments, the air traffic control tower, the National Weather Service, the Flight Service Station, the FAA Airway Facilities and any other interested or concerned parties.

4. SNOWFALL. How much snow is necessary to establish a need for snow removal equipment on an airport?

a. The incidence of snow, the average depth of snow per storm, the density of the snow, and the volume and the nature of the air traffic

served by the airport are factors to be considered in establishing the need for purchasing snow removal equipment.

b. Weather data, as published by the National Oceanic and Atmospheric Administration Data Service, indicate that communities having a mean annual snowfall of 15 inches or less generally receive deposits of less than two inches of snow per storm. Communities having a mean annual snowfall of 15 inches or more have an average snowfall accumulation per storm ranging from two to six inches. Normally, it would not be economically practical to provide large amounts of expensive snow removal equipment which may be needed infrequently or for a very short period of the year. Airports receiving less than 15 inches mean annual snowfall and serving piston-engine aircraft only, or serving CAB-certificated air carriers with two flights or less per day may find contracting their snow removal capability would be to make arrangements with nearby communities or earth moving contractors for furnishing snow removal equipment on a priority basis during periods of snowfall. Many airports have found contracting for snow removal as a means of supplementing their own snow removal crews economically advantageous. The contract crews are normally assigned to nonaircraft movement areas and the aircraft parking ramps. Airports who contract their snow removal operations should require the equipment operators to be totally familiar with the areas they are assigned to clear, particularly during periods of reduced visibility, as well as all applicable airport operating rules and regulations. In addition, the operators should be qualified and experienced in the operation of the equipment they are assigned.

c. Figure 1, page 14, illustrates record data on the mean monthly total snowfall for selected locations in the contiguous United States. This type of data gives an indication of total snowfall and number of months in which it occurs. This information and the data shown in Figure 2, page 15, showing the approximate dividing line for 15 inches mean annual snowfall may be used for determining the feasibility of purchasing snow removal equipment or contracting snow removal operations.

5. ICING CONDITIONS.

a. Ice formed by freezing rain or sleet is generally rare as compared to the frequency of icing conditions caused by the alternate melting and freezing of snow during the cold months of the year. The periods when snow accumulation is of insufficient depth (generally less than one-half inch) to warrant removal, combined with temperatures alternating above and below 32 degrees Fahrenheit presents the greatest probability of ice formation. Icy conditions on paved operational areas can occur with little or no warning during these periods due to minor fluctuations of temperature. The winter utilization of airport runways may be increased by using remote runway surface condition sensors to deploy ice control equipment and chemicals more effectively. These sensors transmit runway surface temperatures and are used to determine the timing of chemical application, particularly in the effective anti-icing mode.

b. Unlike new fallen snow, compacted snow and ice cannot be completely removed by mechanical means. There are two primary reasons for this. First, the texture of the pavement surface, in particular the porosity, permits entry of water to the sub-surface areas prior to freezing. Secondly, the adhesive strength of ice to pavements can be as high as 80 to 120 pounds per square inch (psi) which is closely approaching the tensile strength of the ice itself. An attempt at removing ice by mechanical means alone may result in damage to the pavement surface.

c. Unless procedures are established to promptly remove accumulations of snow, the formation of ice-ridges and/or mounds of hard-packed snow on the runways, taxiways and particularly on aircraft parking aprons may occur. The primary cause of this problem is delaying the start of snow removal operations, thus, allowing aircraft and snow removal equipment to compact the snow into ridges that are hard to remove and then not removing these ridges prior to the thaw-freeze cycle converting them into ice. Frequently, these ice-ridges and mounds of hard-packed snow will cause damage to the landing gear during the landing and take-off roll and while taxiing. Two of the major problems that these hazards present are poor braking action and loss of directional control, possibly being the causal factor to an accident.

d. Of all problems encountered during the winter season one of the most critical and damaging to aircraft is the accumulation of slush. Severe directional control and slipping difficulties are always potential problems caused by slush. Slush melts and creates pools of water and freezes on wheels, landing gear, landing gear and flap actuating mechanisms, flaps, control surfaces, etc. It is exceedingly difficult to manage and should be worked with certain types of equipment.

e. Slush occurs during a snow storm when surface temperatures are above 32 degrees Fahrenheit or after a snow storm when ambient temperatures rise above 32 degrees Fahrenheit. The operations for slush removal are much the same as those for snow removal, except that the snowplows should be equipped with rubber or plastic snowplow blades.

6. SNOW AND ICE CONTROL.

a. An often mentioned and frequently researched method of snow and ice control is the proposed construction of heated runway, taxiway and aircraft parking ramp pavements. With sufficient energy input, dependent upon climatic conditions dry pavement conditions could be maintained regardless of the severity of the weather. While the construction of heated pavements is technically feasible, the construction, operation and maintenance of such a system is cost prohibitive.

b. At present, the most economically effective method of snow and ice control is the complete removal of all snow from the operational surfaces by mechanical/chemical means to prevent the thaw-freeze cycle previously described. The application of ice prevention/deicing chemicals is suggested for removing any residual snow, compacted snow, or ice remaining after the initial mechanical snow removal operation.

c. FAA Advisory Circular 91-6, Water, Slush, and Snow on the Runway, suggests takeoffs not be attempted by turbojet aircraft when standing water, slush, or wet snow greater than 1/2-inch in depth covers an appreciable part of the runway. Airports serving turbojet aircraft should commence their snow removal operation prior to an accumulation of 1/2-inch of wet snow/slush or 2 inches of dry snow. Airports serving piston-engine or turbo-prop aircraft only should commence their snow removal operation prior to an accumulation of 1/2-inch of wet snow/slush or 4 inches of dry snow. A practical method of determining dry or wet snow or slush is: dry snow will not compact into a snowball; wet snow will readily compact into a snowball; and slush is partly melted snow that splashes when driven through.

*d. Abrasives are used on airport operational surfaces to improve aircraft traction and braking performance. The use of abrasives on turbojet operational areas shall be carefully controlled to reduce engine erosion effects.

