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Advisory Circular

Subject: Airport Winter Safety and
Operations

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AC No: 150/5200-30C

Initiated by: AAS-100 **Change:**

- 1. PURPOSE.** This advisory circular (AC) provides guidance to assist airport operators in developing a snow and ice control plan, conducting and reporting runway friction surveys, and establishing snow removal and control procedures.
- 2. CANCELLATION.** This AC cancels AC 150/5200-30B, *Airport Winter Safety and Operations*, dated September 5, 2007
- 3. APPLICATION.** This AC contains guidance on developing plans, methods, and procedures for snow and ice control equipment, materials, and removal that are acceptable to the Administrator and in accordance with Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports, Section 139.313, Snow and Ice Control. Certificated airports are required to follow the requirements of paragraphs 5-6 and 5-7 as of the effective date of this AC. In addition, all certificated airports must submit revised Snow and Ice Control Plans to the FAA no later than April 30, 2009 for approval. At that time, certificated airports will be required to comply with the remaining portions of this AC. The AC is advisory for non-certificated airports.
- 4. PRINCIPAL CHANGES.** The AC incorporates the following principal changes:
 - a.** Paragraph 1-3 clarifies that the location of the snow control center may range from a separate room/facility to a specially equipped operations vehicle.
 - b.** Paragraph 5-6 establishes the winter related conditions that initiate a requirement for closing a runway.
 - c.** Various new or revised text changes that relate to paragraph 5-6 requirements.
- 5. METRIC UNITS.** This AC contains both English and metric dimensions. The metric conversions may not be exact, so the English system governs.

Michael J. O'Donnell
Director of Airport Safety and Standards

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Chapter 1. Introduction

1-1. Snow and Ice Control Committee. The presence of contaminants such as snow, ice, or slush on airfield pavements and drifting snow causes hazardous conditions that may contribute to airplane incidents and accidents. Further, winter storm conditions usually reduce airport traffic volumes through flight delays and/or cancellations and, in severe storm conditions, airport closures. The extent to which these undesirable effects are minimized will depend on the approach taken by the airport operator to combat winter conditions. The most successful airport operators at combating winter storms are those that establish an airport snow and ice control committee that conducts pre- and post-seasonal planning meetings, operates a snow control center (SCC), and, most importantly, implements a written plan. This advisory circular provides recommendations and guidance for writing plans plus identifies topics that should receive special focus to improve operational safety. For airports certificated under 14 CFR Part 139, *Certification of Airports* (Part 139), the written plan is referred to as the *Snow and Ice Control Plan* (see section 139.313, *Snow and Ice Control*.)

1-2. Airport Snow and Ice Control Committee (SICC). All airports subject to icing conditions or annual snowfall of several inches (6 inches (15 cm) or more) should have a SICC. Such committees have been effective in (1) pre-season planning, (2) focusing the operational plan to improve runway safety and communications between various offices/departments involved or impacted by a storm event, (3) addressing the needs of airport users, and (4) critiquing clearing activities of the airfield and ramp areas after the winter season and after each storm event. It is recommended that ongoing evaluation meetings be held, preferably after each storm event, to allow evaluation of procedures, identify safety concerns, and, when necessary, implement revised clearing procedures. The SICC size and functions will vary based on the airport size, airport users, and the type of winter weather experienced within its geographical location. The airport manager or his/her representative should chair the SICC. The committee should include representatives from the following:

- Airport operations staff.
- Airline flight operations departments or fixed-base operators and airline station personnel (deicing representatives).
- FAA air traffic control, flight station, technical operations.
- Other concerned parties deemed necessary, such as the U.S. military (at joint-use airports), service providers, and contractors who may be actively conducting construction activities.

1-3. Snow Control Center (SCC). The airport operator should set up a *Snow Control Center (SCC)* for snow and ice control activities. Depending on the size of the airport and its operations, the SCC may be in a special room or facility, or it might be a “snow desk” in a maintenance building, or it could be the command vehicle of the operations officer. The SCC performs the following main functions: (1) managing snow clearing operations; (2) serving as a prime source of field condition reporting, e.g., timely runway braking conditions, snow accumulations, etc.; (3) informing the airport traffic control tower (ATCT), air carriers, air taxis, and other parties of expected runway closures and openings; and (4) issuing timely NOTAMs

(see AC 150/5200-28, *Notices to Airmen (NOTAMS) for Airport Operators*, and FAA Orders 7930.2, *Notices to Airmen (NOTAMS)*, and 7340.1, *Contractions*).

1-4. Airfield Clearing Priorities for the Snow and Ice Control Plan (SICP). Airport operators cannot simultaneously clear all snow, slush, ice, or drifting snow from both the entire aircraft movement area and all supporting facilities necessary for flight. However, the airport operator can limit interruption of service as much as possible by classifying the most critical portions of the aircraft movement area and supporting facilities as Priority 1 and then taking care of other areas in their order of importance. For such a system to work, the SICP should identify at a minimum two priority categories based on the airport's safety requirements, flight operations, visual navigation aids (VISAIDs) and electronic navigational aids (NAVAIDs), and other factors deemed important by the airport operator. Figure 1-1 illustrates an airport with typically prioritized areas.

a. Priority 1. Items normally included in this category are the primary runway(s) with taxiway turnoffs, access taxiways leading to the terminal, terminal(s) and cargo ramp(s), airport rescue and fire fighting (ARFF) station(s) and emergency service roads, NAVAIDs, and other areas deemed essential, such as fueling areas and airport security/surveillance roads.

b. Priority 2. Items normally included in this category are crosswind/secondary runways and their supportive taxiways, remaining aircraft movement areas, commercial ramp areas, access roads to secondary facilities, and airfield facilities not essential to flight operations or not used on a daily basis.

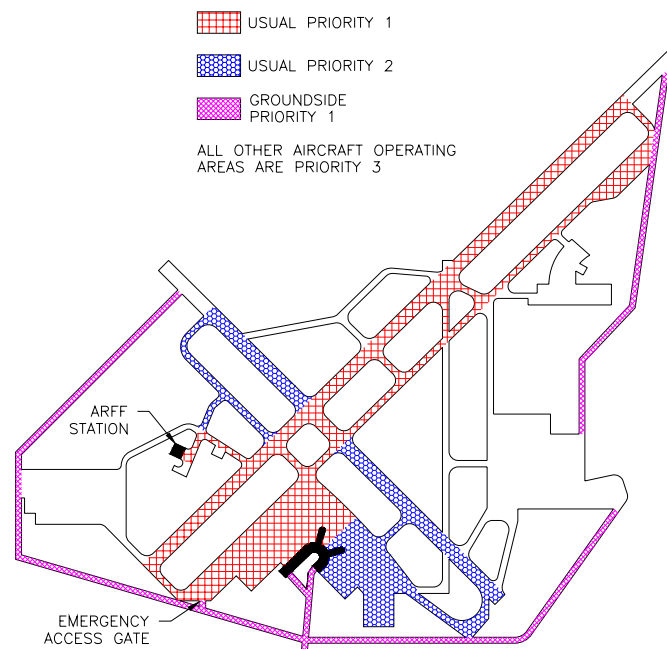


Figure 1-1. Example of Prioritized Paved Areas for the Snow and Ice Control Plan

1-5. Terminal and Landside – Ground Side Priority. The clearing of snow from the terminal and landside infrastructure to and from the terminal is a separate category generally not contained in the SICP because the objective of this clearing operation is public access, not airplane operational safety. Moreover, different chemicals, clearing equipment, and techniques, and possibly the use of municipal or service contractors, might be standard for such operations

1-6. Airfield Clearance Times. Airports should have sufficient equipment to clear within a reasonable time 1 inch (2.54 cm) of snow weighing up to 25 lb/ft³ (400 kg/m³) for the priorities outlined in Paragraph 1-4 that accommodate anticipated airplane operations. If supportive runways (such as a parallel runway) typically have simultaneous operations during the winter months, then the areas for both runways and associated principal taxiways should be included in the total area. The term “reasonable time,” as used in this AC, is based on the airport type and number of annual operations. The guidance in a. and b. below is provided to assist the airport operator in determining necessary equipment. It should not be interpreted as a requirement to clear surfaces within any particular time.

a. First, use the footnote in Table 1-1 to classify the airport as a *Commercial Service Airport* or a *Non-Commercial Service Airport*.

Table 1-1. Clearance Times for Commercial Service Airports

<i>Annual Airplane Operations</i> (includes cargo operations)	<i>Clearance Time</i> ¹ (hour)
<i>40,000 or more</i>	<i>½</i>
<i>10,000 – but less than 40,000</i>	<i>1</i>
<i>6,000 – but less than 10,000</i>	<i>1½</i>
<i>Less than 6,000</i>	<i>2</i>
<i>General: Commercial Service Airport means a public-use airport that the U.S. Secretary of Transportation determines has at least 2,500 passenger boardings each year and that receives scheduled passenger airplane service [reference Title 49 United States Code, Section 47102(7)].</i>	
<i>Footnote 1: These airports should have sufficient equipment to clear 1 inch (2.54 cm) of falling snow weighing up to 25 lb/ft³ (400 kg/m³) from Priority 1 areas within the recommended clearance times.</i>	

Table 1-2. Clearance Times for Non-Commercial Service Airports

<i>Annual Airplane Operations</i> (includes cargo operations)	<i>Clearance Time¹</i> (hour)
<i>40,000 or more</i>	<i>2</i>
<i>10,000 – but less than 40,000</i>	<i>3</i>
<i>6,000 – but less than 10,000</i>	<i>4</i>
<i>Less than 6,000</i>	<i>6</i>
<i>General: Although not specifically defined, Non-Commercial Service Airports are airports that are not classified as Commercial Service Airports [see Table 1-1, general note].</i>	
<i>Footnote 1: These airports may wish to have sufficient equipment to clear 1 inch (2.54 cm) of falling snow weighing up to 25 lb/ft³ (400 kg/m³) from Priority 1 areas within the recommended clearance times.</i>	

b. Second, using the appropriate table, find the number of annual airplane operations handled by the airport and the recommended clearance time. As shown, this action-initiating condition, compared with an action-initiating event based on weather forecasts or runway surface condition sensors, calls for clearing operations for 1-inch (2.54-cm) snowfall with an assumed weight (snow density) of up to 25 lb/ft³ (400 kg/m³). For airports located in regions where snow densities over 25 lb/ft³ (400 kg/m³) are the norm, the airport operator should consider using a 1/2-inch (1.25 cm) snow depth as the action-initiating condition. Airport operators should keep in mind that heavier snow densities can increase the size and type of equipment comprising the fleet used to clear Priority 1 paved areas within the recommended clearance times (for details, see AC 150/5220-20, *Airport Snow and Ice Control Equipment*.)

1-7. Sizing and Staffing Snow and Ice Control Equipment Fleet. Sizing the snow and ice control equipment fleet should be based on the total Priority 1 paved area that is cleared of snow, slush, or ice within a recommended clearance time. AC 150/5220-20 offers guidance on how to select the number and types of equipment necessary to meet recommended clearance times. As for staffing, Part 139, sections 139.303(a) and (b) relate equipment fleet size with sufficient, qualified staff. Section 139.303(b) requires certificate holders “to equip personnel with sufficient resources needed to comply with the requirements of this part.” Part 139, section 139.303(a) requires certificate holders “to provide sufficient and qualified personnel to comply with the airport’s Airport Certification Manual and the requirements of this part.” While snow removal and surface treatment may be adequate for runways, the adequacy should extend to keeping all required associated taxiways cleared and to maintaining adequate surface friction to the extent practical.

1-8. Storage of Snow and Ice Control Equipment. Whenever possible, snow and ice control equipment should be housed in a heated building to prolong the useful life of the equipment and to enable more rapid response to operational needs. Additionally, repair facilities should be available within the building for onsite equipment maintenance and repair during the winter season. Operationally, equipment should be inspected after each use to determine whether additional maintenance or repair is necessary. Guidance on storing snow and ice control

equipment is provided in AC 150/5220-18, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*.

1-9. Definitions.

a. Contaminant. Any substance on a runway. For the purposes of this AC, references to contaminants mean winter contaminants such as snow, slush, ice or standing water.

b. 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 water in the system. The limit of freezing point depression, equivalent to 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 is the eutectic composition. Collectively, they are referred to as the eutectic point.

c. Ice. The solid form of water consisting of a characteristic hexagonal symmetry of water molecules. The density of pure ice is 57 lb/ft³ (913 kg/m³), 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/ft³ (800 kg/m³).

d. Snow (on the ground). A porous, permeable aggregate of ice grains, which can be predominately single crystals or close groupings of several crystals.

(1) Dry Snow. Snow that has insufficient free water to cause cohesion between individual particles. This generally occurs at temperatures well below 32° F (0° C). If when making a snowball, it falls apart, the snow is considered dry.

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

(3) Compacted Snow. Snow that has been compressed into a solid mass that resists further compression and will hold together or break up into lumps if picked up.

e. Slush. Snow that has 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. This type of water-saturated snow will be displaced with a splatter by a heel and toe slap-down motion against the ground.

f. Patchy Conditions. Areas of bare pavement showing through snow and/or ice covered pavements. Patches normally show up first along the centerline in the central portion of the runway in the touchdown areas.

g. Primary Runway. A runway expected to be used under the existing atmospheric and storm event conditions where most of the takeoff and landing operations will take place.

h. Secondary Runway. A runway that supports a primary runway. Takeoff and landing operations on such a runway are generally less frequent than on a primary runway.

Chapter 2. The Snow and Ice Control Plan

2-1. Safety Requirements. Snow, ice, and slush should be removed as expeditiously as possible. The goal is to maintain runways, high-speed turnoffs, and taxiways in a “*no worse than wet*” (i.e., no contaminant accumulation) condition, realizing that this is not always possible. Surface friction can be improved by application of sand 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 runway incursions and interference or conflict with airplane operations. This safety responsibility is shared by airport personnel, airplane operators, and any contract service providers. 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.). Post-clearing operations must be conducted to ensure airfield signage and markings between the runway(s) and apron are visible to pilots to reduce the potential for runway incursions.

a. Airport Operators. Airport operators have a major duty to ensure the safety of operations at their facilities. This involves performance according to accepted principles, ensuring a high standard of care, providing state-of-the-art standards in equipment and techniques, and maintaining qualified crews. Care should be taken to ensure the snow and ice control plan 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 assigned snow and ice control duties. Airport operators, however, have the duty to warn the users of the airport of any change in published procedure or change in the physical facility. As an example, an airport operator should give *timely* or *proper notice* of pavement or visual aids that may have been damaged by a snow plowing operation. Complete documentation of compliance with the snow and ice control plan (SICP) should be kept. This advisory circular will use the term “*Snow and Ice Control Plan*” to represent all types of snow and ice control plans.

b. Snow and Ice Control Plans. The Snow and Ice Control Plan (SICP) is a basic document encompassing at least two separate phases. Phase #1 addresses pre- and post-winter season subjects that prepare the airport operator for the new winter season. This phase may include revising the existing SICP after the winter season ends. Phase #2 addresses the sequential actions, via instruction and procedures, taken by the airport operator for dealing with winter storms and notifying airport users in a timely manner when less than satisfactory conditions exist at the airport including the closure of runways. Chapters 1, 3, 4, and 5 of this AC offer guidance, recommendations, and standards for writing instructions and procedures for Phase #2. Additionally, Sections 2 and 3 of this Chapter should be used to maintain a safer airfield. At minimum, the following questions should be addressed when outlining new plans or revising existing plans.

- Are we materially prepared and adequately budgeted for the new winter season?

