A Guidebook for Airport Winter Operations

DETAILS

126 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-30827-4 | DOI 10.17226/22221

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 123

A Guidebook for Airport Winter Operations

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Aviation • Operations and Traffic Management • Planning and Forecasting

Research sponsored by the Federal Aviation Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2015
www.TRB.org

AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

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ACRP REPORT 123

Project 10-15
ISSN 1935-9802
ISBN 978-0-309-30827-4
Library of Congress Control Number 2014957870

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AIRPORT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at

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Printed in the United States of America

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AUTHOR ACKNOWLEDGMENTS

The ACRP 10-15 Project Team consisted of Gresham, Smith and Partners (GS&P) in association with Tim Anderson, Richard Marchi, Paul Sichko, Eric Tolton, and Vesta Rea & Associates, LLC (VRA). Robert McGormley was the Project Director and Principal Investigator for GS&P. Mr. McGormley and Mr. Sichko were the primary guidebook authors. Contributing authors included: Vesta Rea-Gaubert (VRA), Timothy Arendt (GS&P), Devon Seal (GS&P), and Elizabeth Fisher (GS&P). Research, technical, and editorial contributions were provided by Mr. Anderson, Mr. Marchi, and Mr. Tolton.

The Project Team would like to thank the staff at the following airports for accepting our request to visit their facilities and for their generous hospitality: Centennial Airport (APA); Boise Air Terminal/Gowen Field (BOI); General Edward Lawrence Logan International Airport (BOS); Denver International Airport (DIA); Dallas/Ft. Worth International Airport (DFW); General Mitchell International Airport (MKE); Teterboro Airport (TEB); Calgary International Airport (YYC); and Toronto Pearson International Airport (YYZ). We would also like to thank the many airport staff who completed questionnaires and participated in interviews during the research phase of this project.

FOREWORD

By Theresia H. Schatz
Staff Officer
Transportation Research Board

ACRP Report 123: A Guidebook for Airport Winter Operations serves to help managers, operators, and users of small to large airport facilities prepare for, operate during, and recover from disruptive winter events as well as manage airport user expectations. The guidebook identifies and evaluates best practices in airport airside and landside winter operations, as well as provides guidance on how to manage overall passenger experience within a framework of safety and efficiency. The guidebook also provides guidance to airport operators on determining the optimal level of investment necessary to implement an effective program given expected winter conditions and the nature of the aviation activity at that particular airport.

Winter weather has the potential to disrupt operations at airports of all sizes, and recent events at several airports have again illustrated the importance of preparing for, operating during, and recovering from winter events. Lack of preparation by an airport for these events can result in potential safety issues. In addition, it is well known that dealing with winter operations can represent a significant cost to airports. For example, the FAA Office of Investment Planning and Analysis estimated the 2014 operating cost of a delayed passenger aircraft to be $82.66 per minute, and the 2014 value of time for a delayed business passenger to be $1.05 per minute with flight cancellations posing even greater costs—a factor that can support a decision to increase investment in snow removal so as to reduce the time required to clear a runway. To prepare for these events, airports have to develop a variety of procedures based on individual or unique requirements. Examining the range of existing procedures and evaluating effectiveness would help airports in general respond to a continuing winter operations requirement.

Under ACRP Project 10-15, research was conducted by Gresham, Smith and Partners in association with Paul Sichko, Vesta Rea and Associates, Tim Anderson, Eric Tolton, and Richard Marchi to develop a guidebook that provides a useful framework based on best practices to ensure optimal investments into effective winter operations plans are being made at airports of varying sizes. As part of the research, the team visited a wide variety of airports including Centennial, Boise, Denver, Boston, Dallas, and Toronto, among others. In addition to this guide, the contractor's final report is available on the TRB website (trb.org) by searching for "ACRP Report 123."

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Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

CHAPTER 1

Introduction

Winter weather has the potential to disrupt operations at airports of all sizes; a particularly harsh 2013–2014 winter season across the United States again illustrated the importance of preparing for, operating during, and recovering from severe winter events. Inadequate investment in preparation for these types of events can result in potentially serious safety issues or frequent airport closures. Understanding that safety is paramount, the level of investment in an airport winter operations program must be balanced by the significant financial costs of the program. This is the challenging reality for airport operators.

Unilateral decisions on the level of airport investment in winter operations can be a source of conflict between airport operators and their stakeholders, particularly tenant air carriers. For example, an airport operator choosing the minimum levels of snow removal equipment (SRE) described in FAA Advisory Circular (AC) 150/5200-30C, *Airport Winter Safety and Operations*, and AC 150/5220-20, *Airport Snow and Ice Control Equipment*, may contribute to flight delays and cancellations that financially impact air carriers and their passengers. The FAA Office of Investment Planning and Analysis (IP&A) estimated the 2014 operating cost of a delayed passenger aircraft to be $82.66 per minute, and the 2014 value of time for a delayed business passenger to be $1.05 per minute with flight cancellations posing even greater costs (*1*). Conversely, airport operators choosing to invest hundreds of thousands and even millions of dollars in SRE and equipment operators to minimize flight delays and cancellations may increase costs to air carriers if the equipment is funded through rates and charges.

Achieving stakeholder buy-in on winter operations investment decisions requires active engagement of airport stakeholders during pre-season planning and continuing throughout the winter season. This engagement enables the definition and maintenance of mutually agreeable, predictable cost and winter operations performance expectations. Collecting and evaluating performance data during and at the conclusion of each winter season can define unanticipated operational shortfalls and facilitate informed decision making on potential additional investments necessary to meet mutual expectations. This collaborative, data-driven approach to meeting expectations can assist with determining and maintaining a dynamic, optimal level of investment in winter operations.

1.1 Guidebook Objectives

The first objective of this guidebook is to provide a process for identifying the optimal level of investment needed to prepare for, operate during, and recover from disruptive winter events, as well as manage airport passenger expectations. There are numerous guidance documents available within the industry. Many are in the form of FAA ACs and ACRP guidebooks that focus on aspects of an airport winter operation program, and many of these are highlighted throughout this guidebook. However, none specifically addresses how to achieve this objective. (Note that the ACRP report cover images throughout this guidebook are linked to the PDFs of the actual reports themselves. Simply click on a cover image to navigate to these PDFs.)

The second objective of this guidebook is to present summarized airside and landside winter operations best practices identified during research conducted in preparation for writing this guidebook. These best practices represent potential strategic and tactical opportunities to improve winter operations performance and, as such, support the first objective. Best practices are presented in Chapters 8 through 11, as described below. Additionally, some best practices are highlighted in other chapters as call-out boxes, and are presented adjacent to directly relevant chapter text.

1.2 Guidebook Organization

This guidebook is organized around the concept that a winter operations program can be structured using a management system approach, a framework of strategies and tactics (defined as processes and procedures) to achieve winter operations goals and objectives. Management systems also strive to achieve continuous improvement. The chapters are grouped by recurring airport winter operations program phase including:

- Operations planning,
- Strategy and tactic implementation,
- Performance evaluation, and
- Improvement opportunity identification.

Figure 1-1 illustrates the four phases, which resemble the common management system phases of Plan-Do-Check-Act. A similar figure appears at the introduction to each chapter highlighting the applicable phase addressed by the chapter. Readers can proceed directly to the guidebook chapters most relevant to the winter operations program phase they are currently in and apply

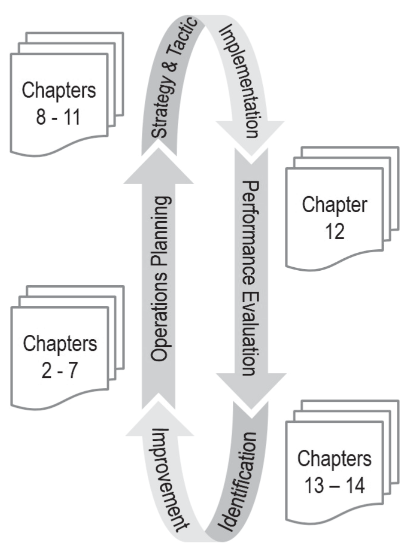


Figure 1-1. The guidebook organization is based on a management system approach to winter operations.

the concepts presented therein. However, Chapters 2 through 5 establish the foundation for a strong winter operations program and should not be overlooked. A description of each chapter is provided below.