Abrasives used on airport operational surfaces shall consist only of washed and dried materials free of stones, clay, debris, chloride salts, and other corrosive materials. The pH of the material in a water solution shall be approximately neutral. All abrasive materials shall conform to the following material gradation chart. Material size gradation tests shall use U.S.A. Sieve Series, ASTM Specification E-11-70.

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

e. In the event that ice storms or freezing rains deposit ice on the paved surfaces, or residual ice remains on the paved surfaces after the initial mechanical/chemical snow removal operation, spreading chemically treated and/or warm dry sand may provide a reasonably non-skid surface texture. Sand can be spread most effectively when it is warm and dry, as any retained heat will assist in setting the sand in the ice. Alternate methods of setting the sand in the ice are to apply heat, using weed burners on the ice after the sand has been spread, or to apply just enough liquid anti-icing/deicing chemical (about 1 gallon per 1,000 square feet) to soften the surface of the ice and then spread the sand. The suggested rate of application of sand is in the range of 2 to 4 pounds of sand per square yard. It is suggested that a test area be used to predetermine the exact rate of application of sand to produce an acceptable surface texture. In the event sand is used, it should be removed as soon as the ice melts and the water evaporates to prevent damage to aircraft engines through sand ingestion. Small piles of sand that accumulate when the spreading vehicle stops momentarily are dangerous to aircraft operations and should be removed prior to permitting aircraft to use the treated surface.

f. Snow removal around FAA localizer and glide slope installations and transmissiometer equipment should be undertaken simultaneously with removal of snow from runways, taxiways and ramps. However, prior to snow removal around FAA localizer and glide slope installations and transmissometer equipment, contact should be made with the air traffic control tower or the Flight Service Station to determine if any instrument approaches are in progress. If any instrument approaches are in progress, no work around these installations should be permitted until the instrument approaches are completed. In addition to the above provisions, the local Airway Facilities office should be contacted prior to any work around these facilities to ascertain that there will be no derogation of the signals. In the event these facilities are non-Federal NAVAIDS, reference should be made to the particular facility's operations/maintenance manual regarding snow removal requirements in the critical area. However, if suitable snow fences to protect these facilities are used, snow removal problems will be less critical and outages of these facilities will be kept to a minimum. Care should be exercised by snow removal crews that these facilities are avoided by blower deposits or plowing accumulations. Prior to installing any snow fences, the nearest FAA Airway Facilities office should be contacted for technical guidance and determination as to what effect the snow fences will have on the navigational/approach-landing aids situated on the airport. The Airway Facilities office will determine whether a flight check of the navigational/approach-landing aids should be conducted after the snow fence is erected. At many airports, FAA facility maintenance personnel are responsible for snow removal in these areas.

7. SNOW REMOVAL EQUIPMENT.

a. Effective wintertime airport operation depends in part on having readily available all the equipment necessary to keep the airport operational areas clear of hazardous accumulations of snow, slush or ice. The equipment should be properly maintained, serviced, and most important, operated by skilled personnel who are totally familiar with the equipment and the airport's runway and taxiway configuration and who have knowledge of all applicable airport operating rules and regulations. This is particularly important during periods of reduced visibility.

b. All snow removal and ice control vehicles actively engaged in such procedures on the airplane movement areas of an airport having an airport traffic control tower should be equipped with a two-way radio. Radios should be operated on the appropriate ground control frequency or such other frequency as may be assigned by the airport traffic control tower. Vehicles not properly equipped should be under the direct supervision of a control vehicle having a two-way radio operating on the assigned frequency. Airports without an airport traffic control tower should use the Notice to Airmen system in advising of snow removal operations and the time these operations are expected to begin and then advise when the snow removal is completed. In addition, airports without an airport traffic control tower should have their equipment operators monitor the radio frequency (Unicom or Flight Service Station) while conducting snow removal operations on or while traversing the aircraft movement areas on the airport, or be under the direct supervision of a control vehicle having this capability.

c. The selection of the snow removal equipment package best suited for an individual airport is a complex problem involving many variables. Factors to be considered should include annual snowfall, average depth of snow per storm, weight or density of the average snow, frequency of storms, frequency of freezing rain and sleet, area to be cleared, types of aircraft, including the most critical aircraft using the facility, and the frequency of aircraft operations. For these reasons the types and quantity of snow removal equipment should be determined on each individual airport's needs.

d. The two basic mechanical snow control tools are the snow removal machine and the snow displacement machine. In order to analyze the performance of any snow removal system it is necessary to understand that a basic runway/taxiway snow removal procedure is built around a high-speed snowblower. The snowblower is the key to the snow removal operation, and its capacity will govern the performance of the entire removal task. Displacement machines which may be classified as support equipment for the snow blower include snowplows, road

graders, front-end loaders, brooms (sweepers) and any other equipment used for pushing snow. The brooms can be used most effectively for removing small (generally less than one-half inch) deposits of snow off the operational surfaces, for cleanup operations after plowing, clearing snow off in-pavement lighting systems and for removing sand and other debris off the paved areas, particularly after sanding of ice. Road graders, front-end loaders, and trucks are generally used on airports to remove compacted snow and/or ice, especially from the heavily used ramp areas. Caution should be exercised in specifying or using snow removal equipment whose wheel loading forces exceed the pavement design strength.

e. The basic chemical ice control tools are granular material-spreading devices and fluid distribution vehicles.

(1) The granular spreading devices may be anything from a common fertilizer spreader used on many farms to a truck-mounted hopper-spreader. These devices may be used for spreading granular anti-icing/deicing chemicals such as shotted Urea or for spreading sand.