- Did the SICP incorporate identified post-season improvements?
- Are we staffed adequately with qualified personnel?
- Is our training program adequately tracking test records and development of qualified personnel?
- Do our environmental mitigation procedures for disposal of deicers and equipment maintenance materials and supplies keep us in compliance with storm water regulations?
- Should our Snow and Ice Control Committee (SICC) conduct more pre- and post-season meetings?
- Did our weather forecasting method monitor last year's storm events accurately and in a timely manner?
- Do we need to change our prescribed storm conditions to start clearing operations or preventive measures?
- Do we need to change our runway closure procedures as defined in paragraph 5-6 for closing a runway and other paved areas used by airplanes?
- In reference to our runway closure procedure, do we need to revise the steps we prescribed in the SICP for continuously monitoring the runway(s)?
- Do the same personnel continue to initiate the runway closure procedure (as developed by the airport) and are there any new procedures for the closure of a runway?
- Are there any changes to our chain-of-command and phone numbers?
- Do we need to update or issue a Letter of Agreement (LOA) with the airport traffic control tower (ATCT) or other parties for implementing runway closure procedures?
- Were there any changes to the airfield areas to be cleared and maintained, the timing of operations, and how clearing will be done?
- Are we informing our users frequently and in a timely manner when we must close the airport or report less than satisfactory surface conditions? Did we get complaints?
- Are we meeting all applicable Part 139 requirements?
- How do we ensure markings, signs, and lighting systems are legible/visible after clearing operations? Are touchdown markings addressed in our procedures?
- What are our procedures in case of airfield accidents involving snow clearing crews, airplanes, or other airport vehicles?
- Did we address all unique airport site conditions?
- Have all storm crews received training on the SICP and trained on new equipment?

2-2. Topics for Pre- and Post-Season SICC Meetings. As with all plans, the SICP should be reviewed at least annually to collectively assess the previous year's program. Three general topics are recommended for discussion, namely to incorporate (1) changes to airport staff, equipment, runway chemicals, and airport clearing procedures; (2) changes to air carrier ground

deicing/anti-icing programs; and (3) “*lessons learned*” from actual events encountered. The FAA recommends that before each winter season, the SICC holds a series of meetings to prepare for and adequately budget for the upcoming winter season. Two distinct meetings should be held; one focused on airport clearing operations, and the other focused on air carrier ground deicing/anti-icing programs. Each meeting should discuss any new topics not dealt with in past years, such as new FAA aircraft ground deicing/anti-icing polices and new Federal, state, or local storm water runoff regulations.

a. Topics Relative to Airport Clearing Operations Discussions. The following are topics normally covered:

- Areas designated as Priority 1 areas, to include any new airfield infrastructure.
- Clearing operations and follow-up airfield assessments to further mitigate the potential for pilot and vehicular surface incidents or runway incursions.
- Staffing requirements and qualifications (training) for snow crews and Snow Control Center staff.
- Update to the training program to close any ambiguity.
- Streamline decision-making process, the “line-of-command” authority.
- Response times to keep runways, taxiways, and ramp areas operational, e.g., to rectify problems encountered during previous storm events that hampered airport operations.
- Communications, terminology, frequencies, and procedures with the airport traffic control tower (ATCT), snow crews, and the Snow Control Center.
- Monitoring and updating of runway surface conditions after a clearing operation and deicing or sanding applications.
- Issuance of NOTAMs and dissemination to ensure timely notification.
- Equipment inventory, including assessing the condition of snow control equipment, scheduling repairs, and stocking spare parts.
- Status of procurement contracts and specifications for new vehicles or equipment.
- Preventive maintenance program for snow control equipment and maintenance and calibration for friction testing equipment.
- Status of procurement contracts and specifications for deicer-/anti-icer materials and sand supply, including their storage before the first snowfall.
- Validation of deicer certification letters from vendors.
- Procedures for storm water runoff mitigation.
- Snow hauling and/or disposal plan, including sites for dumping snow.
- New runoff requirements for the containment and/or collection of deicing chemicals and vehicle maintenance fluids and materials.
- Changes to contract service for clearing ramps.

b. Topics Relative to Air Carrier Ground Deicing/Anti-icing Programs. The airport operator should act as a facilitator and arrange a meeting for the parties that may be affected by

airplane ground deicing plans, including those plans required of air carriers operating under 14 CFR Part 121, *Operating Requirements: Domestic, Flag, and Supplemental Operations*. These parties include airport management and consultants, the air carriers, other airport users, corporate tenants, pilot representatives, and FAA Air Traffic Control. The meeting should assess the impact of any airplane ground deicing activities on airport operations and identify actions that can be taken by the various parties to maximize the efficiency of operations during icing conditions. For example, the committee may be able to identify the most effective locations for secondary deicing and establish procedures for its implementation. At most airports, one meeting to discuss these subjects before the start of the winter season should suffice. However, at other airports, subsequent meetings may be necessary to assess the effectiveness of plans and to modify them if necessary. These meetings typically address the following topics:

- Assessment of all air carriers' deicing programs from the previous year, including—
 - Reviewing airplane surface flow strategies.
 - Reviewing ground time and takeoff clearances after deicing.
 - Analyzing and adjusting to airplane deicing plans.
- Actions needed to maximize efficiency of operations during icing conditions, including—
 - Identifying locations for airplane deicing that use chemicals or infrared deicing technology.
 - Planning taxi routes to minimize ground time.
 - Developing rates that control deiced departures.
 - Allocating departure slot capacities.
 - Determining airport deicing crew needs.
 - Verifying communication procedures between air traffic control and airplanes to be deiced.
- Any requirements for containment/collection of deicing/anti-icings.

2-3. Outlining a Snow and Ice Control Plan (SICP).

a. A logical first step in writing the SICP is to identify and prioritize those aircraft movement areas to be cleared of snow and/or ice within certain times. Paragraphs 1-4 and 1-5 of this advisory circular discuss airfield clearing priorities and clearance times. These parameters, in turn, guide the airport operator in selecting the conditions that initiate activities, such as, clearing operations, chemical applications, runway friction surveys, and other operations. (Chapter 3 provides information about action-initiated conditions and events.)

Next, the SICP must include instructions and procedures for handling the various types of winter storms encountered by the airport and how to notify airport users in a timely manner of other than nominal runway conditions, including, but not limited to: runway closures, and when any

portion of the movement area normally available to them is covered by snow, slush, ice, or standing water.

b. When winter contaminants are present on pavements and/or a runway has to be closed, Section 1 of this Chapter provides the minimal list of what is to be done, while Chapters 4 and 5 offer guidance, recommendations, and standards for writing the instructions and procedures.

c. Finally, the SICP should address special safety topics to minimize runway incursions during initial and follow-up clearing operations. Sections 2 and 3 of this Chapter offer guidance and recommendations for this step.

2-4. Topics for Writing Instructions and Procedures for Winter Operations and Notification. Part 139 airports are required to address the following topics in their SICP, and it is recommended that all other airport operators address the same topics in their SICP. Each topic provides a cross-reference for further clarification.

a. Prompt removal or control, as completely as practical, of snow, ice, and slush on each movement area (see Paragraph 1-1 and Chapter 3).

b. Positioning snow off the movement area surfaces so all airplane propellers, engine pods, rotors, and wing tips will clear any snowdrift and snow bank as the airplane's landing gear traverses any portion of the movement area (see Chapter 4, Paragraph 4-1 and Figure 4-1).

c. Selection and application of authorized materials for snow and ice control to ensure they adhere to snow and ice sufficiently to minimize engine ingestion (see Chapter 4, Paragraphs 4-6 and 4-7).

d. Timely commencement of snow and ice control operations (see Paragraph 1-1 and Chapter 3).

e. Prompt notification in accordance with Part 139.339, *Airport Condition Reporting*, to all air carriers using the airport when any portion of the movement area normally available to them is less than satisfactorily cleared for safe operation by their aircraft (see Chapter 5, Paragraphs 5-6, *Requirements for Runway Closures*, and 5-2, *Runway Condition Reporting*). In addition, all airplane operators should be informed any time pavements are contaminated with ice, snow, slush, or standing water.

2-5. Runway Incursion Mitigation and Operations During Non-Towered Air Traffic Control Periods. The SICP should contain specific procedures for those periods when the ATCT is closed and for airports that do not have an ATCT (non-towered airport). Additionally the SICP should contain specific procedures for unexpected situations, such as when "whiteout" conditions occur while snow clearing crews occupy the runways. The following items should be considered:

a. Runway clearing procedures must ensure snow removal operations will not create the possibility for a runway incursion after the runway reopens, for example, by covering taxiway signs with plowed snow. The SICP should specifically address that taxiway directional signs,

such as those leading out and toward the terminal area(s), and runway holding position signs are legible and light fixtures are distinguishable after clearing operations.

b. Although it is not required, airport operators should consider closing runways during snow clearing operations. For airport operators that choose to keep runways open during such operations, the SICP should include procedures requiring continuous coordination among the clearing crew and the SCC to ensure the equipment operators on runways are aware of their surroundings. Snow removal equipment operators should monitor appropriate air traffic control (ATC) or other frequencies for information on approaching or departing airplanes.

c. The overlying air traffic control frequency should be monitored along with the local frequency by the airport's Snow Control Center at all non-towered airports and at airports where the ATCT has less than 24-hour operations. This should apply even if a NOTAM has been issued closing the runway for snow clearing operations. Such monitoring is especially important during marginal visual meteorological condition (VMC) and instrument meteorological condition (IMC).

Note: The overlying air traffic facility may be enroute, terminal, or flight service. Monitoring is recommended for snow crews to hear an airplane approaching and therefore be able to clear the runway of personnel and equipment, if necessary. At times air traffic control and /or the pilots may not be aware about a runway closure at the non-towered airport. That is, sometimes a NOTAM is issued after an airplane becomes airborne and the pilot did not receive the latest update, especially at an uncontrolled airfield.

d. Include special snow crew communication procedures for "whiteout" conditions at both towered and non-towered airports.

e. Include special snow crew communication procedures for occasions when a single equipment operator needs to return to the runway after a major clearing event.

2-6. Staff Training and Recordkeeping. The SICP should describe qualification criteria and training for individuals directly involved in snow and ice control operations. That is, the SICP might specify that an implemented training program contain specific course material for equipment drivers, staff working in the Snow Control Center, etc. The SICP should also outline recordkeeping procedures for tracking employee progress in achieving training goals and objectives. Although airport operators should develop their own training programs to address conditions at their particular airports, the FAA recommends the programs contain the following minimum components:

a. Use of formal classroom lectures, training films if available, and discussion periods to teach the contents of the SICP to individuals who need to understand procedures in detail.

b. Conduct of tabletop exercises that use miniature equipment on airfield layouts to simulate operations.

c. Hands-on training for equipment operators on how their equipment works as well as practice runs under typical operational scenarios.

d. Instruction on airfield familiarization that includes both day and night tours of the airfield and ensures an understanding of all surface markings, signs, and lighting.

e. Instruction for all personnel on proper communication procedures and terminology. This includes the special procedures to be followed during “whiteout” conditions and when radio signal is lost between drivers and/or the ATCT. See FAA AC 150/5210-20, *Ground Vehicle Operations on Airports*, for guidance on communication procedures for airport personnel.

f. Instruction for drivers on the proper procedures and communications to follow when the ATCT is not operating or the airport has no ATCT.

g. Training in following runway closure criteria for personnel responsible for closing and opening runways during snow events. This training is especially important for non-towered airports or part-time towered airports.

2-7. Other Related Items. The implemented SICP needs to take into account how the document will integrate with other airport plans, programs, and lease agreements.

a. Other Airport Plans and Programs. Although the SICP is a stand-alone plan, it should integrate with other airport plans and programs to avoid conflicts and duplication of procedures and responsibilities. A few examples of closely related plans/programs are the *Airport Certification Manual*, *Airport Emergency Plan*, and the *Storm Water Pollution Prevention Plan* (for deicer runoff mitigation). The FAA recommends the airport fire fighting and rescue service receive a copy of the SICP for their familiarization, especially so responders will know which service roads will be closed.

b. Post Accident/Incident Recommendations. To address accidents or incidents that might occur during adverse weather conditions, the SICP should contain procedures that ensure surface conditions occurring during the event are properly inspected and documented. Additionally, the airport operator must not disturb evidence on the runway until the appropriate Federal authority (FAA/National Transportation Safety Board (NTSB) provides a release. To help NTSB, the airport operator should document the type and depth of contamination on the runway at the time of the accident/incident, which should include conducting a runway friction assessment and taking still and/or video photography. If wreckage is observed on the pavement, the airport operator must not attempt to conduct testing in those areas that would disturb evidence on the runway (see AC 150/5200-12, *Fire Department Responsibility in Protecting Evidence at the Scene of an Aircraft Accident*).

c. Snow and Ice Control Contractors/Lease Agreements. The principle of ensuring safety of operations applies equally to lease holders and service contractors hired to perform

snow and ice control services. In particular, contractual agreements should be clear and specific in terms of duties, procedures for snow and ice control, responsibilities for communications and ground control, and other contingencies. Service contractors and leaseholders should receive a copy of the latest airport SICP, not necessarily the complete *Airport Certification Manual*. Contracted service providers are recommended to have similar training as described in Paragraph 2-6(a) – (f).

d. Storm Water Runoff Regulations. Greater emphasis has been placed on mitigating the negative impacts associated with snow clearing operations and equipment maintenance on bodies of water off the airport. The SICP should be reviewed and modified, if necessary, to ensure it complements the airport's storm water discharging permit. That is, the SICP should help the airport operator achieve compliance with Federal, state, and local environmental storm water runoff regulations.

Chapter 3. Snow Clearing Operations and Preventive Measures

3-1. Weather Forecasting. Appropriate responses to a winter storm event begin with accurate and timely weather information. A reliable weather forecast not only enhances the effectiveness and efficiency of any SICP, but it offers airport operators operational cost savings associated with snow clearing tasks, chemical usage, and staffing. Airport operators should base their snow clearing operations or preventive measures on weather forecasting that offers continuous, up-to-date, and airport weather-related information. The FAA recommends that airport operators select a weather forecasting approach that offers usable information to airport users as well as to the airport operator. One such approach, the *Weather Support to Deicing Decision Making (WSDDM) System*, is described below.

3-2. FAA Forecasting Research and Development for Airport Operators. The FAA Aviation Weather Research Program began research in the 1990s to fully understand the safety problems faced during winter storm events and to improve decision making by airport operators and air carrier ground operations during these events. The research resulted in the *Weather Support to Deicing Decision Making (WSDDM) System*, an integrated display system that depicts accurate, real-time determinations of snowfall rate, accumulations and their liquid equivalents, temperature, humidity, wind speed, and direction of storm events.

a. Weather Support to Deicing Decision Making (WSDDM) System. The WSDDM System is an automated system that analyzes and forecasts short-term winter weather conditions within the airport vicinity. The data inputs to the system are provided by snow gauges; weather radars, such as Doppler; surface weather stations; and National Weather Service Aviation Routine Weather Report (METAR) data from Automated Surface Observing Systems (ASOS). All data are processed by software algorithms to produce a graphical and text depiction of current weather conditions and a 1-hour forecast of expected snowfall rate and accumulation at the airport. The displayed analyses and forecasts can be easily understood by most users. The graphical data can be generated and displayed on a local computer or viewed online. The system has been effective at major U.S. airports.

The basic version of the WSDDM system, known as Basic WSDDM, is for unidirectional storm fronts. The system has a single snow gauge with a computer display of the current and historical liquid equivalent snowfall rates and accumulation. Airports that routinely encounter multiple storm fronts should use two or more snow gauges. Figure 3-1 shows one type of snow gauge used by WSDDM. Figure 3-2 illustrates the Basic WSDDM schematic for a unidirectional storm configuration.