1.2.1 Operations Planning

Chapter 2

Chapter 2 presents three essential elements that set a foundation for successful and industry-recognized winter operations programs—effective communication, collaboration, and coordination within an airport operator's organization and among its winter operations stakeholders. It encourages identifying the range of stakeholders that may be impacted by, or may impact, winter operations, and it presents the characteristics that make up effective communication, collaboration, and coordination.

Chapter 3

Chapter 3 identifies the requirements for certificated airports to prepare, maintain, and carry out a snow and ice control plan (SICP). Airport operators subject to these requirements are referred by regulation to ACs that contain methods and procedures for snow and ice control equipment, materials, and removal that are acceptable to the FAA Administrator. The chapter identifies ACs directly applicable, or applicable in part, to airport winter operations and summarizes the purpose of each AC.

Chapter 4

Chapter 4 presents a discussion of environmental laws and regulations, focusing on those intended to protect stormwater runoff quality from typical airport winter operations. This discussion addresses various permits, permitting requirements, and guidance on interpreting permit conditions. It concludes with a discussion of airport deicer management system design, components, and operation as a means to achieve stormwater permit compliance.

Chapter 5

Chapter 5 presents an approach for characterizing and understanding the range of meteorological conditions associated with winter storm events common to an airport's regional geography. It discusses various meteorological data sources and presents guidance on manipulating data to conduct frequency analyses in order to define winter event conditions. Once the recurrence intervals for the winter storm events are summarized and defined, the information can offer perspective on past winter operations performance. This information can also assist airport operators and stakeholders with setting performance expectations under threshold winter-event conditions, as described in Chapter 7.

Chapter 6

Chapter 6 presents a framework for establishing a winter operations performance management system that will enable more informed decision making when it comes to investing in a winter operations program. The chapter also provides guidance on how to set clear performance goals and objectives.

Chapter 7

Chapter 7 describes how to develop a performance and cost baseline for airport winter operations, and a cost baseline based on delay costs for air carriers and passengers. This cost and delay information can be used, as will be described in Chapters 13 and 14, to evaluate potential opportunities for improvement and select from a list of potential improvement alternatives.

The chapter also describes the need to establish threshold winter-event conditions that define the expectations of the airport operator and its stakeholders, and that will be used to set performance targets.

1.2.2 Strategy and Tactic Implementation

Chapters 8 through 11

Chapter 8 presents the best practices related to winter operations in general accordance with the contents of AC 150/5200-30C, Chapter 1, "Introduction." Chapter 9 presents best practices related to the contents of AC 150/5200-30C, Chapter 2, "Snow and Ice Control Plan." Chapter 10 presents best practices related to the contents of AC 150/5200-30C, Chapter 3, "Snow Clearing Operations and Preventive Measures," and Chapter 4, "Snow Clearing Operations and Ice Prevention." Chapter 11 concludes the presentation of best practices by presenting those related to the contents of AC 150/5200-30C, Chapter 5, "Runway Surface Assessment and Reporting."

1.2.3 Performance Evaluation

Chapter 12

Chapter 12 presents a structured and systematic winter operations performance evaluation process that relies upon documented performance measurement data. It also provides a detailed process for evaluating significant performance shortfalls. The chapter will enable factually supported decision making about winter operations strategies, tactics, and procedures that are meeting established performance targets and those that are falling short.

1.2.4 Improvement Opportunity Identification

Chapter 13

Chapter 13 presents a process focused specifically on reducing runway occupancy time by SRE (a common winter operations performance measure) by identifying a snow removal capacity shortfall and potential alternative(s) to meet performance targets set by the airport operator and its stakeholders (see Chapter 7). The process uses equations presented in AC 150/5220-20 and provides guidance on estimating equipment needs. Chapter 13 also provides guidance on estimating the benefits of an investment in new or additional SRE to reduce runway occupancy time. This includes a comparison of baseline performance costs for airport operations and baseline delay costs for air carriers and passengers described in Chapter 7 compared to estimated costs associated with the investment in new or additional SRE. The results of this process can facilitate informed alternatives selection, as described in Chapter 14.

Chapter 14

Chapter 14 presents high-level considerations for selecting from multiple potential alternatives to reduce or eliminate performance shortfalls. The selection processes described in this chapter can be used for minor and major investments.

1.3 Guidebook Limitations and Disclaimer

The term "best practice" used herein denotes a practice that was identified as being highly effective at one or more airports that have fully implemented it. However, in many instances it may not be possible or practicable to implement a particular best practice at a specific airport.

Readers should be aware that because the guidebook's focus is on best practices, standard industry practices associated with winter operations were typically not included. Therefore, this guidebook should not be considered to be a comprehensive reference document on airport winter operation practices or associated regulatory requirements.

The photographs included in the guidebook are intended as illustrations of equipment and concepts to facilitate the reader's understanding of presented material. TRB of the National Academies, the National Research Council, and the sponsors of ACRP do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the guidebook.

CHAPTER 2

Relationships as the Foundation for Winter Operations Success

Research for this guidebook revealed that airports with successful and industry-recognized winter operations program share three essential elements that set a foundation for their success: effective communication, collaboration, and coordination. These three elements are not exclusive to an airport operator's organization. Given the number of stakeholders having key roles in maintaining safe flight operations during winter storm events, effective stakeholder communication, coordination, and collaboration likely have an even greater impact on an airport's program success. Many beneficial winter operations strategies and tactics, including those presented in this guidebook, require these internally and externally focused elements as an underpinning for successful implementation.

2.1 Identify Stakeholders

The first step toward building relationships based on effective communication, coordination, and collaboration is to identify the winter operations program stakeholders. Consider the entities that have the ability to impact winter operations performance through their actions or decisions. Conversely, consider who may be impacted by an airport operator's actions or decisions. Advisory Circular 150/5200-30C, *Airport Winter Safety and Operations*, recommends this group of stakeholders be included in an airport's Snow and Ice Control Committee (SICC) (*2*).

Within an airport organization, individual departments should be identified as unique stakeholders because their functions and areas of focus differ. Common internal airport operator stakeholders include, but are not limited to, terminal and airfield operations, airfield maintenance, facilities maintenance, engineering, public relations (PR) and communications, executive management, finance, public safety, and airport rescue and firefighting.

There are many external winter operations stakeholders including, but not limited to, the FAA, air carriers, fixed-base operators (FBOs), aircraft deicing contractors, snow removal operators, and the multiple organizational components of large external winter operations stakeholders that should be individually identified. For example, FAA stakeholders may include the Air Traffic Control Tower (ATCT), Terminal Radar Approach Control (TRACON), Air Route Traffic Control Center (ARTCC), and Air Traffic Control System Command Center (ATCSCC). Air carrier stakeholders may include the local station and the System Operation Center/Airline Operation Center.

While the list of stakeholders may be lengthy, it is important to maintain detailed contact information for each. When possible, obtain the names of individual personnel. After all, these are the people with whom your organization will need to communicate, coordinate, and collaborate.

2.2 Communication

Effective communication is essential prior to, during, and following winter events and winter seasons. Without it, attempts at coordination and collaboration would be futile. Communications during pre-season planning, pre-event briefings, Snow Control Center (SCC) operation, and performance evaluation meetings, as examples, will ideally incorporate the following communication characteristics:

> **BEST PRACTICE—Cooperative Relationships with Stakeholders**
>
> Airports that invest in 365/24/7 cooperative relationships with air traffic control (ATC) and key airport stakeholders have a higher probability of coordinated, effective, and successful snow removal operations. Most large airports conduct regularly scheduled daily operational teleconferences to maintain communication throughout the year. Some airports host daily face-to-face briefings. Airport operators at smaller facilities cultivate working relationships with FBOs, key tenants, and pilots. Some airports host on-airport events as a means to create and improve important relationships. Investment in personal relationships pays dividends during a snow and ice control event.