(2) The fluid distribution vehicle may be used solely for applying anti-icing/deicing chemicals, usually a combination Urea/Glycol liquid. Caution should be exercised in the use of all anti-icing/deicing chemicals. There have been instances where the use of these chemicals has resulted in the paved surfaces becoming very slippery by virtue of their own peculiar characteristics. However, in any case, the chemical will melt ice or snow and result in slush and water. This water, in combination with the remaining ice or snow, can itself generate very slippery conditions. In this latter case, runway grooving has proved extremely helpful in eliminating the problem entirely. Prior to use, establish a test area to determine results. It is also suggested, especially if the runway is not grooved, when applying any chemical for anti-icing/deicing, that the runway be closed for a specific time and should be thoroughly broomed and cleaned. A light application of grit will give good braking action and prevent the slippery conditions mentioned above. When the pavement becomes dry, the sand can be completely broomed off.

f. Timing of chemical applications for ice control (particularly for anti-icing) may be made more effective by the use of remote surface condition monitoring equipment. These devices remotely transmit information on actual pavement surface temperature and moisture content to an operational base station, and allow operations personnel to anticipate runway icing conditions and apply chemicals just prior to ice formation when they are the most effective. Local conditions may dictate the number of sensors installed in each runway. Among the installation factors are: runway length and gradient, temperature, water and wind patterns.

g. Of the available chemicals, urea (aero) prills[1/] is the suggested chemical for airport use when the surface temperature is above plus 15 degrees Fahrenheit. Urea should never be used when the surface temperature is below plus 15 degrees Fahrenheit as there will be absolutely no physical reaction, thus, no melting. The spreading device should be a suitable self-contained granular material-spreading unit, having a positive feed mechanism, a spread control device, a 5 to 7 cubic yard capacity and be suitable for mounting on a snowplow truck.

(1) The rate of application suggested for urea (aero) prills is in the range of 0.32 to 2.17 pounds per square yard, contingent upon the surface temperature and the thickness of the ice. It is suggested that a test area be used to predetermine the exact rate of application needed to produce the desired results.

1/ Urea (aero) prills is urea especially formulated for use on airfield pavements and will have a greater concentration of soluble urea than the prilled urea used for agriculture fertilizer, but both are acceptable for use on airfield pavements for ice control.

UREA APPLICATION CHART

ICE-DISSOLVING CAPACITY LB. UREA/SQ. YD.

Temperature	15°F	20°F	25°F	30°F
Ice Thickness				
1/16 inch	1.09	0.79	0.50	0.16
1/8 inch	2.17	1.59	1.01	0.32
3/16 inch	3.26	2.38	1.51	0.48
1/4 inch	4.35	4.17	2.01	0.64
5/16 inch	5.44	4.96	2.52	0.80
3/8 inch	6.53	5.75	3.02	0.96
7/16 inch	7.62	6.54	3.53	1.12
1/2 inch	8.71	7.33	4.03	1.28

Caution: Whenever urea or other chemicals are used to remove ice already formed, the previous comments on slush and water should be kept in mind. The water, on top of the ice, causes the condition to become worse. The aircraft movement surfaces should be reopened to aircraft only after a thorough inspection indicates the ice has been completely removed.

(2) Urea should be stored in a dry location until ready for use as it requires adequate protection from moist or humid conditions during lengthy storage to prevent excessive caking and loss of material into solution. Urea is noncorrosive to aircraft and has no detrimental effect on airfield pavements. One of the most notable characteristics of Urea is the residual effect it exhibits which appears to inhibit the runway surface against subsequent bonding of ice or compacted snow for 2 to 3 days after each application. ICE PREVENTION/DEICING CHEMICALS USED ON AIRPORT OPERATIONAL SURFACES SHOULD NOT INCLUDE SALTS, PARTICULARLY SALTS OF THE CHLORIDE FAMILY, OR ANY OTHER CHEMICALS KNOWN TO BE CORROSIVE TO AIRCRAFT.

(3) To gain the maximum benefit from Urea, it should be applied only after the paved surface is well wetted either from falling snow or freezing rain and definitely prior to the formation of 1/8-inch of ice. This will allow the prilled Urea to dissolve and a much smaller amount of Urea will be needed to prevent the formation of the ice-to-surface bond, thus, making any further ice accumulation easily removable by mechanical means. The rate of application under these conditions will be as given in the chart for 1/8 inch of ice thickness appropriate to the existing surface temperature.

(4) From the above discussion, the logical conclusion can be drawn that from both an effectiveness and economical standpoint, chemicals are far more useful as "anti-icers" than as "deicers." The energy and cost requirements for prevention of ice are minimal when compared to the energy and cost necessary to remove the ice.

8. SNOW REMOVAL TECHNIQUES WHERE IN-PAVEMENT LIGHTING SYSTEMS ARE INSTALLED.

a. Runway centerline, exit turnoff and touchdown zone light fixtures rise gradually from the periphery of the unit at the pavement level to a height at the center of three-eights inch for taxiway centerline and turnoffs and one-half inch for runway centerline and touchdown zone light fixtures. While these fixtures were designed to support known loads and to provide a relatively smooth surface which would not readily engage a snowplow blade, evidence indicates that they will not survive the impact of a steel-bladed snowplow operating with the sharp-blade edge riding on the runway surface. Tire chains also damage the fixtures, as will the steel plow shoes and the steel-wheeled casters.

b. Recent investigations of in-pavement lighting installations at several "snow belt" airports revealed varying amounts of damage to light fixtures from snow removal operations. Gouged holes and surface cuts in the top fitting, broken lamps, broken and loose lenses, and misalignment were attributed to snow removal operations. The extent of damage to in-pavement lighting fixtures is dependent upon a number of factors, including the type of equipment, the operating speed and the skill and capability of the vehicle operator.

c. The following procedures are suggested as a means of preventing damage to in-pavement lighting installations:

(1) Leave in-pavement lights off as long as possible, consistent with safety of aircraft operations, to avoid the formation of ice "igloos" around the lights.

(2) As snow starts to accumulate, use rotary brooms or rubber plow blade-equipped snowplows to remove snow from all in-pavement light fixtures. Rebrooming or replowing of these areas should be accomplished as often as necessary to keep the light fixtures relatively free from snow. This procedure defines the area of in-pavement lights so that steel-bladed plows and blowers may avoid them and help prevent buildup of an ice "igloo" when the light is turned on.

(3) The snow displaced from these areas can then be removed from the runway by use of snowblowers or snowplows. Segmented snowplows blades, consisting of several spring-loaded segments, which will rise on contact with the fixtures, are less damaging to these fixtures than conventional blades, provided that the sharp corners of each segment are rounded off. Whenever snowplows must traverse in-pavement light fixtures, they should be either traveling at less than 5 m.p.h. or have the blades lifted clear of the fixtures.