WSDDM systems must comply with the equipment performance and installation requirements described in Society of Automotive Engineers (SAE) *Aerospace Standard (AS) 5537, Weather Support to Deicing Decision Making (WSDDM), Winter Weather Nowcasting System*. The SAE specification is available for purchase at <http://www.sae.org>.

b. Safety and Operational Benefits. The WSDDM system provides current and 1-hour NOWCAST forecasts (current conditions) of snow bands and surface weather conditions on the

airport and the surrounding 125-mile (200-km) vicinity. The display is optimized to allow airport operators and air carriers to understand (typically within 1 minute) the current weather conditions at the airport and in the surrounding region. This capability allows for more rapid and appropriate decision making during winter storms with minimal impact on airport resources and staff workload.



Figure 3-1. Single Alter Wind Shield Type

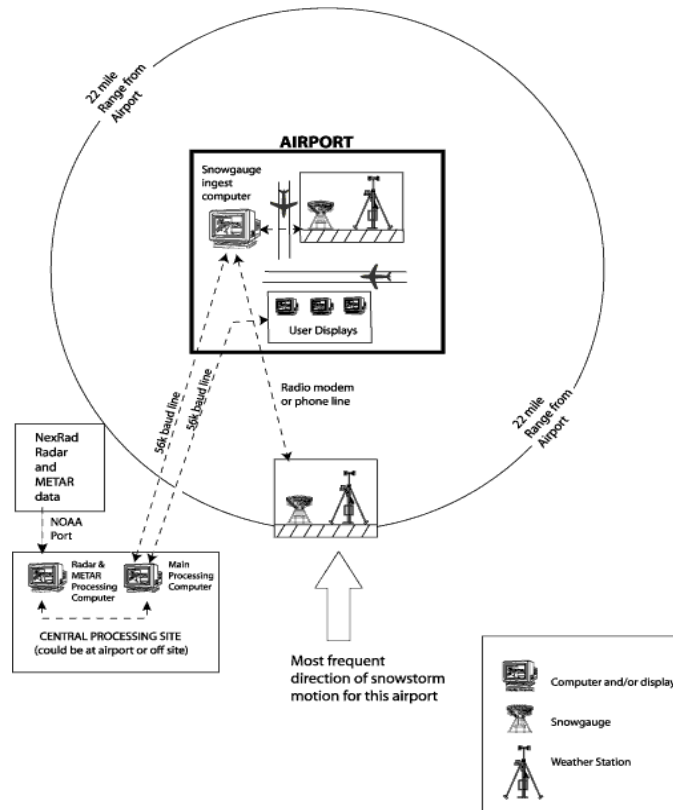


Figure 3-2. Schematic of Unidirectional Storm WSDDM Configuration

(1) Benefits to Airport Operators. Users of WSDDM have reported various operational and cost-saving benefits. WSDDM optimizes runway clearing operations by providing airport operators more accurate information about when a snow band will affect the airport. Accurate timing saves on anti-icers because it allows crews to apply them according to the manufacturer's recommended lead times. In terms of managing crew workloads, WSDDM determines gaps in storm events, which can be used to change crew shifts, take rests, and refill chemical trucks, sand spreaders, and other equipment. Airport operators are also able to more accurately determine when the airport can resume normal operations by examining the radar loops and storm tracks and watching storm trends. By examining the storm tracks, users can make fairly accurate 3- to 4-hour forecasts of snow onset, which, in turn, allow airport operators to prepare more appropriately for winter storms.

(2) Real-Time Liquid Content Forecast. A key safety element of the WSDDM system is the use of one or more precision snow gauges. These snow gauges provide real-time estimates of the liquid equivalent snowfall rate for every minute. This measurement is key to air carrier deicing operations because the deicing community has shown *the liquid equivalent snowfall rate is the key factor leading to the failure of deicing/anti-icing fluids*. The current National Weather Surface METAR stations do not provide this data. Instead, METAR provides hourly snow intensity estimates based on *visibility*. Snow intensity estimates based on visibility have been shown to be misleading when wet snow, heavily rimed snow (snow that has accreted significant amounts of cloud droplets), and snow containing single crystals of compact shape (nearly

spherical) occur. Researchers define the hazard as high-visibility/high-snowfall rate conditions. Recent examination of five of the major airplane ground deicing accidents showed that high visibility-high snowfall rate conditions were present during a number of these accidents. All of the accidents had nearly the same liquid equivalent rate of 0.1 inch/hour (2.5 mm/hour), but widely varying visibilities. The WSDDM System was designed to address this safety concern by including snow gauges to measure liquid equivalent snowfall rate every minute.

3-3. Forecasting Runway Surface Conditions. One proven method of forecasting the surface conditions of runways is to use runway surface condition sensors (RSCS). Two basic types of RSCS are in use today, namely in-pavement stationary sensors and vehicle-mounted infrared sensors. The safety benefit of RSCS is their predictive capability for proactive anti-icing decision making. Since the temperature of pavements lag behind air temperature, the use of air temperature to infer surface conditions is imprecise. Therefore, the use of air temperature is never recommended because it frequently leads to misinformation about the true behavior of pavement surfaces. This inaccuracy can result in inappropriate airfield clearing operations or poorly timed preventive measures. At its worst, this misinformation might result in delays that allow ice to bond to paved surfaces, the hardest condition to rectify. With the exception of freezing rain, ice will not form on pavements unless the pavement temperature itself reaches the freezing point. Therefore, knowledge of the direction and rate of temperature change within a pavement structure provides the predictive capability as to when to expect the formation of ice. The predictive nature of RSCS is particularly valuable as it ensures the timely application of anti-icing (or deicers) chemicals, which provides a cost savings in chemicals, and helps crews make appropriate chemical selections to prevent, weaken, or disbond ice or compacted snow from paved surfaces. Airport operators have at their disposal in-pavement RSCS at pre-determined sites and mobile RSCS that are hand-held or vehicle-mounted to evaluate any pavement.

a. Stationary Runway Weather Information Systems. These stationary sensors provide only site-specific pavement and air temperature trends, dew point temperature, chemical strength, and other atmospheric weather conditions at the installation sites. Sensor information is generally disseminated via a central computer to airport users. An added bonus of in-pavement RSCS is their ability to predict when previously applied chemicals have been diluted sufficiently to require reapplication of chemicals. The FAA recommends that in-pavement RSCS comply with the performance and installation requirements of *SAE Aerospace Recommended Practice (ARP) 5533, Stationary Runway Weather Information System (In-pavement)*. The SAE specification is available for purchase at <http://www.sae.org>.

b. Mobile Infrared Surface and Ambient Temperature Sensor Systems. These vehicle-mounted sensors provide pavement and air temperatures at any desired airfield pavement location. Information is disseminated directly to the viewer or driver of the vehicle-mounted units. Presently, *SAE G-15, Airport Snow and Ice Control Committee*, is in the process of finalizing *SAE ARP 5623, Mobile Infrared Runway Surface and Digital Ambient Temperature Sensor Systems*. Until finalized, FAA recommends that mobile RSCS comply with the performance requirements specified by the United States Air Force specification. The SAE specification, once finalized, will be available for purchase at <http://www.sae.org>.

Chapter 4. Snow Clearing Operations and Ice Prevention

4-1. Introduction. Snow, slush, ice, and standing water **on a runway** impede airplane acceleration by absorbing energy in compaction and displacement, and by impinging on parts of the airplane after being kicked up by the tires. For airplanes decelerating, slush, snow, and standing water-covered pavements and, especially iced surfaces, hamper deceleration rates due to a reduction in the friction coefficient of the runway and the potential for hydroplaning. Large chunks of ice, from refreezing snow or slush, or deposited from aircraft gear during landings, can cause severe damage to tires, engines and airframes. Wet snow, slush, and standing water on a runway can also limit operations due to potential structural damage caused by the contaminants impinging on the airplane at high speed. Although the limits vary for different airplanes, most transport category airplanes are prohibited from operating on runways covered by more than ½ inch of wet snow, slush, or standing water (see AC 91-6A, *Water, Slush, and Snow on the Runway*.) Consequently, these runway surface contaminants should be minimized to maintain safe landing, takeoff, and turnoff operations. For these reasons, snow clearing operations for Priority 1 runway(s), taxiway connectors, and taxiways to the terminal(s) should start as soon as possible after snowfall or icing begins. One prime goal is to take the appropriate measures so snow in its various forms, such as slush or frozen water, does not bond to the pavement. Dry snow falling on cold dry pavements will generally not adhere and may be blown off by wind or airplane operations or removed by brooming operations. In such conditions, only brooming may be needed to prevent the formation of compacted snow tracks. Snow fences may be of use to airports that primarily experience dry snowfalls. Wet snow, however, cannot be blown off the pavement and will readily compact and bond to it when run over by airplane wheels. Consequently, the airport operator will need to implement different clearing and/or preventive measures for wet snow than those used for dry snow conditions. When measures are taken, the airport operator's Snow Control Center (SCC) must (1) maintain close coordination with the ATCT and the Flight Service Station (FSS) or UNICOM to ensure prompt and safe responses to winter storm events and (2) inform the users of the airport when less than satisfactory conditions exist.

4-2. Snow Clearing Principles. Winter conditions and rates of accumulations of precipitation vary widely from airport to airport. However, there are some basic guidelines that apply to all airports that should be followed as closely as possible. The airport operator should notify airport users promptly and issue a NOTAM advising users of unusual airport conditions. Wind speed and direction, available equipment, and local conditions that may require special equipment and techniques collectively determine the snow clearing procedures for the airport's SICP. The following guidance offers a generic outline for writing the SICP that covers ramp/terminal-related items and runway/taxiway-related items.

a. Ramp and Terminal – Clearing Objectives. Accumulations of snow and slush, snow tracks, and thin layers of ice on ramps and airplane parking areas, including holding areas, can make for safety hazards. The SICP should contain measures to mitigate at least the following four common situations:

(1) Slick Ramp Surfaces. Ramp equipment and ramp personnel operating on slick or icy ramp surfaces lack sufficient traction to start, stop, or even remain in place when encountering jet exhaust from surrounding airplanes. Maintaining good traction is critical to the safety of personnel, equipment, and airplanes.

(2) Increased Airplane Engine Thrust. Pilots of parked or holding airplanes must apply increased engine thrust to break away, maneuver, and taxi under adverse ramp surface irregularities, such as frozen ruts formed by tire tracks. The resultant excessive engine blast necessary to overcome such obstacles may damage other airplanes, ramp equipment, or ramp personnel.

(3) Obscured Taxi Signage. The clearing of snow from ramp areas must not be performed in a way that partially or completely covers taxiway signs leading to the airfield with plowed snow. *Observing this precaution will reduce the risk of runway incursions.*

(4) Obscured Terminal Visual Aids. The obscuration of normally visible surface markings or obliterated sign messages could make maneuvering on ramps difficult and slow. Pilots, unable to see these visual aids, are hard pressed to judge direction and taxiing clearances.

(5) Snow Stockpiles Adjacent to Airplane Operating Areas. Airport operators should exercise care when moving snow from the ramps and terminals toward taxiways and runways. Depending on the amount of snow cleared and the size of the ramp, ramp signage directing pilots toward the runway could become obscured (covered with snow), and the resulting height of snow stockpiles could cause a clearance issue between taxiing airplanes and the snow stockpile. Airports that experience heavy snowfalls and have large ramps with limited space for stockpiling snow should consider operating snow melters or hauling snow away.

b. Runway and Taxiway Suggested Clearing Objectives. The following guidance should not be interpreted to require specific equipment at any airport. It is presented to show efficient use of various equipment to optimize snow clearing operations. Some types of equipment may not be appropriate for some airports. Equipment and procedures used must be determined based on many factors, including but not limited to climate, number and types of operations, airport staffing, and the airport budget.

(1) Focus runway snow clearing operations on keeping the entire primary runway(s), as near as practicable, bare from snow accumulations or ice buildup. Depending on precipitation rate, the time required to clear the full width of the runway may result in additional accumulation, and thus less braking capability, on the critical center portion. In such a case, concentrating clearing operations on the center portion can result in greater safety. The minimum width required will vary by airplane type, but is generally 100' for transport category airplanes. The airport operator should check with airport users regarding their minimum runway width requirements.

(2) Depending on the equipment fleet, etc., some operations will start at the center of the runway and work outward to the shoulders.

(3) Use sweepers or brooms initially to keep the primary runway or its center portion, as near as practicable, bare of accumulations. Also, when snow has melted or ice begins to separate from the pavement due to the action of chemicals, sweepers or brooms should be used to remove the residue. As soon as snow has accumulated to a depth that cannot efficiently be handled by the sweepers or brooms, displacement plows and rotary plows (snow blowers) should be used as follows.

(i) Use displacement plows, in tandem if more than one, to windrow snow into a single windrow that can be cast over the edge of runway lights by a rotary plow.

(ii) For runways or other paved areas with in-pavement surface condition sensors, remove any snow or ice that affects the performance of the remote sensors.

(iii) Regarding the use of displacement plows, ice and snow will always melt around runway centerline and touchdown zone light assemblies. However, under cold temperatures, ice rings, termed “igloos,” tend to form around them. In order to prevent damage to lights, use appropriate polyurethane cutting edges or shoes and casters on plow moldboards and on the front of rotary plows.

(iv) Rotary plows should throw snow a sufficient distance from runways/taxiways edges so adequate clearance is available between airplane wings and engine nacelles and the cast snow banks. Figure 4-1 shows desired maximum snow height profiles, which are based on airplane design groups.

(4) Obscured visual aids—in particular in-pavement and edge lights, taxiways, runway markings (such as touchdown marking), airport guidance signs, and runway end identification lights (REIL), precision approach path indicator (PAPI) or visual approach slope indicator (VASI) — need to be maintained free of snow and ice.

(5) All drivers must maintain a safe distance between equipment operating in echelon (i.e., V-formation, close wing formation) in order to avoid accidental contact or accidents.

(6) A covering of snow and ice or drifts may affect visual and electronic NAVAIDs. Any snow or ice that affects the signal of electronic NAVAIDs should be removed. When clearing with rotary plows and displacement plows, special procedures need to take into account the location of all NAVAIDs, especially to protect the guidance signal of instrument landing systems (ILS). The SICP needs to address the following situations:

(i) Glide slope critical ground areas along the runway require that snow depths be limited in height to prevent signal loss or scattering. Figure 4-2 provides graphic representations of the glide slope ground snow clearance areas with prescribed snow depth limitations according to type of facility and aircraft approach category. When snow depths exceed the specified depth limitations, minima are raised to the “localizer only” function until the conditions revert or are corrected. Two consecutive pilot reports of glide slope signal malfunctions generally result in raised minima (a NOTAM must be issued by the owner of the NAVAID). A few additional points should be considered. First, the 200-foot width dimension adjacent to the threshold might

be wider for an antenna mast placed further out (see FAA Order 6750.49, *Maintenance of Instrument Landing System (ILS) Facilities*). Second, the snow clearance areas illustrated in the figures are minimal in size. Third, snow clearing activities should not allow snow banks, mounds, or ridges exceeding 2 feet to be placed along the edges of the prescribed snow clearance areas. Fourth, snow banks should not be placed off the approach ends of runways, especially for CAT II/III operations.

Note: Snow banking operations need to take into account the guidance in Figure 4-2.

(ii) Visibility of signs (legibility) and lights should be maintained by certain prescribed clearing techniques or by performing post-clearing maintenance. Maintaining visibility can be better achieved by taking into account wind directions. For example, in crosswind conditions, cast in the downwind direction. Figures 4-3 through 4-5 provide general guidance.