- **Clarity**—Avoid unnecessarily complex communications and the use of potentially ambiguous terminology to increase the likelihood of understanding. Make sure the point of the message is abundantly clear.
- **Concise**—Be concise in verbal and especially written communications to facilitate rapid understanding. Supporting or background information can always be provided later, if needed.
- **Targeted**—Target messages to specific audiences, or provide the messages in a manner that enables the intended audience to easily extract the information directly relevant to it.
- **Timely**—Disseminate information as soon as is practical to enable the intended audience to understand, consider, and act on the information, if necessary.
- **Recurring**—Communicate important information more than once to ensure it reaches the intended audience, particularly if the information is relevant and to be retained over an extended period of time.
- **Two Way**—Utilize two-way communication when it is important to ensure both parties understand each other as intended. Two-way communication is critically important in resolving differences. Face-to-face communication is a preferable form of verbal two-way communication, especially when dealing with complicated or contentious subject matter. It will also make collaboration much easier.

2.3 Coordination

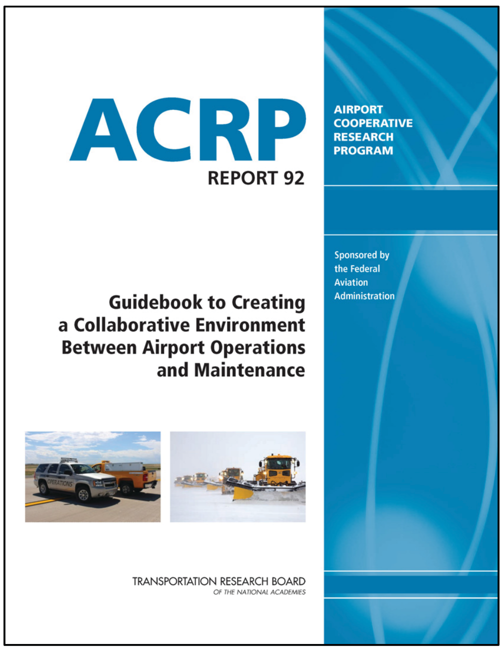
Given the number of airport departments and stakeholders that play an active role in airport operations during a winter weather event, effective coordination of each party is required to maintain safe airport operations. Winter operations coordination practices will ideally reflect the following characteristics:

- **Planned**—Planning requires the definition and communication of the overall operational goals and objectives, how these goals and objectives will be achieved, and what roles and responsibilities individuals have in achieving them.
- **Efficient**—Winter operations efficiency is achieved when individuals and organizations understand and execute their specific assigned roles and responsibilities without requiring duplication or redundancy.
- **Defined Authority**—A clearly defined chain-of-command increases operational efficiency and minimizes the potential for miscommunication or uninformed decision making.
- **Effective Leadership**—Effective leadership is required throughout the coordination process, from planning to execution, and enables clear direction and responsive, unimpeded, two-way communication flow between employees, supervisors and management.

- **Inclusive**—Airport departments and stakeholders actively participating in winter operations should have liaisons to the command structure to facilitate integration of operations and timely information exchange.
- **Adaptive**—The coordination process must withstand unanticipated events by remaining flexible and allowing airport employees, supervisors, managers and stakeholders to adapt to changing conditions (*3*).
- **Reliable**—The coordination process must provide reliable information and produce reliable outcomes. Without reliability, plan deviations will increase, efficiency will decrease, and decision making will become isolated.

2.4 Collaboration

ACRP Report 92: Guidebook to Creating a Collaborative Environment Between Airport Operations and Maintenance defines collaboration as two or more individuals or organizations with complementary skills interacting to develop a shared understanding and achieve shared goals that none had previously possessed or could have achieved on their own (*4*, p. 110). Collaboration among airport departments and stakeholders is imperative in the pursuit of improved winter operations outcomes for all parties involved. Chapter 10 of this guidebook relies on effective collaboration as part of evaluating winter operations performance and specifically investigating and improving performance shortfalls.



Collaboration is a well-documented business management concept. However, despite common acceptance of the need for collaboration, it does not always occur unimpeded. Building a collaborative environment with others requires the commitment of all involved. While the need for collaboration within a multi-stakeholder airport setting has long been recognized, *ACRP Report 92* confirms that challenges to collaboration remain within and beyond airport organizations. Effective collaborative efforts include the following characteristics:

- **Outcome Oriented**—Progress toward achieving shared goals will sustain a collaborative effort, while a lack of progress will erode confidence among participants that a collaborative effort is worthwhile.
- **Leadership**—While there may be a number of participating stakeholders, the airport operator needs to offer effective leadership to facilitate buy-in, collective decisions, and ultimately progress toward the group's shared goals.
- **Understanding**—Individually, participants in collaborative settings need to make a concerted effort to listen to each other for the sake of understanding. Doing so will encourage others to listen.
- **Respect**—All participants need to respect each other's opinions and perspectives, and acknowledge that, while differences may exist, they will each benefit from achieving shared goals.
- **Compromise**—Given the inevitability of competing individual interests, compromise will, at times, be required to continue moving forward. While this may sound idealistic, compromise is realistic if participants' focus remains on the benefits of achieving the shared goals rather than on how that is accomplished.
- **Trust**—In the presence of understanding, respect, and compromise, trust between the airport operator and its stakeholders will grow and facilitate progress toward shared goals.

"Effective collaboration is attained through broader participation. Addressing the state of just one division or department in an airport neglects to understand the entirety of the issue. Instead, a practical approach to fostering collaboration must be utilized. Any and all other agencies that affect the decision-making process, such as federal and state agencies, airlines, and other tenants, must also be considered in the effort."—ACRP Report 92 (*4*, p. 6).

2.4.1 Collaborating with Peer Airports

As with many aspects of airport management, maintaining close relationships with peer airports can prove invaluable in the planning and conduct of winter operations. Collaborating with airports that experience comparable winter conditions is an ideal way to gain insights into equipment needs, performance, and operation. Aviation industry conferences focused on winter operations present invaluable opportunities for group and one-on-one information sharing. Most of the airports with industry-recognized winter operations that were contacted during the research phase for this guidebook cited staff attendance at winter operations conferences as contributing to their program success. Specifically, these airports benefitted from others sharing lessons learned and from their staff developing a professional network to facilitate further winter operations collaboration.

CHAPTER 3

FAA Requirements and Guidance Related to Winter Operations

The sponsors of public-use U.S. airports that accept FAA-administered airport development assistance also assume federal obligations mandated by federal statute and incorporated in the grant agreements and property conveyance instruments entered into by the sponsor and the U.S. government. These obligations include maintaining and operating airport facilities safely and efficiently and in accordance with specified conditions (*5*, p. 1–5). Except for certificated airports subject to the additional requirements of Federal Aviation Regulations (FAR) Part 139, "Certification of Airports," the federal obligations to maintain the airport safely and efficiently do not impose specific responsibility to remove snow or slush or to address icy pavements. However, these airport sponsors are responsible for providing a safe, usable facility, which may require closing all or parts of an airport until unsafe conditions, including accumulated snow and slush, are remedied within a reasonable amount of time (*5*, p. 7–8).

Certificated airports located where snow and icing conditions occur, and thus subject to Section 139.313, "Snow and Ice Control," must also prepare, maintain, and carry out an SICP in a manner authorized by the FAA Administrator. Section 139.313(c) directs these airport operators to certain ACs that contain methods and procedures for snow and ice control equipment, materials, and removal that are acceptable to the FAA Administrator. There are additional ACs that also offer guidance directly applicable, or applicable in part, to airport winter operations.

During the airport site visits conducted as part of the research for this guidebook, airport staff requested that the guidebook identify and summarize ACs applicable to winter operations. To accommodate this request, the following sections provide a particular AC description, including a summary of its purpose extracted from the referenced document. For certain ACs, additional information is provided to illustrate their relevance to winter operations. Guidebook users are encouraged to monitor FAA's web site to identify when draft, new, and revised ACs are available. FAA's index of Series 150 ACs for Airport Projects is accessible at: http://www.faa.gov/airports/resources/advisory_circulars.