(4) All steel plow shoes and casters on snowplows should be replaced with rubber-tired (pneumatic) casters.

9. RUNWAY AND TAXIWAY EDGE LIGHTS AND THRESHOLD LIGHTS.

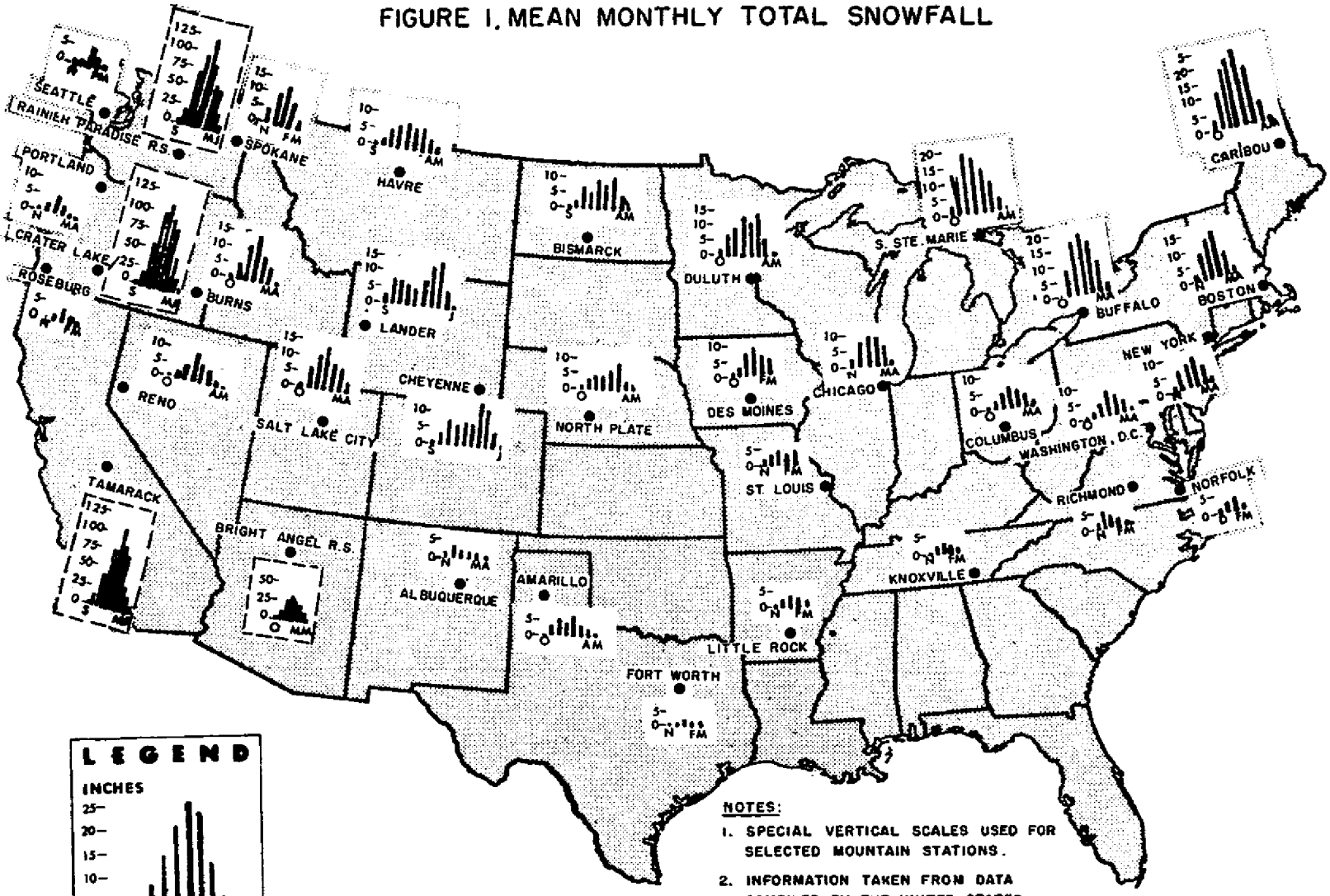
a. All runway and taxiway edge lights and runway threshold lights should be exposed and visible for safety of flight operations during periods of reduced visibility and during the hours of darkness. If unable to clear the snow from around the lights, the airport manager should promptly notify the airport users and issue a notice to airmen (NOTAM) advising of the airport conditions.

b. The selection of equipment for this phase of the snow removal operation will be contingent upon the ability of the ground to support the imposed wheel loads. If the ground is either dry, or has sufficient frost penetration to support snowplows, motor patrol graders, frontend loaders, or snowblowers, the area around the lights can be plowed by either plowing parallel to the lights or by the serpentine method of weaving between and around the lights. Extreme caution should be exercised during this operation so as not to damage the light standards or create ruts in the turf with the equipment. When soil conditions are such as to preclude the use of equipment, such as during the spring thaw, these lighting fixtures will need to be cleaned by using hand tools, such as shovels, rakes, hoes, etc.

10. MARKING OF PAVED AREAS ON AIRPORTS FOR FROST PROTECTION.

Advisory Circular 150/5340-1E, Marking of Paved Areas on Airports, recommends that pavements subject to front heave be marked with striated markings. This Advisory Circular also provides guidance for marking snow covered runways.