(iii) The snow depth height limitations noted in Figure 4-2 do not take into consideration airplane characteristics. That is, at some airports, airplane characteristics, such as engine clearances, may dictate lower snow banks than shown in Figure 4-2. The objective here is prevention by avoiding the introduction of hazardous snow banks, drifts, windrows, and ice ridges that could come into contact with any portion of the airplane wing or nacelle surface.

(7) Upon completion of snow clearing operations, runway friction measurements should be taken to assess the effectiveness of the snow clearing operation. See Chapter 5 for recommended procedures.

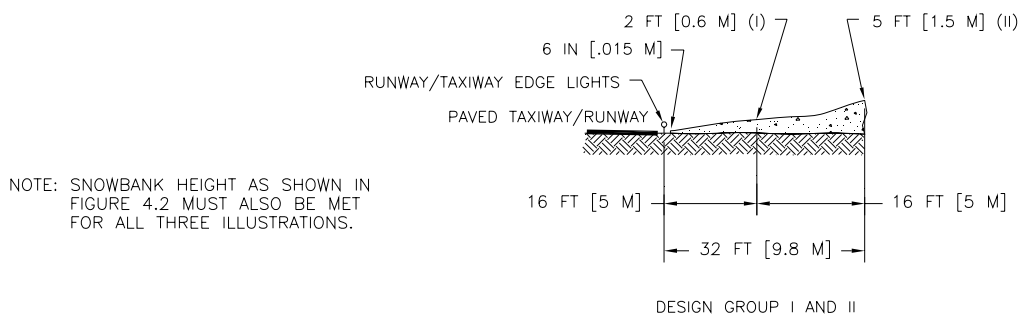
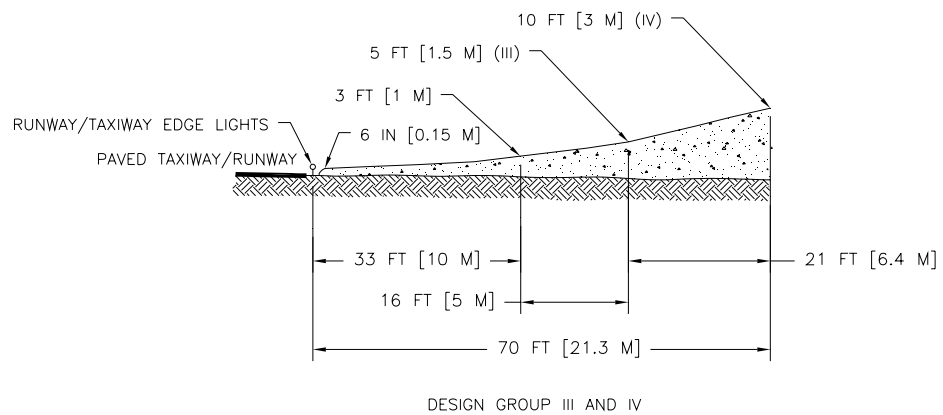
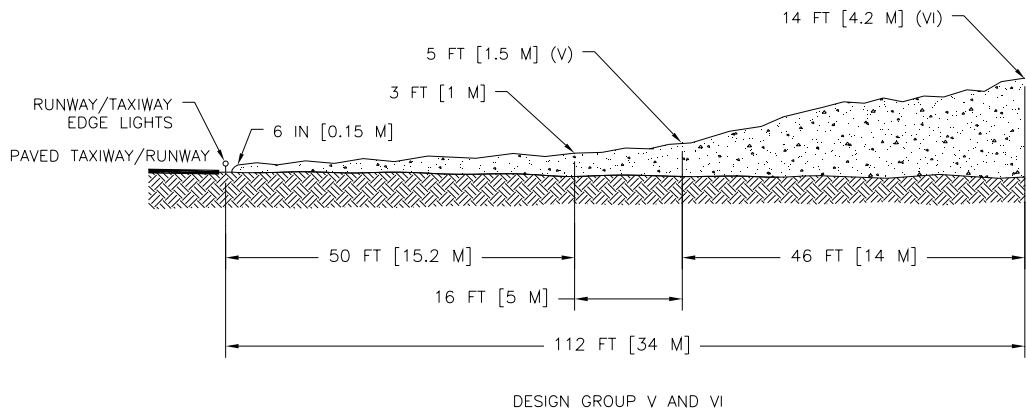
(8) If the airport's operation involves the use of snow banks, their height profiles should be compatible with NAVAID ground requirements and offer sufficient clearance between airplane wings and engine nacelles to avoid structural damage to jet and propeller airplanes. Figure 4-1 shows desired maximum snow height profiles, which are based on airplane design groups (see AC 150/5300-13, *Airport Design*, for airplane design group categories.) Snow banking along terminal or cargo aprons likewise should comply with Figure 4-1 to prevent operational problems caused by ingestion of ice into turbine engines or by propellers striking the snow banks. Appendix 1, which used numerous airplane models, was used to develop criteria for figure 1.

(9) If the runway pavement temperature is warm enough for snow to compact and bond or if freezing rain is forecasted, approved anti-icing chemicals and/or heated sand should be applied prior to the start of precipitation or as soon as precipitation starts. Some airport operators prefer to apply deicing chemicals rather than anti-icing chemicals for different weather conditions. Paragraph 4-6 provides a listing of approved fluid and solid material specifications.

(10) All snow removal units operating in aircraft movement areas must maintain radio communication with the ATCT, if one exists, or be under the direct control of a designated supervisor who in turn is in direct communication with the ATCT.

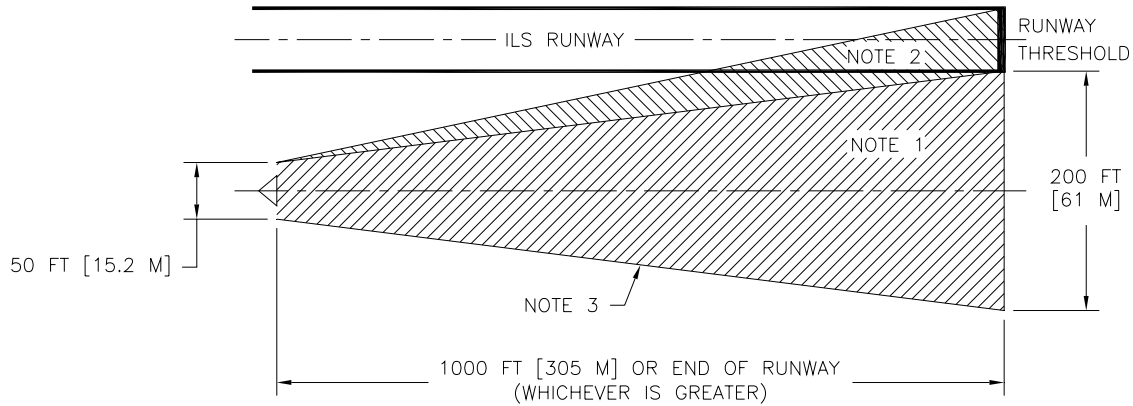
(11) High-speed runway turnoffs require the same attention for ice and snow control and removal as runways. These turnoffs should offer sufficient directional control and braking action for airplanes under all conditions. Accident data clearly illustrate that poor attention to high-speed runway turnoffs contributes to veer offs.

(12) Joint-use airports with military operations may have arresting barriers located near the end of the runway or at the beginning of the overrun areas. Great care should be taken in clearing snow from the barriers. Barriers located on the runway should be deactivated and pendants removed prior to snow removal operations. Snow should be removed to the distance required for effective run-out of the arresting system.



NOTE: SNOWBANK HEIGHT AS SHOWN IN FIGURE 4.2 MUST ALSO BE MET FOR ALL THREE ILLUSTRATIONS.

Figure 4-1. Snow Bank Profile Limits Along Edges of Runways and Taxiways with the Airplane Wheels on Full Strength Pavement (see Figure 4-2 guidance)



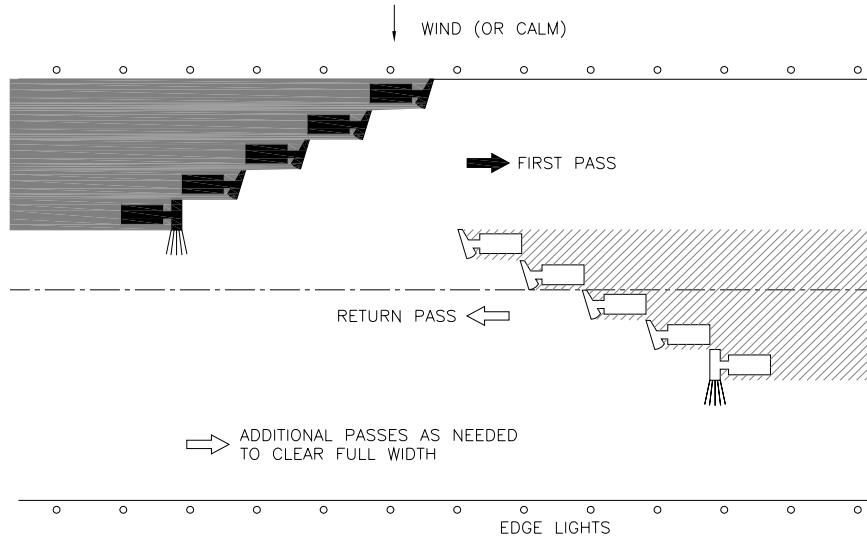
NOTES:

1. CATEGORY I GLIDE SLOPE SNOW CLEARANCE AREA.
2. CATEGORY II AND III GLIDE SLOPE SNOW CLEARANCE AREA. THE AREA DEPICTED UNDER NOTE 1 SHALL ALSO BE CLEARED.
3. THE DEPTH OF SNOWBANKS ALONG THE EDGES OF THE CLEARED AREA SHALL BE LESS THEN 2 FEET.

ACTION TAKEN	SNOW DEPTH		
	SBR <6 IN [15 cm] NR. CEGS <18 IN [45 cm]	SBR 6 TO 8 IN [15 TO 20 cm] NR. CEGS 18 TO 24 IN [45 TO 60 cm]	SBR >8 IN [20 cm] NR. CEGS <24 IN [60 cm]
SNOW REMOVAL (SEE ABOVE FIGURE)	REMOVAL NOT REQUIRED RESTORE FULL SERVICE AND CATEGORY.	ILS CATEGORY I REMOVE SNOW 50 FT [15M] WIDE AT MAST WIDENING TO 200 FT [60M] WIDE AT 1000 FT [300M] OR END OF RUNWAY TOWARD MIDDLE AMRKER. ILS CATEGORIES II AND III AS ABOVE PLUS WIDEN THE AREA TO INCLUDE A LINE FROM THE MAST TO THE FAR EDGE OF RUNWAY THRESHOLD.	
NO SNOW REMOVAL	RESTORE FULL SERVICE AND CATEGORY.	ALL CATEGORIES RESTORE TO CATEGORY I SERVICE. CATEGORY D AIRCRAFT MINIMA RAISED TO LOCALIZER ONLY. TYPICAL NOTAM TEXT: "DUE TO SNOW ON THE IXXX (APPROPRIATE IDENTIFER) GLIDE SLOPE, MINIMA TEMPORARILY RAISED TO LOCALIZER ONLY FOR CATEGORY D AIRCRAFT" IF APPLICABLE, "CATEGORY II NA"* OR "CATEGORY II/III NA".	ALL CATEGORIES APPROACH RESTRICTED TO LOCALIZER ONLY MINIMA. TYPICAL NOTAM TEXT: "DUE TO SNOW ON THE IXXX (APPROPRIATE IDENTIFER) GLIDE SLOPE, MINIMA TEMPORARILY RAISED TO LOCALIZER ONLY.

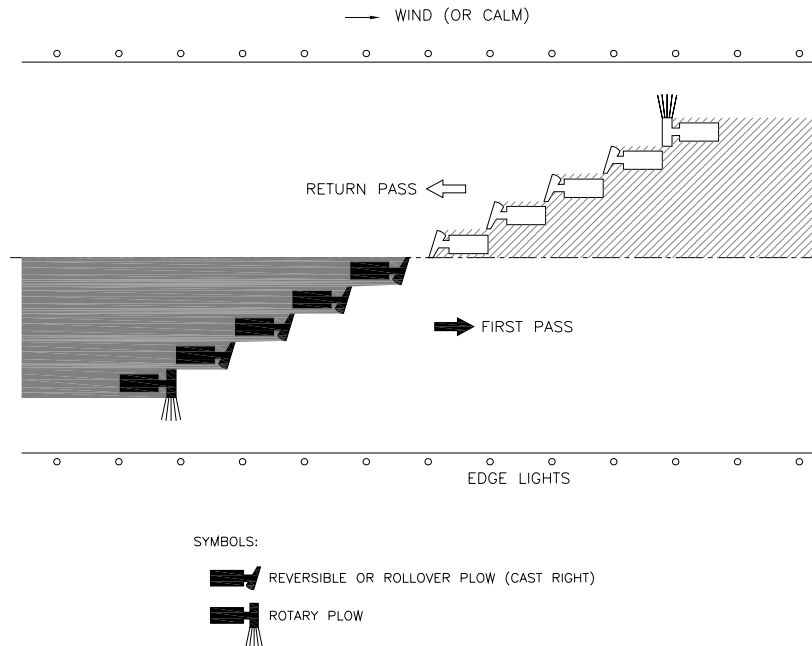
* NA (NOT AUTHORIZED)

Figure 4-2. ILS CAT I and CAT II/III Snow Clearance Area Depth Limitations



- SYMBOLS:
- REVERSIBLE OR ROLLOVER PLOW (CAST RIGHT)
 - REVERSIBLE OR ROLLOVER PLOW (CAST LEFT)
 - ROTARY PLOW

Figure 4-3. Possible Team Configuration with Perpendicular Wind (Dependent upon Rotary Plow performance)



- SYMBOLS:
- REVERSIBLE OR ROLLOVER PLOW (CAST RIGHT)
 - ROTARY PLOW

Figure 4-4. Possible Team Configuration During Light Snowfall with Parallel or Calm Wind (Dependent upon Rotary Plow performance)

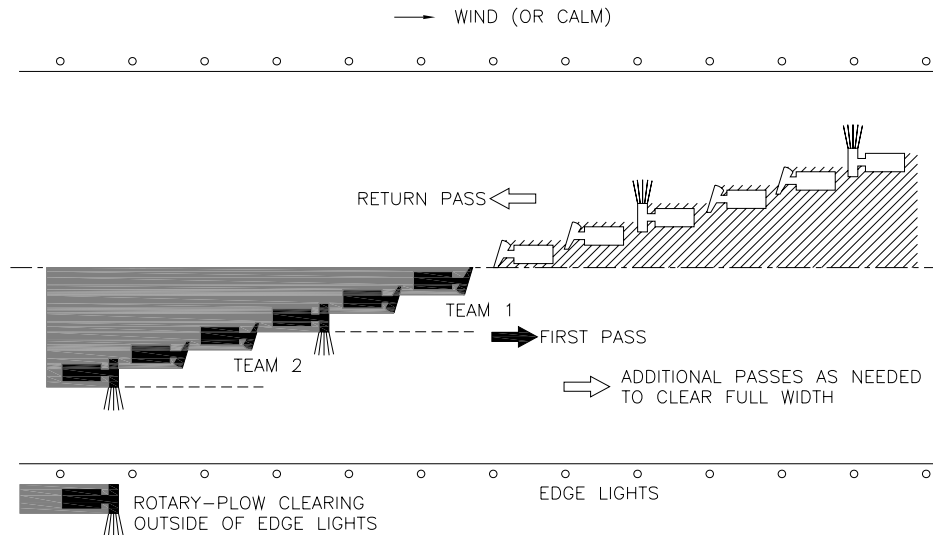


Figure 4-5. Possible Team Configuration During Medium to Heavy Snowfall with Parallel or Calm Wind (Dependent upon Rotary Plow performance)

c. Surface Incident/Runway Incursion Mitigation Procedures. The FAA strongly recommends the SICP contain specific safety procedures or a separate written section to mitigate the possibility for surface incident/runway incursions. These specific safety procedures should provide answers to, at minimum, the following two questions: (1) How can pilots of small or large airplanes or vehicle drivers traversing the airfield cause a runway incursion because of our snow clearing operations? and (2) How do snow operation personnel at either non-towered airports or airports with less than 24-hour ATCTs monitor information released by the ATC enroute center? The procedure addressing the latter questions should apply even if a NOTAM has been issued closing the runway for snow clearing operations. This precaution is especially important during marginal visual meteorological condition (VMC). The SICP should address the following topics:

(1) Radio Communications. Equipment operations must be timed carefully and coordinated properly with team members to ensure an orderly turnaround for safe return and start of a new pass. The SICP should designate a lead operator for each shift who maintains contact with his team members and the ATCT. At airports lacking an ATCT or when the tower is closed, proper radio communications must be maintained at all times and in accordance with SICP procedures. Consideration should be given to providing vehicle operators with headphones to minimize ambient noise disruption from vehicular noise.