3.1 ACs Presenting Methods and Procedures for Snow and Ice Control Equipment, Materials, and Removal

3.1.1 AC 150/5200-30C, *Airport Winter Safety and Operations*

This AC provides guidance to assist airport operators in developing an SICP, conducting and reporting runway friction surveys, and establishing snow removal and control procedures.

3.1.2 AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*

This AC provides guidance for the site selection and design of buildings used to store and maintain airport snow and ice control equipment, store approved materials, and provide personnel required to support the requirements under the airport operator's winter storm management plan.

Source: Gresham, Smith and Partners

3.1.3 AC 150/5220-20, *Airport Snow and Ice Control Equipment*

This AC provides guidance to assist airport operators in the procurement of snow and ice control equipment for airport use. Change 1 provides guidance to airport operators involved in the procurement of snowsweepers to control ice and snow at airports during inclement weather.

3.2 Other Winter Operations-Related ACs

3.2.1 AC 91-6A, *Water, Slush, and Snow on the Runway*

This AC is issued to provide information, guidelines, and recommendations concerning the operation of turbojet aircraft when water, slush, and snow are on the runway.

3.2.2 AC 120-57A, *Surface Movement Guidance and Control System (SMGCS)*

This AC describes the standards and provides guidance in the development of a Surface Movement Guidance and Control System plan for U.S. airports where scheduled air carriers are authorized to conduct operations when the visibility is less than 1,200 feet runway visual range. An SMGCS plan facilitates the safe movement of aircraft and vehicles on the airport by establishing more rigorous control procedures and requiring enhanced visual aids.

3.2.3 AC 150/5200-18C, *Airport Safety Self-Inspection*

This AC provides information to airport operators on airport self-inspection programs and identifies items that airport operators should include in such a program. Section 10 discusses regularly scheduled snow and ice inspections that are required to evaluate an airport's implementation of their FAA-approved SICP. Additionally, Section 13 discusses special condition snow and ice inspections that may be needed during winter storms until the airport is back to normal operation.

3.2.4 AC 150/5200-28D, *Notices to Airmen (NOTAMS) for Airport Operators*

This AC provides guidance on using the NOTAM system for airport condition reporting. Paragraph 15 discusses multiple NOTAM messages that have special reporting considerations under certain conditions. These conditions include friction measurement, braking action, winter conditions, depth of snow, plowed runways, runway sanding or deicing, snowbanks, and continuous snow removal operations on multiple runways.

3.2.5 AC 150/5210-20, *Ground Vehicle Operations on Airports*

This AC and its attached appendices provide guidance to airport operators in developing training programs for safe ground vehicle operations and pedestrian control on the airside of an airport. This includes both movement and non-movement areas, ramps, and aprons. Not all the items addressed in this document will be applicable at every airport. The FAA recommends that each item be evaluated in terms of how it may apply to the size, complexity, and scope of operation of the airport. This AC contains recommended operating procedures, a sample training curriculum, and a sample training manual.

Source: M-B Companies, Inc.

Section 11(c) of AC 150/5210-20 (Change 1) discusses snow and ice removal as it relates to vehicles and operators required to remove snow and ice. A vehicle operator's situational awareness may diminish as a result of snow conditions at airports. Generally, poor weather conditions can be attributed to snow, fog, and rain, and these conditions create additional risks when operating vehicles at airports.

3.2.6 AC 150/5210-25, *Performance Specification for Airport Vehicle Runway Incursion Warning Systems (RIWS)*

This AC provides a performance specification for airport vehicle RIWS equipment. It discusses two types of detection systems: a preconfigured, commercial off-the-shelf system and a system with custom hardware and software. Runway incursions could happen more frequently due to winter weather conditions that may potentially increase loss of situational awareness and add to poor visibility.

3.2.7 AC 150/5220-16D, *Automated Weather Observing Systems (AWOS) for Non-Federal Applications*

This AC contains the FAA's standard for the non-federal AWOS. It applies to anyone proposing to design, procure, construct, install, activate, or maintain an AWOS. Section 3.17 discusses runway surface condition sensors, which should be capable of detecting three runway conditions: dry runway, wet runway, and possible freezing conditions. There are performance testing criteria that the sensor must meet during an entire winter season.

3.2.8 AC 150/5220-22B, *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*

This AC contains standards for the planning, design, installation, and maintenance of EMAS in runway safety areas. Engineered materials are high energy absorbing materials of selected strength, which will reliably and predictably deform under the weight of an aircraft.

Section 9 of AC 150/5220-22B discusses EMAS design requirements including construction that accommodates navigational aids within the EMAS boundary. Any snow or ice accumulation on the navigational aids (prior to removal) cannot interfere with the functionality of any navigational aids within the EMAS. Furthermore, "the EMAS design must consider ice accumulation and, in areas that are subject to snow or ice removal requirements, must be designed to be mechanically or manually cleared of ice and snow." Section 10 discusses material qualification that indicates all materials comprising the EMAS must be resistant to deterioration due to blowing sand and snow. Additionally, Appendix 3 discusses SRE that is compatible with the EMAS base.

3.2.9 AC 150/5220-26, *Airport Ground Vehicle Automatic Dependent Surveillance Broadcast (ADS-B) Out Squitter Equipment*

This AC provides guidance on the development, installation, testing, approval, and maintenance of ADS-B out squitter units for airport ground vehicles. Using this AC, airports will be able to acquire approved and authorized airport ground vehicle ADS-B squitter units that are compliant with Title 14 Code of Federal Regulations (CFR), Part 91, ADS–B Out Performance Requirements to Support Air Traffic Control (ATC) Service, as well as the initial set of ADS-B applications. Please note that the technical specifications for manufacturing ADS-B squitter units for airport ground vehicles are published in the FAA's document, Vehicle ADS-B Specification, Version 2.4, published May 01, 2012. Ground vehicles used for airport winter operations that will be outfitted with ADS-B out squitter equipment are subject to this AC.

3.2.10 AC 150/5300-14C, *Design of Aircraft Deicing Facilities*

This AC provides standards, specifications, and guidance for designing aircraft deicing facilities. It discusses the subjects of sizing, siting, environmental runoff mitigation, and airfield operational requirements to maximize deicing capacity while maintaining safety and efficiency. It also provides design recommendations and emphasizes that centralized aircraft deicing facilities have unique deicing/anti-icing operational issues associated with deicing/anti-icing aircraft that must be addressed.

Source: Gresham, Smith and Partners

3.2.11 AC 150/5320-12C, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*

This AC contains guidelines and procedures for the design and construction of skid-resistant pavement, pavement evaluation with friction measuring equipment, and maintenance of high skid-resistant pavements.

3.2.12 AC 150/5320-15A, *Management of Airport Industrial Waste*

This AC provides basic information on the characteristics, management, and regulations of industrial wastes generated at airports and guidance for the development of a Stormwater Pollution Prevention Plan (SWPPP) that applies best management practices (BMPs) to eliminate, prevent, or reduce pollutants in stormwater runoff associated with particular airport industrial activities. A major problem facing airport operators is the pollutant loading from deicing/anti-icing runoff to receiving waters and wastewater treatment plants to ensure compliance with applicable permits and regulations.

3.2.13 AC 150/5340-26B, *Maintenance of Airport Visual Aid Facilities*

This AC provides recommended guidelines for maintenance of airport visual aid facilities. It addresses using in-pavement taxiway edge lights more frequently in areas of high traffic or

Source: Fortbrand Services, Inc.

frequent damage resulting from SRE. It also describes practices to lessen the damage to light fixtures by SRE removing snow around the lighting fixtures so that the fixtures are not obscured.