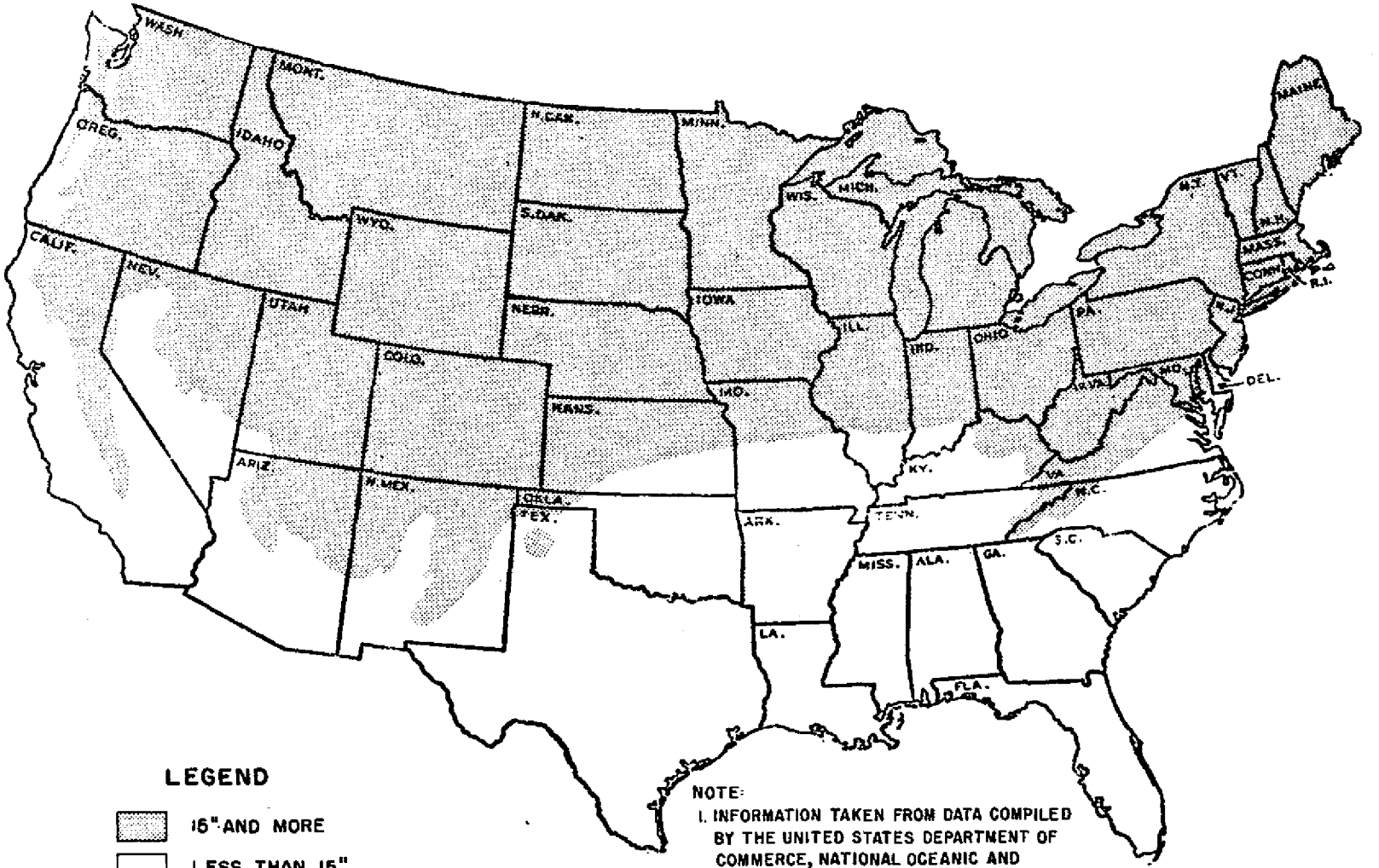
FIGURE 1. MEAN MONTHLY TOTAL SNOWFALL



NOTES:

1. SPECIAL VERTICAL SCALES USED FOR SELECTED MOUNTAIN STATIONS.
2. INFORMATION TAKEN FROM DATA COMPILED BY THE UNITED STATES DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, ENVIRONMENTAL DATA SERVICE.

FIGURE 2. MEAN ANNUAL SNOWFALL



LEGEND

- 15" AND MORE
- LESS THAN 15"

NOTE:
1. INFORMATION TAKEN FROM DATA COMPILED BY THE UNITED STATES DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPERIC ADMINISTRATION, ENVIRONMENTAL DATA SERVICE.

CHAPTER 3. MINIMUM LEVELS OF SNOW REMOVAL EQUIPMENT

11. RECOMMENDED MINIMUM LEVELS OF SNOW REMOVAL EQUIPMENT.

a. Economics and safety are inherent in the following recommended minimum levels of snow removal equipment. Economic factors such as the cost of aircraft delays and diversions, and delays to passengers were considered. Also considered were safety factors such as the need to provide the aircraft with snow and ice free airport pavement surfaces. The following recommended minimum levels of snow removal and ice control equipment should significantly reduce the cost of delays and diversions, and increase the safety of aircraft operations.

b. The recommended minimum levels of snow removal equipment to maintain the aircraft operational areas of an airport during periods of snowfall is that equipment capable of removing one inch of snow from one primary instrument runway, and one or two principal taxiways connecting the runway to the aircraft parking apron. In addition, clean sufficient gate positions or aircraft parking apron to accommodate the aircraft operations anticipated to utilize the runway during periods of snowfall.

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

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

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

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

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

(2) High-speed snowblowers should be supported by a minimum of two snowplows per snowblower and have similar operational characteristics. (See paragraph 12 for equipment size ranges.)

(3) Airports should provide one truck-mounted hopper-spreader for spreading granular material, such as sand or prilled Urea, or one liquid spraying rig for each 750,000 square feet of the one primary instrument runway. In addition, these airports should provide one self-propelled high speed runway sweeper or truck-mounted runway sweeper for each 750,000 square feet of the one primary instrument runway.

(4) Airports should provide one front end loader with a 1 1/2 cubic yard capacity bucket for loading sand or Urea into the truck-mounted hopper spreader and for miscellaneous snow removal in the ramp area, around the lights (runway and taxiway), etc. The front-end loader should be equipped with a snowbucket having an 8 to 10 cubic yard capacity.

c. The recommended minimum levels of snow removal equipment to maintain the aircraft operational areas of a utility airport during periods of snowfall is that equipment capable of removing one inch of snow from one primary instrument runway, or that runway providing the maximum wind coverage, one principal taxiway connecting the runway to the aircraft parking apron, and 20 percent of the aircraft parking apron.

(1) The recommended minimum snow removal equipment for airports served exclusively by propeller driven aircraft having a gross weight of less than 12,500 pounds should include one or more high-speed snowblowers having a demonstrated or manufacturer's certified capacity sufficient to remove snow which has a density of 25 pounds per cubic foot, with a minimum casting distance of 50 feet (measured from the blower to the point of maximum deposition) from the above described areas under the following criteria:

(a) 40,000 or more annual operations, remove one inch of snow within 2 hours.