(2) Failed Radio Signals. The SICP must outline specific procedures when radio signal is lost between crews and when a single driver loses radio signal. All drivers must be trained in the specific procedures to follow.

(3) Airfield Signage and Lights. Airfield and ramp signs must be kept clean of plowed or cast snow to maintain the legibility of signage. Priority should be given to lights and signs

associated with holdlines, direction and location signs, and ILS critical areas. Common methods to remove snow from signs include using a truck mounted with an air-blast unit, spraying the faces of signs with an approved liquid deicer, or hand shoveling.

(4) Low Visibility and Whiteouts. It is of utmost importance to maintain visual contact with your surroundings during snow clearing operations, especially for operations in an echelon formation. The SICP must specify procedures to follow if visibility suddenly drops to near zero or whiteout conditions exist while clearing operations are in progress. For example, the airport operator may require that all equipment stop immediately with all drivers radioing in their positions to the designated supervisor or to ATCT for runway evacuation instructions.

(5) Driver Fatigue. Consideration should be given to monitoring the “*windshield time*” of drivers (length of shift) operating snow removal equipment because operator fatigue could become a contributing factor for runway incursions. In response, some airport operators have implemented limits on driver operating hours.

4-3. Controlling Snow Drifts. Preventing snow from drifting onto operational areas at airports receiving severe winter storms reduces the duration and frequency of snow clearing operations. Two methods for controlling drifts are described below.

a. Snow Fences. Snow fences that are properly designed and located can reduce windblown snow across airfields. Experience at a particular airport is the most helpful in determining optimum locations for snow fences. The following precautions and guidance are provided:

(1) Prior to any installations, the airport operator must contact the nearest Air Traffic technical operations control center of any planned installations in the vicinity of a NAVAID system. Failure to remove snow or the introduction of snow in areas adjacent to NAVAID systems could result in erroneous signal guidance or facility shutdown.

(2) Snow fences should be located upwind of the area to be protected.

(3) A study conducted by the U.S. Department of Agriculture showed 12-foot (3.7-m) high fences were generally most effective. Shorter heights can be and usually are necessary on airport property, since snow fences must not penetrate any critical surfaces or be located inside the runway safety area or the runway object free area, as defined in AC 150/5300-13.

b. Snow Trenches. Snow trenches that catch and store drifting snow have been used at times by airports with heavy snowfalls. This approach is considered an expedient way to control snow from drifting after it has been cleared to the edge of the runway. Multiple trenches spaced longitudinally about 10 feet (3 m) apart running parallel to the runway can store more snow. A trench should be excavated no closer than 50 feet (15 m) from the runway. Figure 4-6 illustrates typical snow trench formation relative to wind direction.

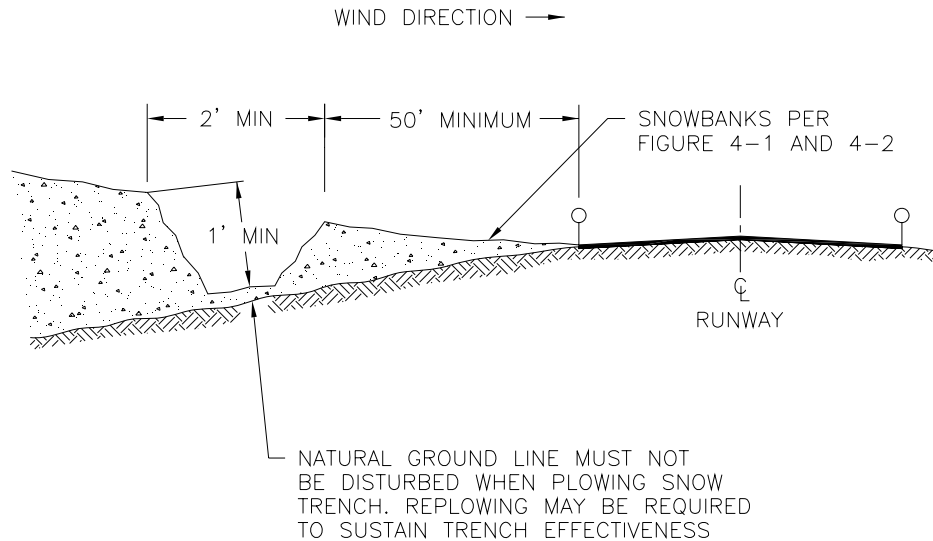


Figure 4-6. Typical Snow Trench Dimensions

4-4. Snow Disposal. The SICP should also specify how and where large quantities of snow are to be disposed. Two common approaches are as follows:

a. Melting Pits or Portable Melters. A variety of snow and ice melters are in use at various airports that deal with large snow falls and for the environmental mitigation of deicer chemicals. This approach may be an economical viable solution to expensive snow hauling services. In contrast, melters eliminate the need for convoys of trucks to enter and exit secured airport areas, i.e., a lesser security risk. Environmentally, contaminants within the snow are retained for proper disposal. Portable melters in comparison to melting pits can be conveniently setup at various melting sites instead of having to transport collected snow to a designated snow hauling area(s).

b. Identifying Disposal Sites. If there is insufficient space for storing snow near areas to be cleared and no melting or flushing means are available, hauling to a disposal site may be necessary. If deemed necessary, the disposal site should be selected before winter sets in and identified in the SICP. The selection process should at least consider the following: (1) disposal sites do not compromise airplane operations, airport NAVAIDs, airport traffic, and ATCT operations such as ATCT line-of-sight requirements; (2) sites have adequate drainage capability; and (3) sites offer, if required, environmental mitigation of captured chemicals.

4-5. Methods for Ice Control and Removal. Preventing a bond from occurring between ice and the pavement surface is always preferred over the mechanical removal or melting of the bonded ice. Appendix 2 provides the characteristics of ice and other forms of snow and other details about handling problems. Paragraph 4-6 provides the FAA-recommended chemical specifications for approved airside anti-icer and deicer products. Prevention is achieved by applying *approved* anti-icing chemicals to pavements with temperatures expected to go below 32° F (0° C). Fluid anti-icing products instead of solid anti-icing products are recommended since the liquid form is more effective in achieving uniform distributions and improved

chemical-adhesion to the pavement surface. The primary drawback of solid chemicals on cold pavements is their inability to adhere properly to the surface, which can lead to their being windblown or scattered about.

Once the ice has bonded to the pavement surface, the airport operators may use approved deicers to melt through the ice pack to break up or weaken the ice bond; increase the frictional characteristics of the surface, for example, by applying heated sand; or use mechanical means, such as plowing with under-body scrapers or scarifying the ice surface to break the ice packs. The type of brooms used to remove a layer of ice is important since in some cases the broom may actually “polish” the ice, thus reducing traction. Steel bristles are better than poly bristles since one “cuts” the ice surface while the other “flips” snow. Paragraph 4-7 provides guidance on methods to improve the frictional characteristics of surfaces, and Paragraph 4-8 provides the FAA recommended sand gradation for runway and taxiway usage.

4-6. Approved Chemicals.

a. Airside Chemicals. The FAA either establishes approval specifications or, upon acceptance, references the specifications of professional associations, such as SAE Aerospace Material Specifications (AMS), and the U.S. military (MIL-SPEC). The approved airside chemicals for runway and taxiway applications are fluid and solid products meeting a generic SAE or MIL specification. These specifications require vendors to provide airport operators with a lab certification stating the chemical conformed to the applicable specification and a material safety data sheet (MSDS) for handling the product. With the increased accountability placed on airport operators to manage deicing/anti-icing chemical runoff, they should request vendors to provide certain environmental data. These data consist of information on pollutants the Environmental Protection Agency and the State Department of Natural Resources request of the airport operators in their discharge reporting requirements. Typically, the information includes percent product biodegradability, biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), pH, presence of toxic or hazardous components, if any, and remaining inert elements after application. MSDSs provide measures on how to secure large product spills and a 24-hour toll-free emergency phone number. While these fluid and solid specifications cover technical requirements for deicing/anti-icing products, they do not address the compatibility issue of combining products during operations. Airport operators, therefore, should query manufacturers about the safe and proper use of concurrently applying multiple deicers/anti-icers. The FAA-approved airside chemical specifications, which may be restricted by state or local environmental regulations, are as follows:

(1) Fluid Deicer/Anti-icers. The approved specification is SAE AMS 1435, *Fluid, Generic Deicing/Anti-icing, Runways and Taxiways*. Approved products include glycol-based fluids, potassium acetate base, and potassium formate-based fluids. The SAE specification is available for purchase at <http://www.sae.org>. Application rates for a specific product are based on manufacturer recommendations. In terms of material cost-savings, less product is used by anti-icing operations than by deicing operations.

(2) Solid Deicer/Anti-icer.

(i) **Generic Solids.** The approved specification is SAE AMS 1431A, *Compound, Solid Runway and Taxiway Deicing/Anti-icing*. Approved solid compounds include airside urea, sodium formate, and sodium acetate. It is noted that, in comparison to airside urea, sodium formate and sodium acetate products continue to be effective for much colder pavement temperatures. 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 1-9, which is approximately 11° F (-12° 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 rates for a specific product are based on manufacturer recommendations.

(ii) **Airside Urea (or "Carbamide").** The approved specifications are SAE AMS 1431A, *Compound, Solid Runway and Taxiway Deicing/Anti-icing*, and MIL SPEC DOD-U-10866D, *Urea-Technical*. Agricultural grade urea that meets any of these specifications, called airside urea, is acceptable. This nontoxic solid white chemical comes in either powder or "shotted" ("prilled") form. The latter form's shape is small spheres of about 1/16 inch (1.5 mm) in diameter. Both forms are primarily for deicing, where powdered urea is frequently mixed with sand. Hot mixtures of powder or "shotted" urea and sand are used by airport operators for 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. Table 4-1 provides guidance on application rates in relation to pavement temperature and ice thickness.

Table 4-1. Guidance for Airside Urea Application Rates

Ice Thickness Inch (cm)	Temperature Degree F (°C)		
	30 (-1.1)	25 (-3.9)	20 (-6.7)
Less than 1/32 (0.08)	0.016 (0.078)	0.023 (0.11)	0.06 (0.29)
1/32 up to but not including 1/8 (0.08 - 0.32)	0.03 (0.15)	0.06 (0.29)	0.125 (0.61)
1/8 (0.32) to 1/4 (0.32 - 0.64)	0.125 (0.61)	0.175 (0.86)	0.275 (1.34)

b. Landside Chemicals. The most effective landside chemicals used for deicing/anti-icing in terms of both cost and freezing point depression are from the chloride family, e.g., sodium chloride (rock salt), calcium chloride, and lithium chloride. However, *these chemicals are known to be corrosive to aircraft and therefore are prohibited for use on aircraft operational areas*. When any corrosive chemical is used, precautions should be taken to ensure that (1) vehicles do not track these products onto the aircraft operational areas and (2) chemical trucks

used for transporting corrosive chemicals are cleaned prior to transporting airside chemicals or sand. It is noted that although the solids sodium acetate and sodium formate and the fluids potassium acetate and potassium formate products are classified as salts, those that contain corrosion inhibitor packages to comply with an SAE specification are approved for airside applications.

c. Environmental and Pavement Aspects of Anti-icing and Deicing Chemicals.

(1) Deicing/anti-icing chemicals commonly used on airfields and for aircraft degrade rapidly due to chemical and biological processes. These processes often cause a large drop in the dissolved oxygen levels of receiving waters off the airport. It has been suggested that the resultant dissolved oxygen levels are too low to support healthy biotic communities occupying those water bodies. Although low temperatures and dilution from heavy snow runoff during periods of use minimize the effects of low dissolved oxygen, and the ammonia from decomposing urea quickly dissipates, it is wise to consult with an agency having expertise in water quality. This consultation should highlight best management practices or best available technology for effectively meeting storm water permit conditions established to protect the water quality of aquatic life in receiving waters.

(2) All freezing point depressants can 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 one year after placement. Concrete meeting the compressive strength outlined in ASTM C 672, *Scale Resistance of Concrete Surfaces Exposed to Deicing Chemicals*, will perform well when subjected to chemical deicers. Certain PCC runways may experience excessive alkali-silica reaction that causes accelerated deterioration and cracking. Proper selection of aggregates and the use of additives can mitigate this occurrence in new PCC runways. Coatings for existing PCC runways are being researched to determine their effectiveness in mitigating this occurrence. No surface degradation of asphalt concrete has been observed from approved chemicals.

4-7. Runway Friction Improvements. 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 an anti-icing/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 a surface treatment of the ice or snow. It is emphasized that heated sand is not a deicing chemical and will not remove ice or compacted snow. In fact, heavy applications of heated sand can insulate the ice and therefore prolong its presence.

a. Pavement Surface Modification. Surface texture and surface treatment 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 anti-icing/deicing chemicals, reduce loss, and prolong their actions. Grooves also assist in draining melt water and preventing 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 grooving 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 may need to 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 sand accumulates in the voids and plugs them.

b. Surface Treatment. This is the approach taken to rapidly increase the frictional coefficient of an ice surface. Two methods are generally used by airport operators, namely applying coarse granular material (heated sand) or scarifying or breaking up the ice surface with a serrated blade.

(1) Sand. Granular material provides a roughened surface on ice and thereby improves airplane directional control and braking performance. Use of sand should be controlled carefully on turbojet movement areas to reduce engine erosion. If the granules do not embed or adhere to the ice, they will likely be ingested into engines and/or blown away by wind or scattered by traffic action and thus serve no useful function. This is particularly the case when unheated sand is applied to 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 sand: (1) it can be heated to enhance embedding into the cold surface; (2) the granules can be coated with an approved deicing chemical in the stockpile or in the distributing truck hopper; or (3) diluted 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 further treatment. 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 sand has passed, treated pavements should be swept as soon as air traffic volume allows to remove the residue to prevent engine damage. Other factors to consider when deciding to apply sand are pavement and air temperatures and frequency of operations. The use of other abrasives, such as slag, is not recommended since some metal-based slags may affect engine components.

(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 should only be employed when very low temperatures prevent rapid chemical action or mechanical removal. The grooves trap sand or chemicals and hence contribute to improving the surface friction characteristics and melting action.

4-8. Sand.

a. Material. All sands do not perform the same. In general, the greater the quantity of sand applied, the greater the increase in traction. Fine sands show superior performance on warmer ice (>20° F (-7° C)), while coarser sands show superior performance on colder ice (<15° F (-9° C)). For the purpose of this AC, sand retained on a #30 sieve is considered “coarse”, and sand passing through a #30 sieve is considered “fine”. The FAA recommends that airport operators inform tenant airlines about the material used on the runways.