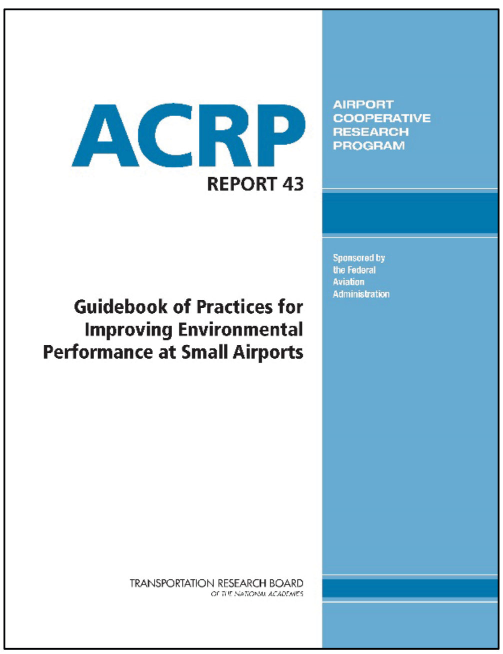
3.2.14 AC 150/5370-17, *Airside Use of Heated Pavement Systems*

This AC establishes minimum performance requirements for the design, construction, inspection, and maintenance of heated pavement systems for use in the aircraft operations area. The AC includes principles of operation and applications; design process, including heat requirements, formulas, and sample calculations; prospective locations and characteristics; design considerations for electric and hydronic systems, including system controls; system performance requirements and specification template; system construction requirements and specification template; and inspection and maintenance requirements. Heated pavement systems offer an alternative strategy for effectively mitigating the effects of winter contaminants by melting snow and preventing bonding to the pavement surface.

CHAPTER 4

Regulation of Winter Operation Impacts on Stormwater

Planning for winter operations requires identifying applicable laws and regulations, understanding their implications, and incorporating operational and infrastructure controls to achieve and maintain compliance. Typical winter operations planning activities are understandably focused on compliance with regulations and ACs intended to maintain safe and efficient airport and aircraft operations, as described in Chapter 3. However, familiarity with the laws and regulations intended to control the impact that winter operations have on the environment, including on stormwater runoff quality, is also important and expected.



Routine operations at an airport are subject to extensive environmental regulation. *ACRP Report 43: Guidebook of Practices for Improving Environmental Performance at Small Airports* presents a summary of applicable federal regulations. *ACRP Report 43* also identifies common regulated operational activities, including activities associated with winter operations, and potential regulatory compliance attainment strategies. Additionally, it addresses the regulation of unplanned events, such as fuel spills during equipment fueling. Guidebook users are encouraged to review *ACRP Report 43* if in need of a comprehensive overview of the airport environmental regulatory environment. However, this chapter focuses on the regulation of winter operation impacts on stormwater runoff quality and methods to mitigate these impacts.

4.1 Airport Winter Operation Activities Affecting Clean Water Act (CWA) Regulation and Compliance

The most significant environmental concern associated with airport winter operations is the potential impact on airport stormwater runoff quality. Activities potentially impacting stormwater runoff quality are strictly regulated under the federal CWA. Winter operations by their nature interact with, occur in response to, and require the management of precipitation and resultant stormwater runoff. Stormwater runoff enters storm drains and is routed through stormwater infrastructure to surface water bodies nearby the airport (e.g., streams, rivers, lakes, oceans, etc.). In some situations, stormwater can also be directed to the sanitary sewer. The following winter operation activities can affect stormwater runoff quality, and their potential impact on compliance with the CWA is described further in this section:

- Application of various chemical deicers to aircraft, paved surfaces, and ground equipment;
- Application of sand to paved surfaces; and
- Storage and mechanical melting of deicer-contaminated snow.

4.1.1 Application of Chemical Deicers


Source: Wausau Equipment Company

Chemical deicers are used during the winter season at most northern-tier airports. The term "chemical deicer" encompasses chemicals that assist in melting and preventing refreezing of snow and ice (i.e., deicers) and chemicals that are used to prevent the adhesion of frozen precipitation on clean surfaces (i.e., anti-icers). Chemical deicers may be applied to aircraft as a liquid mixed with water, and to paved surfaces as a liquid or solid. Airport operators are typically responsible for application of pavement deicers. Airport operators may not have direct control over the application of aircraft chemical deicers. However, once the applied aircraft deicers fall onto paved surfaces of airports, airport operators are typically responsible for managing the deicer-impacted stormwater in a manner compliant with applicable environmental regulations and environmental permits. This is accomplished through the planning, construction, and operation of a deicer management system. A detailed discussion of deicer management systems and their components is provided in Section 4.4.

Chemical deicers can be problematic environmentally primarily because they contain highly biodegradable organic constituents. When those constituents are discharged to the storm sewers and to receiving waters, they begin to degrade if exposed to microbial organisms, typically in the form of bacteria. The bacteria use the organic components of the chemical deicers as a food source and in the process use oxygen dissolved in the water. If the levels of dissolved oxygen in receiving surface waters get low enough, fish and other aquatic organisms may be harmed. As such, minimum levels of dissolved oxygen in water bodies are often established by regulatory agencies, which lead to limitations on the quantities of biodegradable pollutants that can be discharged to those water bodies. Those limitations on substances that "demand oxygen" when biodegrading are often expressed in permits in terms of laboratory analyses designed to measure how much oxygen is used up when the deicers are biologically or chemically oxidized. This includes biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Total organic carbon (TOC) is another laboratory measurement that is used to quantify how much organic chemical is present in a sample. In deicer-impacted stormwater, TOC can often be correlated reasonably well to BOD and COD and is, therefore, sometimes included in the effluent limitations or monitoring requirements of permits.

The principal constituents of chemical deicers that are susceptible to biodegradation are the freezing point depressants, which most often are propylene glycol (PG) and ethylene glycol (EG), glycerin, acetates, and formates. Most aircraft deicers are glycol-based with some use of glycerin. Pavement deicers can include any of these constituents. Relatively speaking, PG presents the most significant oxygen demand, followed by glycerin, and then EG.

While the oxygen-depleting characteristics of chemical deicers typically drive environmental permit requirements and the need for deicer management at most airports, other potential environmental effects of chemical deicers may be significant drivers for permit compliance and deicer management at some airports, including:

- Toxicity (potentially from the freezing point depressants and deicer additives);
- Odors;
- Foaming;
- Total dissolved solids (TDS) concentrations from the inorganic salt portion of pavement deicers like sodium formate and potassium acetate; and
- Contribution to biofilm growth of receiving waters (i.e., nuisance growth).

These effects could restrict the amount of the pollutants associated with deicers that are allowed to be discharged to surface waters. The importance of these factors as drivers for environmental permit compliance and deicer management is site specific. Often their importance is driven by characteristics of the receiving stream, applicable state regulations, local regulatory environment, public input, and past history of environmental impacts. It is advisable for personnel managing winter operations to be aware of the potential environmental impacts that underlay environmental permit conditions and compliance expectations.

4.1.2 Application of Sand

Sand is sometimes used instead of, or in conjunction with, chemical deicers to increase friction on runways, taxiways, and ramp areas. The sand is chemically inert, but it can contribute to the solids discharged to water bodies that receive airport stormwater runoff. Often, stormwater discharge permits have requirements that limit and/or require monitoring of solids which are often quantified through an analytical parameter called total suspended solids (TSS). Application and subsequent transport of applied sand can increase the concentration of TSS in stormwater runoff, which increases the potential for a violation of stormwater discharge permit criteria or creation of a water quality issue in the streams. In addition to potentially obstructing in-pavement lighting, sand can also build up, interfere with, and potentially damage the catch basins, pumps, pipes, tanks, and treatment units associated with deicer management systems, as well as with mechanical snowmelters.