(b) 10,000 to 40,000 annual operations remove one inch of snow within 3 hours.

(c) 6,000 to 10,000 annual operations remove one inch of snow within 4 hours.

(2) High-speed snowblowers should be supported by a minimum of one snowplow having similar operational characteristics. (See paragraph 12 for equipment size ranges.)

(3) The recommended minimum level of snow removal equipment for utility airports which have 10,000 or less annual operations and receive less than a year average annual snowfall of 30 inches is one snowplow. The recommended snowplow for airports in this category is a snowplow of any physical design up to 20 feet long.

12. EQUIPMENT SIZE RANGE.

a. Snowblowers:

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

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

(3) Intermediate high-speed snowblower: The blower may be of any physical design having a demonstrated or manufacturer's certified snow removal capacity of 1,200 to 1,500 tons per hour with a casting distance as measured from the blower to the point of maximum deposition under a no wind condition of:

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

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

(4) Large high-speed snowblower: The blower may be of any physical design having a snow removal capacity range of 1,700 to 2,500 tons per hour with a casting distance as measured from the blower to the point of maximum deposition under a no wind condition of:

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

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

(5) Carrier vehicles: The carrier vehicles for the snowblowers should conform to the particular snowblower manufacturer's recommendations, be suitable for mounting the snowblower, and be all wheel drive.

(6) Snowblower capacity certification: The airport sponsor should require the equipment manufacture to certify that the particular snowblower meets or exceeds the rated capacities called for in the bid proposal. These manufacture-certified capacities may be subject to testing by the airport sponsor or a sponsor selected independent testing laboratory to verify the capacities on or before the date of acceptance. See Appendix 2 for suggested testing procedures.

b. Snowplows.

(1) Small snowplow: The plow may be any physical design, but should have a moldboard of at least 6 feet in length and 36 inches high. Included in this group are underbody truck scrapers having a moldboard of at least 15 inches high.

(2) Intermediate snowplow: The plow may be any physical design, but should have a moldboard of at least 10 feet in length and 36 inches high. Included in this group are underbody truck scrapers having a moldboard of at least 15 inches high.

(3) Large snowplow: The plow may be any physical design, but should have a moldboard of at least 15 feet in length and 48 inches high. Included in this group are ramp dozer plows.

(4) Leveling wings: The plows should be equipped with leveling wing plow attachments at the option of the airport sponsor.

(5) Carrier vehicles: The carrier vehicles for the snowplows should conform to the particular snowplow manufacturer's recommendations, be suitable for mounting the snowplow and/or underbody truck scraper, and be all wheel drive.

c. Equipment substitution: A snowplow with carrier vehicle, intermediate or large range, may be substituted, on a one for one basis, for a motor patrol grader equipped with a plow, leveling wings, disc or scarifier apparatus. The recommended minimum flywheel horsepower rating for the motor patrol grader should be in the range of 120 to 150 flywheel horsepower and have a basic operating weight of 21,000 to 30,000 pounds.

13. EQUIPMENT SPECIFICATIONS. Airport sponsors are encourged to develop their equipment specifications within the general guidelines of paragraph 12 when requesting bids on snow removal equipment. Specific and optional features which are best suited to the particular snow removal and ice control problems associated with the specific airport should be included in their request for bids.

14. EQUIPMENT REPLACEMENT. Whenever a unit of snow removal equipment has been rendered unfit for use through normal utilization, and the average yearly maintenance cost exceeds 10 percent of the replacement cost of the unit, replacement of the unit should be considered. With normal preventative maintenance, as prescribed by the manufacturer, the programmed life expectancy of snow removal equipment is 10 years.

APPENDIX 1. SAMPLE SNOW REMOVAL PLAN

PREFACE

The intent of this sample snow removal plan is to provide a guide for all persons engaged in airport snow removal. It is not to be construed as being mandatory or as being the only means of controlling ice and snow. Due to the many variables, it is impossible to set forth, with any degree of accuracy, a texbook-type of instruction for this work. It is suggested that persons using this guide be completely familiar with the entire physical aspects of the airport, adjacent areas and the equipment to be used. Persons developing a snow removal plan for a specific airport are encouraged to add to, or delete from the guidance found herein to suit the characteristics peculiar to their airport. Also, the formulation of a detailed snow removal plan for any airport, in particular, the small single runway airport should not be considered as mandatory.

AIRPORT NAME

SNOW AND ICE CONTROL PROCEDURES

1. RESPONSIBILITIES AND SUPERVISION.

a. The airport manager or his designated representative is responsible for the following:

(1) Determining when snow removal operations shall begin. This shall be based upon his evaluation of existing conditions, present and forecast weather conditions (generally when the snow begins and prior to an accumulation of 1/2 inch)

(2) During snow and/or ice storms, maintaining a continual check of runway conditions for depth of snow, ice, slush and braking conditions.

(3) Disseminating airport information by utilizing the Notice to Airmen (NOTAM) system through the appropriate FAA facilities prior to commencing snow removal operations, when braking action is determined to be fair to poor (Mu-Meter reading of 0.30 or less averaged over 1/3 segments of the runway length), when ridges or windrows of snow remain on or adjacent to the operational areas. Additionally, when any conditions exists that could present a hazard to aircraft operations or when conditions change from those previously reported a NOTAM will be issued.

(4) Informing the airport traffic control tower and air carrier operations office of the current airport surface conditions. When describing the quality of braking action, use the terms "Good", "Medium", "Fair", "Poor" or "Nil" and the method and type of vehicle used for the measurements, also issue a Notice to Airmen as appropriate. Numeric values obtained by the friction measuring device shall be issued as an advisory to the FAA flight service station.

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

c. All supervisors concerned with snow removal and ice control are responsible for the efficient operation of all snow and ice control equipment. This entails that all of the equipment be personally inspected for proper operation, properly sheltered and be in complete readiness for either snow or ice control. This includes chemicals (Urea), sand, all hopper beds and spreaders. At all times there should not be less than a 72-hour supply of both gasoline and diesel fuel on hand in the event that round-the-clock operation is required.