Note: Slag material is not recommended because engine manufacturers have reported problems with internal engine components, especially for certain types of metal slags.

(1) Standard Gradation. Table 4-2 provides the standard gradation for sand. Materials applied to aircraft movement surfaces must consist of washed granular mineral sand particles free of stone, clay, debris, slag, chloride salts, and other corrosive substances. The pH of the water solution containing the material must be approximately neutral (pH 7). Material must meet the following gradation using a U.S.A. Standard Sieve conforming to *ASTM E 11-81*. The upper and lower sand gradations are in response to engine manufacturers input that finer sized sand from time to time produced hard snowballs while coarser sized sand damaged engine components. The later case additionally causes damage to the fuselage.

Table 4-2. Standard Gradation for Sand

Sieve Designation	Percent by Weight Passing
8	100
80	0-2

(2) Recommended Gradation. Table 4-3 provides an expanded sand gradation standard for optimum performance on both warm and cold ice conditions by balancing fine and coarse particles. For this reason, the inclusion of the #30 sieve beyond that required by the FAA standard gradation of Table 4-2 is recommended. Airport operators may modify these recommended gradation requirements to suit their needs, as long as the gradation meets the requirements of table 4-2.

Table 4-3. Expanded Sand Gradation Standard

Sieve Designation	Percent by Weight Passing
8	100
30	20-50
80	0-2

b. Application. Hard silica sand provides the greatest increase in traction and remains effective the longest when compared to softer materials because of its resistance to fracture. However, it is also very abrasive and, therefore, more potentially damaging to airplane engines. Limestone is softer and may be used where available if abrasion needs to be reduced. Tests have shown that application rates of 0.02 - 0.10 lb/ft² (0.1 - 0.5 kg/m²) of sand will substantially increase the runway friction coefficient. The greater quantity is required at temperatures approaching 32° F (0° C), the amount decreasing as the temperatures drops. Fractured particles provide some advantage in traction enhancement but not enough to justify much of a difference in cost. In terms of color, darker sands are preferred over light-colored sands to offer visual verification where sand has been applied.

c. Chemically or Heat-treated Sand. The FAA recommends that sand be heated or treated with approved chemicals to make it adhere better to ice or compacted snow, thereby minimizing the possibility of airplane engine ingestion and preventing loss of material (see 14 CFR Section 139.313(b)(3).) At temperatures above 15° F (-9° C), a solution of airside urea may be used; below this temperature, other approved fluids will be more effective. Airport operators report that approximately 8 to 10 gallons (30-40 l) of fluid chemical are required to coat one ton of sand. The most effective method of applying the chemical is to spray it on granules as they drop onto the spinner mechanism of a material spreader since wetting is more thorough than pouring the chemicals onto the stockpile or the hopper load. Below 0° F (-18° C), heated sand can be more effective because of more rapid adhesion of the granules to ice. If sand will be heated, a coarser mixture (#30 sieve is considered “coarse”) should be used, as fine particles cool too rapidly on dispersal before hitting the ice. Sands heated to 80° F (27° C) or higher adhere well to ice.

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Chapter 5. Runway Surface Assessment and Reporting

5-1. Introduction.

a. Background. The Snow Control Center (SCC) must be aware of the surface conditions of all aircraft movement areas in order to plan and carry out appropriate maintenance actions or to close a runway, taxiway, or ramp area to aircraft use. Assessing and reporting the surface condition of a runway poses a particular challenge for an airport operator and is of the utmost importance to airport users. Pilot braking action reports are the source of braking action information most accepted by pilots, but they can vary significantly, even when reporting on the same contaminated surface conditions, and obviously only apply to the portion of the runway where braking occurred. The use of a truck or automobile to estimate airplane braking action is also subjective. Research by the FAA at one time indicated that measurements using approved friction measuring devices would provide pilots with an objective assessment of the braking action that could be expected on the runway, but later research has not been able to identify a consistent and usable correlation between those measurements and airplane braking performance. Thus, this advisory circular contains significant changes to FAA recommendations regarding reporting of friction values.

b. Providing information to pilots. The goal in reporting runway surface conditions is to provide pilots with the best information available to ensure safe operations. Currently, there is no objective type of measurement of runway surface condition that has been shown to consistently correlate with airplane performance in a usable manner to the satisfaction of the FAA. Pilots and airplane operators are expected to use all available information, which should include runway condition reports as well as any available pilot braking action reports, to assess whether operations can be safely conducted. Although the FAA no longer recommends providing friction measurements to pilots for the reasons stated in the paragraph above, some airport users still consider runway friction measurement values to be useful information for tracking the trend of changing runway conditions. Therefore continued transmittal of Mu values is permissible with the understanding that the particular numerical value has no particular significance other than to provide changing runway condition trend information when associated with previous or subsequent runway friction measurement values. Airport operators are cautioned against using Mu values as their sole indicator of winter runway slipperiness. Additionally, note the U.S. movement to the use of the ICAO term “medium” instead of the term “fair.” Until the transformation to ICAO terminology is complete, this AC will express the term as “medium (fair).”

c. Runway closures. The previously accepted philosophy of the aviation industry was that the airport operator was obligated to provide an accurate description of the runway conditions, and it was solely up to the pilot to decide if the runway was safe for use. Accident data do not support such a philosophy, and FAA Flight Standards Service has determined that operations on runways reported as having NIL braking are inherently unsafe. Admittedly, this is a conservative approach considering the variation in pilot braking action reporting, but considering the possible consequences of ignoring a NIL braking action report, requirements for closure of runways are presented in paragraph 5-6 below.

5-2. Runway Condition Reporting. The SCC needs to carefully monitor changing airfield conditions and disseminate information about those conditions in a timely manner to airport users. Part 139 requires affected airport operators to issue prompt notification, in accordance with section 139.313(b), to all air carriers using the airport when any portion of the movement area normally available to them is less than satisfactorily cleared for safe operation by their aircraft. In addition, SICPs must contain provisions for informing all airplane operators of any pavement condition that is worse than bare and dry. It is imperative that the field condition report contain accurate and timely information. For example, the type and depth of contaminant is critical information to airplane operators. Also, the determination of dry versus wet snow or slush condition is another key element in the report because of its potential for significant impact on an airplane's takeoff and landing performance capabilities.

Because runway surface conditions can change quickly, either due to weather conditions or corrective actions taken to mitigate such conditions, NOTAMs describing the runway surface conditions must be *timely*. The FAA recommends that airport operators review their reporting method and procedures so their SICP procedures are conducive to timely reporting. For airports, particularly smaller airports, that do not monitor weather conditions between certain hours due to staffing limitations, the issued NOTAM should contain text indicating that "*airfield surface conditions are not monitored between the hours of 'x - y'.*" This additional text helps to avoid erroneous condition assessments by users of the information.

a. How to Report Runway Conditions. Whenever a runway is contaminated by ice, snow, slush, or standing water, the airport operator is responsible for providing current runway surface condition reports. Report runway surface conditions in terms of contaminant types and depths (except do not report depths for compacted snow and ice, and for standing water or slush depths less than 1/8 inch). When the cleared runway width is less than the full runway width, also report the conditions on the uncleared width (runway edges) if different from the cleared width.

b. When to Issue New Runway Condition Reports. Runway condition reports must be updated any time a change to the runway surface condition occurs. Changes that initiate updated reports include weather events, the application of chemicals or sand, or plowing or sweeping operations. Airport operators should not allow airplane operations on runways after such activities until a new runway condition report is issued reflecting the current surface condition(s) of affected runways. At certificated airports, such changes to the runway surface condition must be updated and appropriately disseminated so airplane operators are aware of the current conditions before continuing with their operations. During active snow events or rapidly changing conditions (e.g., increasing snowfall, rapidly raising or falling temperatures) airport operators are required to maintain a vigilant runway inspection process to ensure accurate runway condition reports. While pilot reports (PIREPs) of braking action provide valuable information, these reports may not apply to the full length of the runway as such evaluations are limited to the specific sections of the runway surface in which the airplane wheel braking was used. In addition, runway condition reports should be updated at least at the beginning of each shift of operations personnel.

c. Airport Records and Log Controls. The SICP should include procedures to keep and maintain a log of NOTAMs that the airport operator issues. Reviewing NOTAM status should be a checklist item anytime the runway condition changes from that previously contained in the

NOTAM and at the change of each shift of airport operations personnel. Also, retain a copy of the NOTAM as submitted and as transmitted for future reference and to demonstrate regulatory compliance when applicable.

d. Winter NOTAM Abbreviations. Snow-related NOTAMs should adhere to the format and abbreviations found in AC 150/5200-28, *Notices to Airmen (NOTAMs) for Airport Operators*, and FAA Orders 7930.2, *Notices to Airmen (NOTAMS)*, and 7340.1, *Contractions*.

5-3. Runway Friction Surveys. FAA-approved friction measuring equipment may be employed to help in determining the effects of friction-enhancing treatments, in that it can show the trend of a runway as to increasing or decreasing friction. Airport operators must not attempt to correlate friction readings (Mu numbers) to Good/Medium (Fair)/Poor or Nil runway surface conditions, as no consistent, usable correlation between Mu values and these terms has been shown to exist to the FAA's satisfaction. It is important to note that while manufacturers of the approved friction measuring equipment may provide a table that correlates braking action to Mu values, these correlations are not supported by the FAA. To ensure that data collected are accurate, qualified personnel should use FAA-approved equipment and follow the manufacturer's instructions for use. Further guidance on runway friction measurement may be found in AC 150/5320-12C, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*.

a. Conditions Acceptable to Use Decelerometers or Continuous Friction Measuring Equipment to Conduct Runway Friction Surveys on Frozen Contaminated Surfaces. The data obtained from such runway friction surveys are only considered to be reliable when the surface is contaminated under any of the following conditions.

(1) Ice or wet ice. Wet ice is a term used to define ice surfaces that are covered with a thin film of moisture caused by melting. The liquid water film deposit is of minimal depth of 0.04 inch (1 mm) or less, insufficient to cause hydroplaning.

(2) Compacted snow at any depth.

(3) Dry snow 1 inch or less.

(4) Wet snow or slush 1/8 inch or less.

It is not acceptable to use decelerometers or continuous friction measuring equipment to assess any contaminants outside of these parameters.

b. When to Conduct Runway Friction Assessments on Contaminated Surfaces. The airport operator should conduct runway friction assessments whenever it is thought that the information will be helpful in the overall snow/ice removal effort, and the conditions are within the limits above. Within those conditions, runway friction assessments should be conducted:

(1) When the central portion of the runway, centered longitudinally along the runway centerline, is contaminated over a distance of 500 feet (152 m) or more.

(2) Following all snow clearing, anti-icing, deicing, or sanding operations.

(3) Immediately following any aircraft incident or accident on the runway, recognizing that responding ARFF or other circumstances may restrict an immediate response.

5-4. FAA-Approved Runway Friction Measuring Equipment. There are two basic types of friction measuring equipment that can be used for conducting friction surveys on runways during winter operations: Continuous Friction Measuring Equipment (CFME) and Decelerometers (DEC).

a. Continuous Friction Measuring Equipment (CFME). CFME devices are recommended for measuring friction characteristics of pavement surfaces covered with contaminants, as they provide a continuous graphic record of the pavement surface friction characteristics with friction averages for each one-third zone of the runway length. They may be either self-contained or towed. AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, contains performance specifications for CFME in Appendix 3 and a list of FAA-approved equipment in Appendix 4.

b. Decelerometers. Decelerometers are recommended for airports where the longer runway downtime required to complete a friction survey is acceptable, and may actually be preferred at some busy airports where it is difficult to gain access to the full length of a runway crossed by another runway. Decelerometers should be of the electronic type due to the advantages noted below. Mechanical decelerometers may be used, but should be reserved as a backup. Airports having only mechanical devices should plan to upgrade as soon as possible. Neither type of decelerometer will provide a continuous graphic record of friction for the pavement surface condition. They provide only a spot check of the pavement surface. On pavements with patches of frozen contaminants, decelerometers may be used only on the contaminated areas. For this reason, a survey taken under such conditions will result in a conservative representation of runway braking conditions. This should be considered when using friction values as an input into decisions about runway treatments. In addition, any time a pilot may experience widely varying braking on various portions of the runway, it is essential that the patchy conditions be noted in any report intended to relay friction values to pilots. FAA-approved decelerometers are listed in Appendix 3 of this AC, and performance specifications are provided in Appendix 4.

(1) Electronic Decelerometers. Electronic decelerometers eliminate potential human error by automatically computing and recording friction averages for each one-third zone of the runway. They also provide a printed record of the friction survey data.

(2) Mechanical Decelerometers. Mechanical decelerometers may be used as a backup to an electronic decelerometer. The runway downtime required to complete a friction survey will be longer than with an electronic decelerometer. Mechanical decelerometers do not provide automatic friction averages or a printed copy of data.

c. Friction Measuring Procedures.

(1) Calibration. The friction measuring equipment operator is responsible for ensuring that equipment is correctly calibrated in accordance with its operations manual. Some devices perform an automatic electronic calibration each time the power is turned on; others require the operator to initiate the calibration procedure. In the latter case, the electronic calibration should be performed before placing the equipment in operation for the day. The equipment operator should also check all ancillary systems (such as recording devices, tow vehicles, and two-way radios). Factory calibrations of CFME should be performed as recommended by the manufacturer, or sooner if indicated by erroneous data. The operator responsible for the device should perform only adjustments recommended by the manufacturer. Factory calibration should be scheduled during the spring-summer season to ensure the equipment will be ready for the next winter's runway friction surveys.

(2) Advance Coordination. Runway friction surveys take time, and while the tests are being conducted, the runway may be closed to air traffic. Airport operators should work closely with ATC, the airlines, and/or the fixed-base operators to minimize interruption to airplane operations. Close coordination, communication, and cooperation among all parties concerned are vital to ensure personnel safety, efficient traffic management, and timely runway friction surveys. The airport operator should request from ATC an appropriate period of time to conduct a friction survey of the runway. At a high-activity airport, runway friction surveys may have to be conducted in segments. The airport operator should request ATC to plan a break in arrival and departure traffic to provide time to conduct a runway friction survey. With such planning, the friction survey team can position itself adjacent to the runway when ATC gives the clearance to proceed. This cooperative effort with ATC will result in minimal disruptions to airplane operations. A letter of agreement between the airport operator and ATC can be used to identify the procedures and responsibilities for coordination and for reporting runway surface conditions.

(3) Air Traffic Control Clearance When Conducting Runway Friction Surveys on Open Runways. Before proceeding with the friction survey at controlled airports, the airport operator responsible for conducting the friction survey must contact ATC for runway clearance according to standard procedures and remain in radio contact during the entire time it takes to complete the friction survey on an open runway. ATC will provide appropriate clearances on and off the runway to permit the airport operator access to conduct the friction survey. At uncontrolled airports, airport operations personnel must be alert for aircraft and advise any air traffic on advisory frequencies before, during, and after completion of the runway friction survey. In this situation, coordination among the area ATC, the airport operator, and the airplane operators is particularly important to ensure that safe and efficient airplane operations are maintained at all times.

(4) Location and Direction to Conduct Runway Friction Surveys.

(i) Lateral Location. On runways that serve primarily narrow-body airplanes, runway friction surveys should be conducted approximately 10 feet (3 m) from the runway centerline. On runways that serve primarily wide-body airplanes, runway friction surveys should be conducted approximately 20 feet (6 m) from the runway centerline. Unless surface conditions

are noticeably different on the two sides of the runway centerline, only one survey is needed, and it may be conducted on either side.

(ii) Direction. Friction measuring equipment is operated in the same direction that airplanes are landing.