4.1.3 Deicer-Contaminated Snow Storage and Mechanical Snow Melting

Snow falling on paved surfaces is often plowed, broomed, or blown to adjacent perimeter and infield areas, or hauled to designated snow dumps. Both aircraft and pavement chemical deicers can be mixed with the snow (sometimes referred to as "pink snow" due to the dyes in the aircraft deicers). Natural melting of piled or stored snow can often occur over long periods of time. From an environmental standpoint, this often means a prolonged discharge of chemical deicers mixed within the snow well after the time of application. There is some evidence that chemical deicers may migrate from snow piles at rates faster than the rate the snow melts (the "snow cone effect"), resulting in discharges of high concentrations of BOD and presenting a deicer management and permit compliance challenge (6). Rain events and/or increases in temperature can also accelerate melting and chemical deicer discharge. For these reasons, collection and treatment of runoff may be required and provided through a deicer management system.

Source: Gresham, Smith and Partners

It may be necessary, or simply advantageous, to mechanically melt snow. The procedure can take a variety of forms. Snowmelters may be permanently installed at a specified location or they may be mobile, meaning the melted snow discharges to different portions of the storm sewer system at different times. Mechanical snow melting can occur in close proximity to the source of the accumulated snowfall or in remote areas off the ramp where dedicated snow piles exist. Because of the variability in location and timing of mechanical snow melting operations, snow melting can have a significant effect on an airport operator's ability to comply with its environmental permits and the performance of its deicer management system.

4.2 National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge Permitting Under the CWA

Most winter operations occur in areas of airports that discharge stormwater runoff through a point source outfall to a receiving water body. The operations at airports are considered to be industrial activities and are, therefore, required to have one of two types of NPDES permits for industrial activities: a general NPDES permit that is applicable to a group of facilities, or an individual NPDES permit issued specifically for a facility. A few airports are subject to both general and individual NPDES permits. The permitting agency will determine the required permit. To apply for a stormwater permit, an airport operator is typically required to submit a notice of intent. The assigned permit will then provide the criteria, conditions, and monitoring requirements that govern the allowable stormwater discharges. Familiarity with the NPDES permit is essential for appropriate winter operations planning and decision making.

NPDES permits are issued with an effective duration of up to five years, and must be renewed, typically starting six months prior to expiration. It is not uncommon for permit limits and conditions to change when permits are renewed. Permit changes relevant to winter operations should be communicated during pre-season winter operations planning.

4.2.1 General NPDES Permits

A general NPDES permit contains generic language that is applicable to the facilities covered under the permit. General NPDES permits may contain numeric effluent limitations or, more frequently, discharge benchmarks. Effluent limitations define the maximum or minimum extent of pollutants in a discharge. Often, those limits are in terms of concentrations (e.g., maximum BOD concentration) or mass loading (e.g., maximum kilograms of TSS per day). Exceeding those limits can constitute a violation of the permit. If permit criteria are violated, the regulatory agency can require a series of compliance actions that can range from submitting a letter describing the reason for the exceedance to daily fines. Repeated permit violations or excessively high exceedances of criteria can result in the regulatory agency issuing orders or decrees for specific and potentially costly actions to correct the issue. Individuals can also be held responsible for willful violation of permit conditions.

Source: Gresham, Smith and Partners

Effluent benchmarks are less restrictive than effluent limits. If benchmarks are exceeded, the permittee does not incur a permit violation, although it may be required to implement additional practices to prevent further exceedances. If benchmark exceedances continue, more restrictive measures and fines can be required by the permitting authority. The authority could also potentially implement effluent limitations in place of benchmarks if it finds a reasonable potential for frequent exceedance of the benchmarks.

General permits may contain requirements to perform monitoring of stormwater discharges, although the monitoring requirements are often less intensive than in individual NPDES permits. State agencies delegated authority to administer the NPDES program have issued general permits modeled after the U.S. Environmental Protection Agency (EPA) multi-sector general permit, which is only directly applicable to a small number of states that do not have their own NPDES permitting authority. The multi-sector general permit includes requirements that apply specifically to air transportation facilities, including conditions associated with discharges from airfield and aircraft deicing activities. The multi-sector general permit includes effluent monitoring benchmark concentrations for COD (120 mg/L), five-day biochemical oxygen demand (BOD_5) [30 milligrams per liter (mg/L)], ammonia-nitrogen (2.14 mg/L), and pH (6.0–9.0 standard units).

In addition to monitoring stormwater discharges, a general NPDES permit typically includes requirements to:

- Prepare an SWPPP for industrial activities (also refer to AC 150/5320-15A, *Management of Airport Industrial Waste*);
- Conduct inspections;
- Train employees;
- Clean up spills; and
- Implement BMPs.

BMPs are processes, procedures, and structural controls to reduce the release of pollutants typically near the pollutant source. Some BMPs, such as those related to handling of deicer, would be implemented by winter operations staff. As a result, BMPs related to winter operations should be identified in winter operations plans and staff should be trained on the procedures.

4.2.2 Individual NPDES Permits

Individual NPDES permits typically have specific numeric effluent limitations for one or more pollutants, and are usually required by the state agency or EPA in lieu of general permits based upon a higher concern for potential violations of water quality standards. Like general NPDES permits, individual NPDES permits include requirements for preparation of a SWPPP for implementation of BMPs. An individual NPDES permit will often include numeric effluent limits and, potentially, narrative criteria further limiting discharges. Often numeric limits are based on the values that will prevent water quality standards established for the receiving stream from being violated. Individual NPDES permits may also have numeric effluent limits derived from treatment-technology-based standards.

4.2.3 Effluent Limitations Guidelines (ELGs) and New Source Performance Standards (NSPSs)

Airport NPDES permits may include technology-based ELGs to control airport deicing discharges. According to the EPA Fact Sheet, "Effluent Guidelines for Airport Deicing Discharges," the ELG requirements generally apply to chemical deicer-impacted stormwater (referred to as wastewater in the fact sheet) associated with the deicing of airfield pavement at primary airports. Specifically, the fact sheet identifies the following requirements:

- "Existing and new primary airports with 1,000 or more annual jet departures ("non-propeller aircraft") that generate wastewater [i.e., pavement deicer-impacted stormwater] associated with airfield pavement deicing are to use non-urea-containing deicers, or alternatively, meet a numeric effluent limitation for ammonia [i.e., 14.7 mg/L, prior to dilution or mixing with non-deicer-impacted stormwater]" (*7*, p. 1).

Additionally, certain NPDES permits may include NSPS applicable to the following subset of airports described in the fact sheet:

- "New airports with 10,000 annual departures located in cold climate zones are required to collect 60 percent of aircraft deicing fluid after deicing. Airports that discharge the collected aircraft deicing fluid directly to waters of the U.S. must also meet numeric discharge requirements for COD [i.e., 271 mg/L daily maximum, 154 mg/L weekly average]. The rule does not establish uniform, national requirements for aircraft deicing discharges at existing airports. Such requirements will continue to be established in general permits, or for individual permits on a site-specific, best professional judgment basis" (*7*, pp. 1–2).

The provision of the ELG associated with urea-based deicers is critical to understand for airport operators applying pavement deicers. While many airport operators have moved away from the formerly widespread use of urea to melt snow and ice on pavements, some airports still utilize urea or have provisions for use of urea on an emergency basis. The ELG rule does not outright ban use of urea; however, if an airport uses urea, even on an emergency basis, it must ensure that the concentration of ammonia-nitrogen in discharges to the surface waters does not exceed 14.7 mg/L. Since widespread use of urea can easily result in stormwater concentrations greater than 14.7 mg/L, airport operators who consider the continued use of urea may need to demonstrate a means for collecting and/or treating urea-impacted stormwater to reduce ammonia concentrations to less than 14.7 mg/L.

Summary of ELG and NSPS Considerations for Airport Winter Operations

- Use of urea as pavement deicer is banned unless ammonia concentrations at stormwater discharge points are less than 14.7 mg/L.
- There are no national requirements for aircraft deicing discharges for existing U.S. airports.
- COD effluent limits are applicable only to new airports with sufficient flight operations.
- No specific type of deicer treatment technology is mandated.
- ELG-driven conditions are incorporated into NPDES permits.