2. VEHICLES.

a. All snow removal and ice control vehicles actively engaged in such procedures on any airplane movement areas of the airport must be equipped with a two-way radio operating on the appropriate ground control frequency (or such other frequency as may be assigned by the airport traffic control tower) which must be monitored by the operator at all times. Any malfunctioning radio should be taken to the radio repair shop for repairs as quickly as possible, weather conditions permitting.

b. All outside contractors utilized by the airports manager's office and any airport tenant or agency on the airport shall be subject to all airport rules and regulations. They shall operate at the direction of the airport manager's office, and get a clearance from the airport traffic control tower prior to operating on the movement surfaces. At no time will outside contractors, their vehicles and/or equipment be permitted to operate beyond the limits of the existing ramp areas without first being cleared by the appropriate agencies and accompanied by a radio-controlled vehicle. All such controlled vehicles must be equipped with the necessary lights and warning signals for night operation and be appropriately marked in accordance with Advisory Circular 150/5210-5A, Painting, Marking and lighting of Vehicles Used on an Airport.

c. The following listed airport-owned equipment with approved airport employed operators will be utilized for snow and ice control on the airport operational areas.

VEHICLE NO.	TYPE	PLOW	OPERATOR	HOME PHONE
1	4 x 4 Truck	14' Plow	J. Doe	313-6074
2	4 x 2 Truck	Rotary Blower	J. Jones	418-3217

d. The airport has contracted with a local general contractor, the XYZ Construction Company, to provide equipment and personnel for emergency snow removal operations on an as-needed basis. Request for the equipment should be made by contacting the XYZ Construction Company (273-3325) during working hours or contacting Mr. S. Foreman (265-1372)/Mr. I. Superintendent (264-2514) after working hours. The XYZ Construction Company will provide up to three patrol graders, two front end-loaders and four 4 by 4 trucks with snowplows with driver/operators. Request for this equipment shall only be made through the airport manager, his duly appointed representative or his duly appointed duty officer.

3. SNOW REMOVAL OPERATIONS.

a. The following principles regarding snow removal and positioning shall be adhered to in maintaining safe operating conditions on airport operational areas.

(1) Drifted or piled snow shall be promptly removed off usable runway, taxiway and ramp surfaces.

(2) In the event of sizable snow accumulation, snowbanks shall be positioned off usable runway, taxiway and ramp surfaces in heights so regulated that all aircraft propellers, engine pods and wing tips will clear snowdrifts and snowbanks when the aircraft's most critical landing gear is located at any point along the full strength edge of the runway, taxiway or ramp paving.

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

4. RUNWAYS, TAXIWAYS, RAMPS AND ACCESS ROADS.

a. Snow removal operations are to commence when one-fourth inch of wet snow or 1 inch of dry snow accumulates on the paved surfaces. Caution shall be excerised by all equipment operators to prevent damage to, or burying the runway and taxiway edge lights.

b. The active runway, associated parallel taxiway, and taxiways connecting the active runway to the aircraft parking apron are to receive the first priority. If a wind shift to the crosswind runway is expected (forecast by the meteorologist) and if the continued use of the active runway will not derogate the safety of flight operations, the crosswind runway will receive the first priority. The standard procedure will be:

(1) The initial plow cut will be along the edge of the runway with the windrow being cast towards the runway centerline.

(2) The second and subsequent passes with the plows will be along and parallel to the runway centerline moving the snow to both sides of the runway, where the high-speed blower will blow the windrow beyond the edge light system.

(3) When there is sufficient plowing equipment available, the runways and taxiways will be plowed with the equipment in echelon. When wind conditions dictate, it may be advantageous to plow the snow in one direction, i.e., start plowing on the up-wind side of the runway and plow the snow to the down-wind side of the runway. This procedure is very slow and will be used only under severe and unusual wind conditions.

c. Snow removal operations will commence concurrently on the Crash Fire and Rescue (CFR) access roads and/or emergency airport access gates, the aircraft parking ramp, the cross-wind runway, its associated taxiway, and all connecting taxiways. While work progresses in these other areas, the condition of the active runway will be kept under close surveillance. If the continuing snowfall necessitates replowing, all work in other areas will be suspended and the plows and high-speed blowers will be diverted to replowing the active runway as frequently as may be necessary to maintain safe operating conditions.

d. Snow removal operations on the airport access roads, auto parking lots and service areas will receive the lowest priority and will be plowed only after all aircraft operational areas have been completely cleared of snow.

5. ICE CONTROL PROCEDURES. In general, icing conditions occur when ambient temperatures are between 28 to 34 degrees Fahrenheit. There have been a few instances of icing above and below these temperatures, but these are the exception rather than the rule. When temperatures begin to drop or rise to this range, frequent checks should be made with the

National Weather Service for the probability of icing conditions occurring. Insofar as possible, alerting of airport personnel for ice control purposes will be based on forecasts by the National Weather Service.

6. RUNWAYS, TAXIWAYS AND RAMPS.

   a. The critical time for ice control operation begins just before or right at the start of icing conditions. Urea or sand should be applied to airport operational surfaces and utilize the Notice to Airmen system advising of airport surface conditions. Urea or sand application will follow the same sequence as previously described for the snow removal, i.e., active runway and associated taxiway first, cross-wind runway and associated taxiway second and ramp area last.

   b. In the event that ice forms on the airport operational areas, the standard procedure will be to spread sand and to melt the ice sufficiently to imbed the sand particles upon refreezing. This operation will be accomplished by using open-flame weed burners towed in tandem at a speed of 3 to 5 miles per hour depending upon wind and temperature conditions. The center 100 feet of all runways and the full width of the taxiways are to be treated in this manner. A notification through the Notice to Airmen system will be given to the appropriate FAA facility prior to all sanding operations and as frequently thereafter as conditions warrant. When the ice has melted, all residual sand remaining on the paved surface shall be promptly removed by sweeping with the high-speed brooms. NOTE: NO SALTS OR CORROSIVE CHEMICALS ARE TO BE USED ON RUNWAYS, TAXIWAYS OR AIRCRAFT PARKING RAMPS!