(iii) Runway Survey Zones. The runway length is divided into three equal zones: the touchdown, midpoint, and rollout zones. These zones are defined according to airplane landing direction. If possible, the entire survey should be completed in one pass. However, if ATC cannot schedule enough time to do a complete runway friction survey, the airport operator should request ATC to schedule each zone separately until all three zones have been completed.

(5) Conducting Runway Friction Surveys Using Decelerometers. A minimum of three braking tests are required in each zone to determine the average friction value for that zone. This will result in a minimum of nine tests for a complete runway friction survey. The vehicle speed for conducting the friction survey should be 20 mph (32 km/h). Example #1 provides an illustration.

<i>Example #1</i>	
<i>Runway Zone 1 Touchdown</i>	<i>A qualified airport operator obtains four Mu readings in the touchdown zone: 25, 27, 26, and 31. The average of these readings is 27.25, which would be rounded to 27.</i>
<i>Runway Zone 2 Midpoint</i>	<i>Four readings are obtained for the midpoint zone: 26, 28, 28, and 32. The average of 28.5, which would be rounded to 29.</i>
<i>Runway Zone 3 Rollout</i>	<i>After the minimum three readings (29, 30, and 31) are obtained for the rollout zone, ATC instructs the operator to clear the runway. It is not required that an equal number of readings be obtained for each zone, so the three readings are averaged to a reading of 30.</i>

(6) Conducting Runway Friction Surveys Using CFME. A runway friction survey is recommended for the full length of the runway to determine the average friction value for each zone. The survey may be conducted at any speed up to 40 mph (65 km/h) as safety considerations allow. Some CFME should be operated at slower speeds due to handling characteristics that are a function of their weight, measuring method, etc. Operators should be trained in the use of CMFE, and such training should include information on handling characteristics and optimum testing speeds.

(7) Recording Runway Friction Survey Data. The equipment operator should record all data and observations obtained from runway friction surveys. Recorded data and observations can be used to assess the effectiveness of runway surface treatments and snow removal operations and can aid in accident or incident investigations. Table 5-1 provides a

recommended format for recording this data. The remarks column can be used to record pilot braking action reports and associated airplane type as well as other observations of any unusual conditions that existed when the runway friction surveys were conducted. CFME and electronic decelerometers provide the airport operator with their own records. These records may be used in lieu of the suggested form, as appropriate.

5-5. Friction Assessment Reporting.

a. When to Report Friction Values. Friction values may be reported to interested parties under the following conditions:

(1) When compacted snow and/or ice are present on the center portion of the runway, and friction values are **40 or below** on any zone of the runway.

Note 1: Current friction measurement technologies are not reliable in determining braking effectiveness of a contaminated surface condition above measurements of 40. Therefore, 40 is the highest value for reporting friction measurements on contaminated surfaces. For example, in a case where friction values for the three runway zones are 27, 35, and 42, the reported values would be 27, 35, 40+ (or “above 40”).

(2) When friction values rise above 40 on all zones of any active runway previously showing a friction below 40. The reported value in all cases is above 40 per Note 1.

Note 2: Friction values are technically decimal numbers (e.g., 0.10, 0.24, 0.30) but are generally referred to using whole numbers (10, 24, 30) for convenience. Confusion between the decimal and whole numbers is rarely a problem.

b. Friction Condition Report Contents. The friction condition report should identify the friction tester type and the runway number, followed by the average friction numbers for each of the three runway zones (rounded to the nearest whole number), a short description of the type of contamination causing the runway friction problem, and the time the report was taken. It is especially important that pilots be advised of patchy conditions that may result in different braking action on various sections of the runway. Example #2 provides an illustration.

Example #2

A qualified airport operator conducts a survey on Runway 14R with an FAA-approved CFME and obtains averages for the touchdown, midpoint, and rollout sections of 23, 27, and 32, respectively. The operator notes the surface is contaminated by compacted snow, with patches of ice. The survey is completed at 10:15 AM.

The report transmitted to ATC would include the following: Name of the FAA-approved friction tester, average friction values for Runway 14R of 23, 27, 32, compacted snow with

patchy ice at one zero one five. Information is transmitted by NOTAM.

c. Procedures for Reporting Friction Information to the Airport Traffic Control Tower (ATCT). The procedure for transmitting friction values to ATC for dissemination to pilots may vary from airport to airport. Any letter of agreement between the airport operator and ATCT should spell out the procedures for each type of event— runway closure, friction survey results, runway treatment, etc. For example, certain friction equipment manufacturers offer the airport operator an optional data link system that provides direct transmission of the friction measuring equipment data to the airport operator, ATCT, airline stations, and other airport users. Reports may also be furnished to local operators, airlines, or other users. In the absence of a control tower at the airport, the report should be supplied to the ATC facility that provides approach control service or to an appropriate flight station, fixed-base operator, scheduled service airlines operating at the airport, or other authority to broadcast on the Unicom, Common Traffic Advisory Frequency, or Airport Advisory Service Frequency.

d. Out-of-Service Friction Measuring Equipment. During winter operations, if friction values taken on compacted snow and/or ice have been issued on a regular basis and the equipment used to obtain these values is not available, a NOTAM should be issued and maintained until the equipment is restored to service.

5-6. Requirements For Runway Closures. The following circumstances require the prescribed action by the airport operator:

a. A NIL pilot braking action report (PIREP), or NIL braking action assessment by the airport operator, requires that the runway be closed before the next flight operation. The runway must remain closed until the airport operator is satisfied that the NIL condition no longer exists.

b. When previous PIREPs have indicated GOOD or MEDIUM (FAIR) braking action, two consecutive POOR PIREPS should be taken as evidence that surface conditions may be deteriorating and require the airport operator to conduct a runway assessment. If the airport operator has not already instituted its continuous monitoring procedures (see paragraph 5-7), this assessment must occur before the next operation. If the airport operator is already continuously monitoring runway conditions, this assessment must occur as soon as air traffic volume allows, in accordance with their SICP. Deteriorating conditions include but are not limited to:

- Frozen or freezing precipitation
- Falling air or pavement temperatures that may cause a wet runway to freeze
- Rising air or pavement temperatures that may cause frozen contaminants to melt
- Removal of abrasives previously applied to the runway due to wind or airplane affects
- Frozen contaminants blown onto the runway by wind

c. Under the conditions noted above, the airport operator must take all reasonable steps using all available equipment and materials that are appropriate for the condition to improve the braking action. If the runway cannot be improved, the airport operator must continuously

monitor the runway to ensure braking action does not become NIL. The airport operator's procedure for monitoring the runway should be detailed in the SICP.

d. To ensure that the airport operator receives needed information, a Letter of Agreement (LOA) should be formalized between the airport operator and the air traffic control tower. At a minimum, the LOA should specify how all pilot braking reports (PIREPS) of "POOR" and "NIL" are to be immediately transmitted to the airport operator, e.g., the SCC for action, as required by FAA Order 7110.65, *Air Traffic Control*. It should also include agreement on actions by Air Traffic personnel for immediate cessation of operations upon receipt of a "NIL" PIREP. A reference to the signed LOA, whose procedures for ATCT and the airport will likely vary from airport to airport, should be contained in the airport's SICP. Finally, the airport operator must inform airport users in a timely manner of any runway closure. See paragraph 5-2, Runway Condition Reporting, for disseminating such information in a timely manner to airport users.

5-7. Continuous Monitoring. "Continuous monitoring" procedures can vary from airport to airport. Acceptable procedures may include:

- Observing which exit taxiways are being used.
- Maintaining a regular program of friction testing to identify trends in runway traction.
- Monitoring runway physical conditions including air and surface temperatures, contaminant types and depths.
- Monitoring pilot communications.
- Monitoring weather patterns.

Table 5-1. Runway Contamination Mitigation Record (top) and Runway Friction Survey Record (bottom)

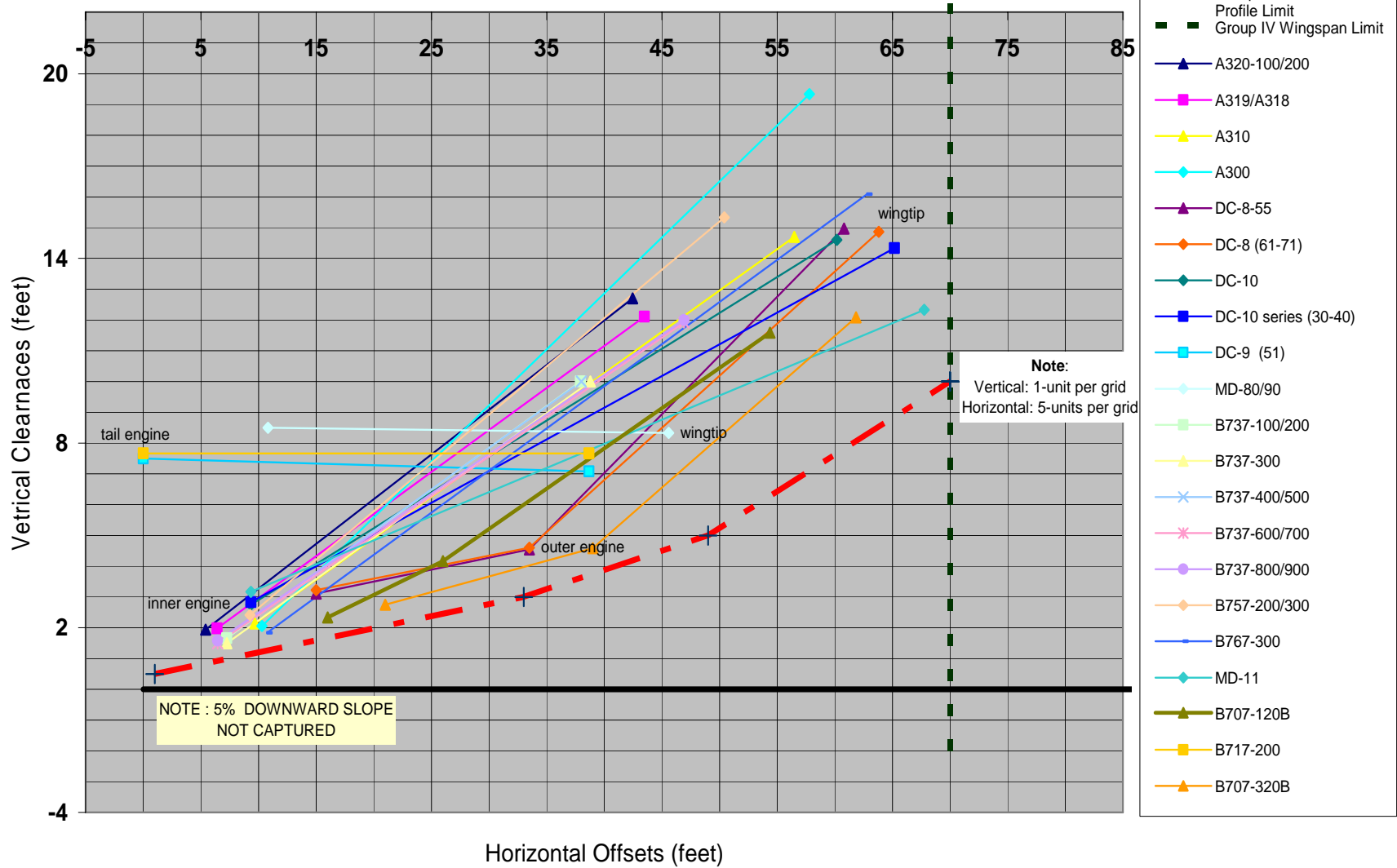
<i>DATE OF SURVEY</i>	<i>TIME</i>	<i>RUNWAY-TAXIWAY DESIGNATOR</i>	<i>DESCRIPTION OF SURFACE CONDITION(S)</i>	<i>TYPE OF CONTAMINANT REMOVED</i>		<i>TEMPERATURE</i>	
				<i>METHOD(S) EMPLOYED</i>	<i>TIME</i>	<i>AMBIENT</i>	<i>PAVE-MENT</i>

<i>TYPE OF FRICTION MEASURING DEVICE USED</i>	<i>DATE OF LAST CALIBRATION</i>	<i>VEHICLE SPEED (MPH)</i>	<i>LOCATION OF TEST RUN FROM RUNWAY CENTERLINE (FEET)</i>	<i>AVERAGED μ READING BY ZONE</i>			<i>REMARKS</i>
				<i>TOUCHDOWN ZONE</i>	<i>MIDPOINT ZONE</i>	<i>ROLLOUT ZONE</i>	

APPENDIX 1. Development of Recommended Snow Bank Height Profiles

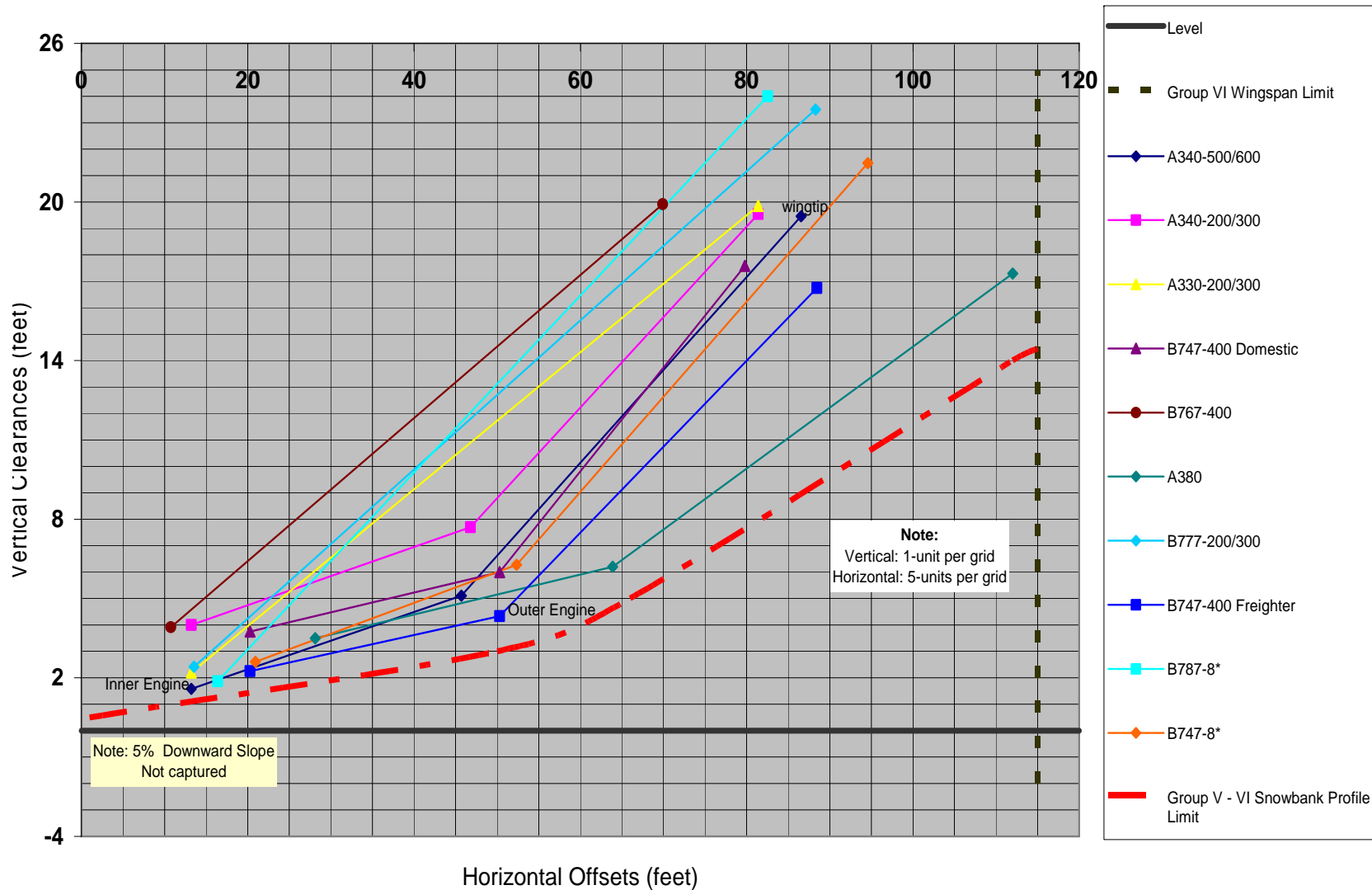
Graphs A2-1 and A2-2 were used to develop the recommended snow bank profile limits for Figure 4-1. Location and height above a horizontal reference line of airplane wingtips and outer and inner engine nacelles' lower edges with airplane outer main gear on the pavement edge determined individual profiles. These individual profiles were then grouped according to airplane design groups to generate the recommendations.