7. ACCESS ROADS AND AUTO PARKING AREAS. During periods of icing conditions it should be remembered that bridges, viaducts, culverts, etc., will freeze over before the roadways. Therefore, salt or chemical distribution vehicles shall make initial spreads on these areas before proceeding to the other areas. The order of priority for salting shall be bridges, culverts, viaducts, etc., first, access roads and service roads second and auto parking areas last. NOTE: ACCESS ROADS AND AUTO PARKING AREAS ARE TO RECEIVE THE LOWEST PRIORITY.

8. SLUSH CONTROL PROGRAM. Slush removal operations are to begin immediately upon the initial formation. Slush removal equipment will be equipped with rubber blades which have a tendency to effect a squeegee action on hard surfaces. Trucks engaged in slush removal will be able to travel rapidly in clearing operational areas, and in all likelihood, will be able to operate between aircraft movements. A constant check

of slush and standing water removal will be made and the Notice to Airmen system will be used as frequently as required. When an accumulation of one-half inch or more of slush covers over 50 percent of any runway, the Notice to Airmen system will be used closing that runway to aircraft operations.

9. CLEANUP OPERATIONS. The airport manager, or his designated representative, will make periodic and frequent inspections of all airport operational areas to determine the areas to be cleaned in addition to those areas previously cleaned. This normally will include any runways, taxiways or ramp areas where snow has been deposited as the result of removal operations and any areas where runway, taxiway, threshold or approach lights may be covered. Cleanup operations will cease only when there are no deposits of snow, slush, or ice on any paved areas on the airport operational surfaces, runway and taxiway lights are uncovered and all access roads have been made safe for vehicle operations. The Notice to Airmen system will be utilized advising that cleanup operations are ongoing, and the time the cleanup operation is anticipated to be completed.

APPENDIX 2

ROTARY SNOWBLOWER CAPACITY TEST

1. RECOMMENDED PROCEDURE FOR ROTARY SNOWBLOWER CAPACITY TEST.

   a. The following outlined procedure is one method for testing the capacity of rotary snowblowers. Other methods may exist which will also perform this function and may, at the discretion of the airport owner/operator, be utilized.

   b. The testing of manufacture-certified snowblower capacities should not be considered mandatory. These tests need only be performed to resolve questions concerning the capability of a specific snowblower.

2. PURPOSE. The purpose of this testing procedure is to determine the actual snow removal capacity at specific casting distances of different makes and models of rotary snowblowers. These tests will also provide a basis for determining the length of time required to complete a given snow removal task.

3. PREPARATION.

   a. Select a suitable site, preferably flat with a paved surface. On this site, construct a windrow of snow with a width at the base of 9 feet ± 1 foot, a nominal depth of 4 feet and an average cross-sectional area of 20 square feet ± 2 square feet. The average density of the snow should be in the range of 25 to 35 pounds per cubic foot. The windrow should have a minimum length of 500 feet.

   b. The rotary snowblower should be at the manufacturer's recommended operating temperature and the operator should be totally familiar with the snowblower and be advised of the operating procedure to be used for the specific test.

   c. The equipment needed for the test should include a 100 foot measuring tape, stopwatch, thermometer, and snow density measuring equipment.

4. MEASUREMENTS.

   a. The windrow should be measured for cross-sectional area at a minimum of 50 foot intervals, and at the beginning and end of the test run.

b. Snow density test should be taken at all locations where the cross-sectional measurements are taken. Three samples of snow should be taken, one at the base, one in the middle, and one at the top, and average the 3 densities obtained from these samples.

c. Measure the ambient temperature.

d. After the test run of the snow blower, measure the distance from the center of the windrow to the point of maximum deposition to determine the casting distance.

5. TEST RUN. The snowblower should be run over the prescribed course in accordance with the manufacturer's recommended procedure for obtaining the maximum capacity for the prescribed casting distance. A series of 3 tests should be performed for each of the prescribed casting distances and the average capacity and casting distance for each of the series calculated.

6. CAPACITY CALCULATION.

a. The capacity of the rotary snowblower can be calculated by using the following formula: $Q=A \times L \times D \times 1.8/t$. where Q = capacity, A = average cross-sectional area of the windrow, L = length of test run, D = average density of the snow, t = time of test run measured in seconds, and 1.8 = a constant $\frac{3,600 \text{ seconds/hour}}{2,000 \text{ pounds/ton}}$

b. Allowances should be given for the maximum capacity determinations when the shear strength of the windrowed snow exceeds 250 pounds per square foot (PSF) as follows:

(1) 250 to 500 pounds PSF will equal a 30% reduction.

(2) 500 to 600 pounds PSF will equal a 50% reduction.

(3) Average shear strengths above 600 PSF will void the test.

c. The average shear strength should be measured with a Ramsonde Penetrometer for the full depth of the windrow.

APPENDIX 3. METRIC CONVERSION TABLE

1 mile (mi) = 1.609 kilometers (km) = 1609 meters (m)
1 yard (yd) = 0.914 meters (m)
1 foot (ft) = 0.305 meters (m)

1 square yard (yd^2) = 0.8361 souare meters (m^2)
1 square foot (ft^2) = 929 square centimeters (cm^2) = 0.0929 m^2

1 cubic yard (yd^3) = 0.7646 cubic meters (m^3)
1 cubic foot (ft^3) = 0.0283 cubic meters (m^3)

1 pound (lb) = 0.4536 kilograms (kg)

100 pounds per mile (lb/mi) = 28.19 kilograms per kilometer (kg/kl)
1 cubic yard per mile (yd^3/mi) = 0.4752 cubic meters per kilometer (m^3/km)

1 pound per cubic foot (lb/ft^3) = 27 pounds per cubic yard (lb/yd^3)
= 16.03 kilograms per cubic meter (kg/m^3)
1 pound per cubic yard (lb/yd^3) = 0.5933 kilograms per cubic meter (kg/m^3)

Degrees Farenheit	Degrees Celsius (Centigrade)
212°F	100°C
50°F	10°C
40°F	4°C
30°F	-1°C
20°F	-7°C
10°F	-12°C
0°F	-18°C
-10°F	-23°C
-20°F	-29°C