Snowbank Limits



Graph A2-1. Individual height profiles of airplane wingtips and outer and inner engine nacelles' lower edges for Airplane Design Groups III and IV

Snowbank Limits



Graph A2-2. Individual height profiles of airplane wingtips and outer and inner engine nacelles' lower edges for Airplane Design Groups V and VI (* indicates preliminary data)

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APPENDIX 2. Snow and Ice Control as a Materials-Handling Problem

A2-1. Introduction. Snow and ice have many unique properties that distinguish them from other materials commonly handled by mechanized mobile equipment. Earthmoving equipment, for example, is generally not well-adapted to handling snow because the properties of snow are so different from earth and other minerals for which this equipment was designed. Typical of these properties is the unique density, hardness, thermal instability, cohesiveness, and metamorphism (age hardening) of snow under varying winter conditions.

A2-2. Snow. Snow is a porous, permeable aggregate of ice grains that can be predominantly single crystals or a close grouping of several crystals. The pores of cold, dry snow are filled with air and water vapor. In wet snow, the grains are coated with liquid water.

a. Density. This is the weight per unit volume, a measure of how much material there is in a given volume. Values range from a very low 3 lb/ft³ (48 kg/m³) for low density, new snow to about 37 lb/ft³ (593 kg/m³) for older snow. Old snow that has not been compacted by vehicles or other loads normally will not exceed a density of 25 lb/ft³ (400 kg/m³). When density exceeds 50 lb/ft³ (801 kg/m³), the air passages become discontinuous and the material becomes impermeable; by convention, it is called ice. Uncompacted snow has little bearing capacity, so wheels readily sink into it and encounter rolling resistance. Snow increases in density either by deformation, such as trafficking, or by a natural aging process (see Paragraph A2-2e below). Density is measured by weighing a sample of known volume. Though earth will compact to some extent, its density on handling will increase only a few percent. In contrast, snow will easily increase in density over 80 percent during plowing or trafficking.

b. Hardness. Hardness or strength depends on the grain structure and temperature. Grain structure, in turn, is dependent on the density of the snow and the degree of bonding between adjacent grains. Snow when it first falls is cohesionless—i.e., individual grains do not stick to one another—but bonds quickly, forming and growing at grain contacts. As the temperature of the snow approaches the melting point, 32° F (0° C), liquid water begins to coat the snow grains. Although density remains the same, the strength will decrease. Conversely, the strength or hardness will increase as the temperature drops. Hard snow is difficult to penetrate with a bucket or a blade plow or to disaggregate with a rotary plow. Typical values for unconfined compressive strength of well-bonded snow range from less than 1 lbf/in² (6.89 kPa) for new snow with a density of 6.2 lb/ft³ (100 kg/m³) to 30 lbf/in² (207 kPa) for well-bonded snow with a density of 25 lb/ft³ (400 kg/m³). Hardness is sometimes determined by measuring the resistance to penetration. However, since a very good correlation exists between compressive strength and density for cold snow, determination of the density might suffice to indicate the snow hardness. In contrast, the strength of dry, frozen ground is little different from thawed ground. It is only when soil contains water that the strength increases upon freezing; and depending upon the ice content, it will be much like hard, compacted snow or ice in its strength.

c. Thermal Instability. Snow exists at temperatures relatively close to its melting point. Most snow properties are dependent on the temperature. Strength, for example, will decrease rapidly when the temperature approaches 32° F (0° C) and will increase, though at a

slower rate, as the temperature is lowered. The thermal instability of snow is particularly important in the case of metamorphism (see Paragraph A2-2e below).

d. Cohesiveness. Individual snow grains will bond to one another to form a consolidated mass. Although cold, dry snow when initially deposited will lack cohesion, the age hardening process will quickly lead to bond formation and increasing cohesion (see Paragraph A2-2e below). Fine particles of snow produced by a rotary snowplow will adhere to each other on contact and tend to clog cutting and blowing equipment.

e. Metamorphism. Metamorphism is also called age hardening. The structure of a snow mass is continually changing by migration of water vapor from small to large grains. The number and extent of grain bonds increases with time even in an uncompacted mass, and, as a consequence, the density and the strength increase. The rate of change is increased when a natural snow cover is disturbed by wind drifting or by mechanical agitation, such as plowing; in either case, the snow is broken into smaller fragments, increasing the surface area and the potential for a greater number of grain contacts. The increase in strength or hardness can be very rapid following plowing, particularly after blowing with a rotary snowplow. Only 2 or 3 hours after plowing, snow may require three times the amount of work to reprocess it. For this reason, it is advisable to clear snow to its final location as promptly as possible in order to minimize the amount of work involved.

A2-3. Ice. Ordinary ice is a solid form of water consisting of a characteristic hexagonal symmetry of the water molecules. Its strength and slipperiness distinguish it from snow both in the action of rubber tires trafficking on ice-covered pavement and in the effort involved in its removal.

a. Methods of Formation. There are four common methods by which ice will form on a surface: (1) radiation cooling, (2) freezing of cold rain, (3) freeze-thaw of compacted snow, and (4) freezing of ponded or melt water.

(1) Radiation Cooling. Any body will radiate energy to another body having a lower temperature. Pavement exposed to the night sky will radiate energy to that nearly perfect blackbody, and if the heat is not replaced as rapidly as it is lost, cooling will result. Pavement temperature can drop below freezing even when the air temperature is above freezing. Water vapor in the air deposits on the cold surface and freezes; the rate and quantity depend on the amount of moisture in the air and the rate at which the heat of condensation and fusion of the water vapor are dissipated. The ice forms in discrete particles and may not cover the pavement completely. Bonding is generally not very strong since particle contact area is small even when the pavement is completely covered, and therefore removal is not difficult. A term applied to this type of ice is surface hoar, or more commonly "hoarfrost." On occasion, dew will form and then freeze; because of its greater area of contact, bonding will be very strong. Since the layer of ice so formed will be very thin and nearly invisible, it is sometimes called "black ice." Clouds or fog will usually prevent cooling of pavement by outgoing radiation.

(2) Freezing of Cold Rain. Freezing rain is one of the most common methods of ice formation and one of the most difficult to remove. If the pavement is at or below 32° F (0° C), rain falling on it can freeze, depending on a number of factors. Conditions favoring formation of so-called glare ice or glaze, a homogeneous clear ice cover, are a slow rate of

freezing, large droplet size, high precipitation rate, and no more than a slight degree of supercooling. The rain has an opportunity to flow over the surface before freezing, forming a smooth, tightly bonded cover. Glaze usually forms at air temperatures between 27° F and 32° F (-3° C to 0° C), though some cases have been reported as low as -5° F (-20° C) or as high as 37° F (3° C). Because of its intimate contact with the pavement, glaze ice is difficult to remove by mechanical means.

(3) Freeze-thaw of Compacted Snow. At low temperatures compaction of cold dry snow by passage of wheels will not cause a strong bond to develop between snow and pavement. However, if the snow has a high water content or some melting takes place and the temperature subsequently drops, a bond as strong as that of glaze ice can develop.

(4) Freezing of Ponded or Melt Water. These are commonly called icings (or “glaciers” in some regions). Though the term was originally limited to ice formed from groundwater flowing onto a pavement, by extension it applies to water from any source other than directly from rain. Thus, melt water resulting from poor drainage or water impounded by snow windrows can cause icings. This type of ice is usually well bonded to the pavement and, in addition, its thickness may exceed that of the other types described above. This is the easiest kind of ice to avoid; proper maintenance practices will prevent accumulation of water leading to icings.

b. Adhesion to Surfaces. The bond between ice and pavement when it is well developed will exceed the tensile strength of ice; and, therefore, when mechanical removal is attempted, failure will occur either within the ice or in the pavement itself.

c. Density. Bubble-free ice has a density of 57 lb/ft³ (914 kg/m³), though by convention compacted snow that has become impermeable (there are no connected air passages) is called ice. This occurs at a density of about 50 lb/ft³ (801 kg/m³). Ice arising from compacted snow will not ordinarily densify beyond this value.

d. Strength. Ultimate strengths of ice at 23° F (-5° C) are as follows:

Tension	15 kgf/cm ²	210 lbf/in ²
Compression	36	500
Shear	7	100
Flexure (bending)	17	240

Ice in the vicinity of the melting point has even lower flexural rigidity and, therefore, will not be fractured when a tire rolls over an ice-covered pavement. Ice becomes brittle with increasing rigidity at low temperatures (below 20° F (-6.7° C)). The bond strength also increases as the temperature decreases.

A2-4. Slush. Wet snow has liquid water coating the grains. Wet snow is easily deformed since the grains are lubricated and slide easily past one another. If the deposit is freely drained, no excess water beyond that wetting the surface of each grain will be present. If, however, the snow lies on an impermeable surface, such as a pavement, water may not drain freely from it. When the amount of excess water reaches about 15 percent (i.e., the amount in excess of the freely drained state) a viscous state is reached and the mass will splash and flow like a thick liquid. Upon impacting a surface, such as the landing gear or underside of an airplane, the excess water will drain, and the snow will compact and frequently bond to the surface. Slush on a runway is a hazard because it—

- (1) Greatly increases drag during the takeoff roll.
- (2) Greatly reduces directional control.
- (3) Decreases braking effectiveness. Slush can be removed by use of displacement plows, which are preferably fitted with rubber or polymer cutting edges (see Paragraph 4-2).

APPENDIX 3. FAA-Approved Decelerometers*

BOWMONK USA Distributor Sherwin Industries, Inc 2129 West Morgan Avenue Milwaukee, WI 53221	BOWMONK DECELEROMETER (414) 281-6400 FAX (414) 281-6404 email: runway@sherwinindustries.com
TAPLEY SALES (CANADA) 241 Norseman Street Toronto, Ontario CANADA M8Z 2R5	TAPLEY DECELEROMETER (416) 231-9216 FAX (416) 231-9121
TES INSTRUMENTS 1 Stafford Road East Suite 303 Ottawa, Ontario CANADA K2H 1B9	TES ERD MK3 DECELEROMETER (613) 832-2687 FAX (613) 832-2721
VERICOM COMPUTERS, INC. 14320 James Road Suite 200 Rogers, MN 55374	VERICOM VC3000 RFM DECELEROMETER (800) 533-5547 FAX (763) 428-4856
NEUBERT AERO CORP. 14141 46 th Street North Suite 1206 Clearwater, FL 33762	NAC DYNAMIC FRICTION DECELEROMETER (DFD) (727) 538-8744 FAX (727) 538 8765 Email: info@airportnac.com

* See Advisory Circular 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, for approved Continuous Friction Measuring Equipment (CFME).

APPENDIX 4. Performance Specification for Decelerometers

A4-1. Scope. This Appendix describes the procedures for establishing the reliability, performance, and consistency of decelerometers.

A4-2. Certification (General). The manufacturer will certify electronic or mechanical decelerometers are—

a. Portable, rugged, and reliable.

b. Capable of being fitted to vehicles qualified by the requirements given in this specification. Minimal vehicle modifications will be necessary to accommodate the mounting plates and electrical connections. Vehicles are qualified according to their size, braking and suspension system, shock absorber capabilities, and tire performance. The vehicles must have the following properties:

(1) Be either large sedans, station wagons, intermediate or full-sized automobiles, or utility and passenger-cargo trucks. Vehicles can be powered by front-wheel, rear-wheel, or four-wheel drive.

(2) Be equipped with either standard disc and/or drum brakes as long as they are maintained according to the manufacturer's performance requirements. They can also qualify if they have a single sensor ABS (anti-lock braking system) installed on the rear axle. Decelerometers should not be installed on vehicles that are equipped with full ABS because the ABS tends to distort the sensitivity of the decelerometer resulting in friction readings that are lower than actually exist. In addition, differences in ABS systems result in high variations in friction readings. This could result in the premature closing of runways. A full ABS has three sensors, one on each front wheel and one on the rear axle. Decelerometers can be installed on these vehicles only if the manufacturer of the ABS approves disengagement of the sensors on the front wheels. If this modification can be satisfactorily achieved, the vehicle's brake system then becomes a single sensor ABS installed on the rear axle, which will then qualify the vehicle for conducting friction tests with decelerometers.

(3) Be equipped with heavy-duty suspension and shock absorbers to minimize the rocking or pitching motion during the application of brakes. The weight should be distributed equally to the front and rear axle of the vehicle. Ballast can be added to achieve and maintain this distribution.

(4) Have tires made from the same construction, composition, and tread configuration. Inflation pressure must be maintained according to the vehicle manufacturer's specifications. When tread wear is excessive on any one tire on the vehicle and/or exceeds 75 percent of the original tread, all four tires on the vehicle must be replaced with new tires.

c. Capable of measuring the deceleration of the vehicle from speeds greater than or equal to 15 mph (24 km/h) to an accuracy of 0.02 g.

- d. Capable of providing deceleration values upon request of the operator.
- e. Capable of consistently repeating friction averages throughout the friction range on all types of compacted snow and/or ice-covered runway pavement surfaces.
- f. Not affected by changes in vehicle velocity.
- g. Not affected by change in personnel or their performance in brake-applied decelerations.
- h. Capable of providing the vehicle operator with a readily visible deceleration reading.

A4-3. Certification (Electronic Only). The manufacturer must certify electronic decelerometers are—

- a. Capable of providing the deceleration values in recorded order, enabling the average friction value for any length of runway to be either electronically or manually calculated.
- b. Capable of providing average deceleration values for touchdown, midpoint, and rollout zones of the runway and the average friction value for the entire runway tested. These averages must be automatically calculated by the decelerometers, thus eliminating potential human error when calculated manually.
- c. Capable of storing a minimum of 21 deceleration values via the internal microprocessor memory.
- d. Capable of providing a hard copy printout of stored deceleration values at the end of the testing period. The printout will record at minimum—
 - (1) The date.
 - (2) The time.
 - (3) The runway designation or heading.
- e. Capable of providing further information, which may be recorded at the manufacturer's discretion, e.g., make of decelerometer, ambient/pavement temperature, airport name and location, and operator identification.

A4-4. Decelerometer Calibration. The decelerometer must be calibrated by the manufacturer before shipping to the airport operator. The manufacturer must provide the airport operator with a certificate of calibration, including test results of the calibration. The manufacturer must provide a 1-year warranty for the decelerometer. The manufacturer must provide the airport operator with a recommended frequency for factory calibration of the decelerometer.

A4-5. Training. The manufacturer must provide the airport operator with training manuals and/or videos of all relevant data concerning friction measuring recording and reporting, including—

- a.** An outline of the principles involved in the operation of the decelerometer-type friction-measuring device.
- b.** Copies of pertinent ACs.
- c.** Procedures for reporting results of the friction tests in NOTAM format.