4.2.4 Guidance for Interpreting Conditions in NPDES Permits

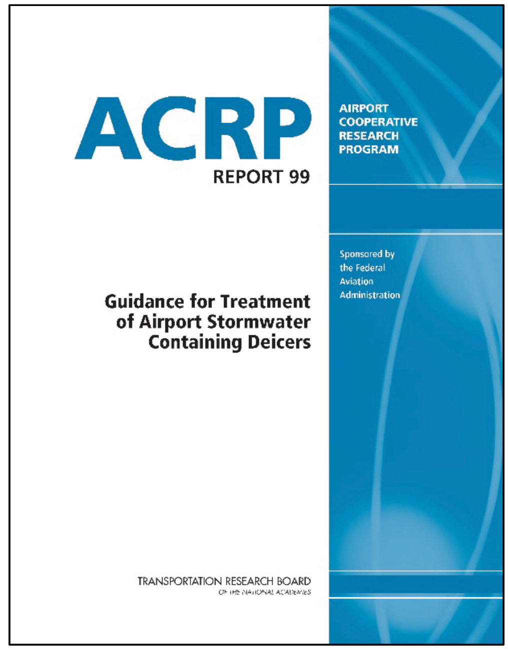
The NPDES permits that govern the discharges of stormwater containing pollutants to surface water bodies may have conditions that affect winter operations. Airfield maintenance and operations staff should consult the airport environmental staff or consultants involved in the permit development and regulatory agency coordination to help interpret the applicability of the permit conditions to winter operations. Knowledge of the permit structure and conditions can be useful in interpreting measures that need to be taken in response to the permit. The permits often have the following elements:

- Listing of point source locations from which stormwater discharges are authorized,
- Limitations on the quantity or concentration of various pollutants in the discharge,
- Limitations on the volume or flow rate of stormwater that can be discharged,
- Requirements for the monitoring of pollutant concentrations and flow rate/volume,

- Special conditions under which stormwater discharges are authorized or limited, and
- Requirements for reporting monitoring data and observations.

NPDES permits for industrial activities apply on a year-round basis, but may include criteria that vary by season. Seasonal criteria are typically listed in the section of NPDES permits where effluent limitations and monitoring requirements are provided on an outfall-by-outfall basis. Criteria may be seasonal because receiving water bodies can assimilate pollutants to different extents in warmer and colder weather and because of the unique nature of winter operations at airports. Summer criteria can often be more stringent than winter criteria. At some airports, the management of snow piles or stored deicer-impacted stormwater can extend into the summer time frame in the NPDES permits. It is, therefore, important to be aware of winter versus summer differences in permit conditions, including the dates at which the conditions change. For example, discharges from snow piles that may have met winter season permit limits might exceed summer season limits.

It is important for airport operators to determine which permit limits represent the most restrictive limits, or governing conditions, in the permit. For more guidance on determining governing conditions from permits and agreements, see *ACRP Report 99: Guidance for Treatment of Airport Stormwater Containing Deicers.*



Summary of NPDES Permitting Considerations for Airport Winter Operations

- NPDES permits for industrial activities are the primary means for regulating discharge of deicer-impacted stormwater.
- Effluent limits are based primarily on local water quality standards.
- Different limits can apply in summer and winter.
- Each drainage area and outfall can have different limits.
- BMPs for managing stormwater may be required and are typically described in an SWPPP.

4.3 Other Regulatory Programs Applicable to Airport Winter Operation Activities

In addition to the NPDES permit program, airport winter operations may also be subject to additional regulation. Chemical deicer-impacted stormwater or applied deicer runoff may be regulated under a municipal separate storm sewer system (MS4) permit, if it is discharged into a stormwater conveyance system owned or operated by a public entity. Additionally, discharges into a sanitary sewer where the discharge is eventually treated at a publicly owned treatment works (POTW) may be regulated by the POTW under the national pretreatment program. For additional guidance on MS4 and pretreatment program requirements, see *ACRP Report 99: Guidance for Treatment of Airport Stormwater Containing Deicers.*

4.4 NPDES Compliance Through an Airport Deicer Management System

If stormwater runoff from winter operations is likely to contain pollutants from deicer application at levels that have a reasonable potential to violate regulatory criteria and NPDES permit conditions, the stormwater must be managed to mitigate potential environmental impacts to

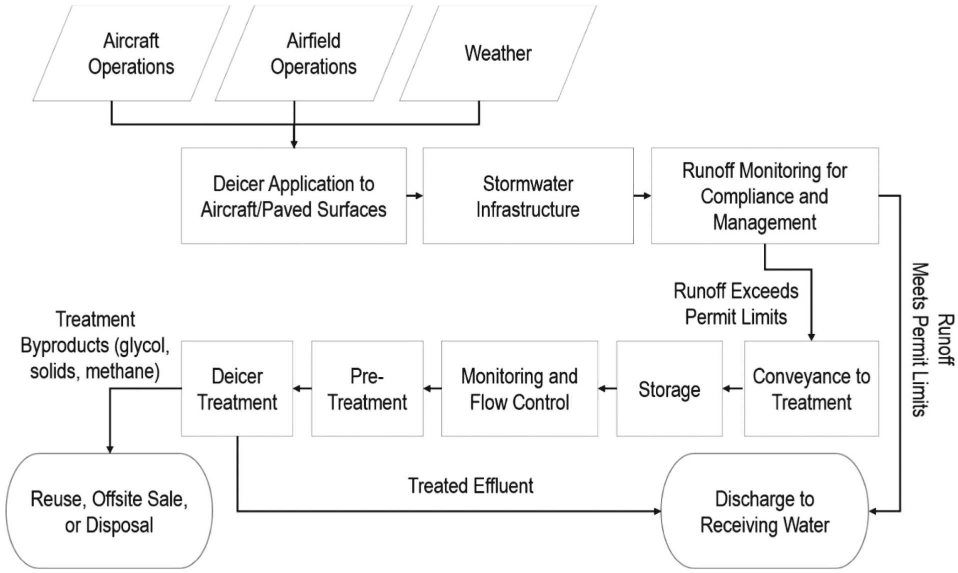


Figure 4-1. Schematic of potential deicer management system components (8, p. 2).

surface water and groundwater. The comprehensive, integrated system for managing deicer-impacted stormwater is called a deicer management system.

4.4.1 System Components

Each airport's deicer management system is different and may not include all of the components depicted in Figure 4-1. Most include some form of designated deicer application areas, stormwater monitoring, collection of impacted stormwater, and discharging stormwater in a way that meets permit conditions. Some airports required extensive systems for temporarily storing the stormwater, means for treating the stormwater onsite or offsite, and sophisticated processes for controlling the deicer management system as a whole. The components, capacities, coverage area, and complexity of an airport's individual deicer management system are dependent upon local climate, aircraft operations, airport infrastructure, assimilative capacity of the local water bodies receiving the stormwater runoff, and regulatory requirements.

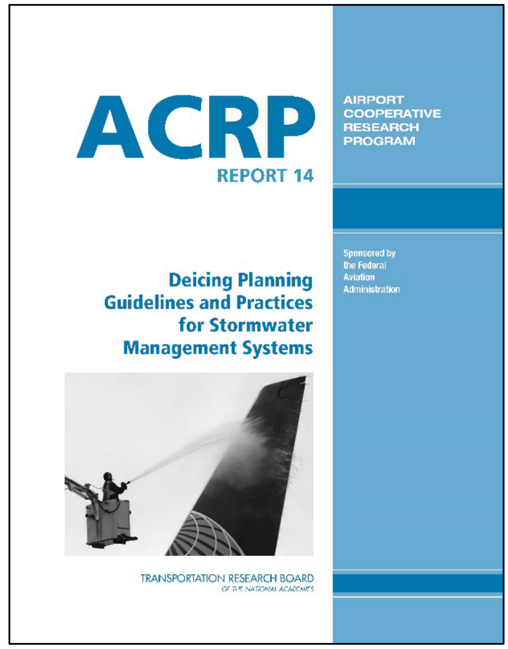
Source: Gresham, Smith and Partners

4.4.2 System Planning and Evaluation

The planning and evaluation of deicer management system needs and the design of the systems can be a complex process that can take years. As a result, implementation of a deicer management system is often undertaken outside the strict confines of winter operations planning (see *ACRP Report 14: Deicing Planning Guidelines and Practices for Stormwater Management Systems*). However, coordination between those designing deicer management systems and those responsible for winter operations planning is essential. Critical areas that require coordination and common understanding include:

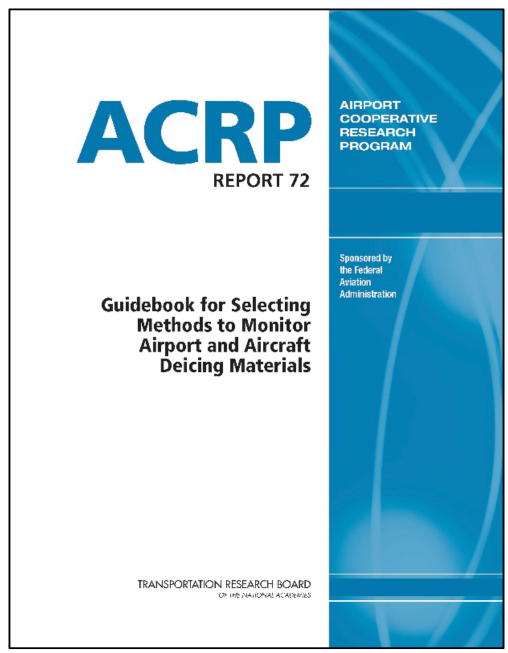
- Deicer application locations, both for aircraft and pavement deicing;
- Types and even specific brands of deicing chemicals;
- Conditions under which deicer is applied;

- Method by which deicer is applied (e.g., use of hybrid forced air deicing units for aircraft deicing);
- Tracking of deicer use;
- Forecasting future deicer use;
- Procedures for overnight parking and deicing aircraft;
- Snow plowing and blowing practices;
- Snow storage locations;
- Snow melting procedures; and
- Runway closure criteria and procedures.



Winter operations staff should actively engage those charged with the design of a deicer management system to help ensure that designers have the best available information on these practices. This will maximize the likelihood that the implemented deicer management system is appropriately sized and capable of successfully operating under the variety of conditions that may be encountered. Designers of deicer management systems should seek to thoroughly understand the winter operations practices and take steps to ensure that the overall winter operations practices are compatible with operational needs for deicer management systems. At some airports, winter operations staff has responsibilities for general winter operations and for deicer management system operation. Coordinating the timing and extent of operational needs for these two sets of responsibilities is essential.

4.4.3 Stormwater Runoff Monitoring (*9*)



Monitoring of stormwater runoff is an integral element of regulatory compliance and a means for managing winter stormwater flows within a deicer management system. This section presents a synopsis of *ACRP Report 72: Guidebook for Selecting Methods to Monitor Airport and Aircraft Deicing Materials.*

Stormwater monitoring can allow the segregation of deicer-impacted stormwater into different fractions based on concentration. The objective is to collect and potentially treat only the stormwater that has pollutant concentrations above permitted concentrations or loadings. Often in these types of systems, online monitors are used to get near-continuous measurements of flow rates and pollutant concentrations, with the results fed to a computer-based control system. If the measured values exceed predetermined set points, actions such as the opening or closing of a slide gate or the turning on or off of a pump are triggered, resulting in the routing of the stormwater to a particular location.

Airports typically implement permit monitoring programs that involve sample collection and analysis for the monitoring parameter. Monitoring consists of two elements: collection of the sample and testing of the sample to quantify the parameter in question. Sampling can be accomplished in a variety of ways, including:

- Collection of individual samples by airport or hired staff.
- Use of auto samplers that are programmed to collect samples at regular intervals or based on how much flow has passed. The auto samplers may be programmed to mix the individual samples together (composite sample) or temporarily hold individual samples (discrete samples).
- Use of specially designed sampling systems that may involve continuous or intermittent pumping of stormwater, typically to a continuous monitoring device.

The testing of the sample to quantify its characteristics typically occurs through analysis at an independent, certified analytical laboratory or analysis onsite at the airport using:

- Analytical equipment permanently situated in the lab.
- "Test kits," which are smaller instruments that may provide results with a lesser degree of accuracy than laboratory equipment. This type of testing is used when the airport desires a faster turnaround time for the results.
- Hand held instruments (e.g., a pH probe) that can be carried from point to point.
- Test equipment permanently installed near the monitoring location. This method is used when a large quantity of data is required, but is limited to a relatively narrow band of parameters.

Common analytical parameters for winter operations include: flow rate; flow volume in a day; BOD; COD; TSS; TDS; and levels of PG, EG, ammonia-nitrogen, phosphorus, pH, and temperature. It is recommended that airport personnel involved in winter operations understand the monitoring requirements, including:

- Sample/monitor location;
- Sample timing;
- Conditions that trigger sampling/monitoring; and
- Areas of the airport draining to each monitoring location.

An understanding of this information and communication with airport personnel responsible for sampling and permit compliance can result in more efficient monitoring with less risk of permit noncompliance.

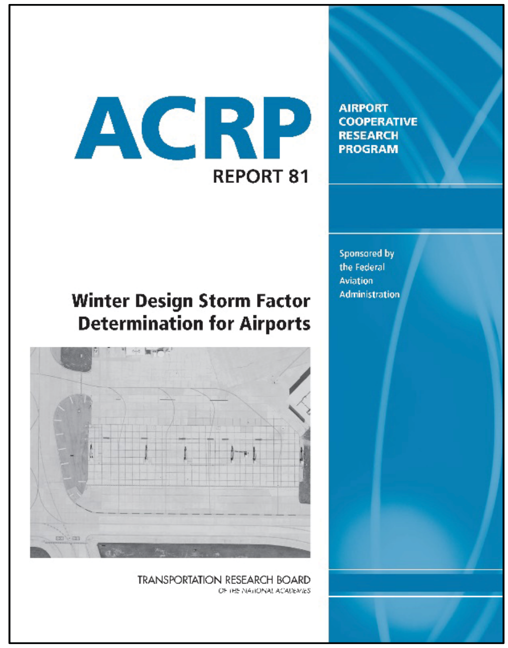
4.4.4 Runoff Collection and Storage

Source: Gresham, Smith and Partners

Deicer management systems have limitations in their ability to manage deicer-impacted stormwater. For most airports, the stormwater drainage areas are too vast for stormwater runoff from all areas to be collected with a deicer management system. As a result, stormwater collection systems are limited to areas where collection is needed to meet regulatory criteria. In addition, at some airports, deicer application is limited to small areas, such as deicing pads, so that the volume of stormwater impacted by deicers is minimized. Understanding the boundaries of the deicer application and stormwater collection is essential for winter operations staff. Deicing outside of these areas can directly lead to noncompliance with environmental permits. If through operational needs or expansion it is not feasible to deice aircraft within areas served by the deicer management systems, other measures must be taken to achieve compliance. Instances where aircraft or pavement is deiced outside of the deicer management system collection areas should be noted and reported by winter operations staff.

Many airports have storage vessels for temporarily containing deicer-impacted stormwater. The vessels may be underground tanks or pipes, lined or unlined lagoons, or aboveground storage tanks. The storage vessels are typically sized to have enough storage for relatively extreme deicing seasons. However, they do not have unlimited capacity, and it is possible that conditions may be encountered where storage capacity is temporarily unavailable. Sizing storage volumes, along with other deicing management system components, should involve identifying an appropriate design storm event, as described in *ACRP Report 81: Winter Design Storm Factor*

Determination for Airports. This process requires an understanding and analysis of airport-specific historical winter event data similar to the process described in Chapter 5 of this guidebook. Winter storm events that exceed the design storm conditions may result in the need to temporarily adjust operations, such as postponing mechanical snow melting until sufficient capacity is available. Communication between deicer management system staff and winter operations staff in these circumstances is necessary.



4.4.5 Deicer-Impacted Stormwater Runoff Treatment (*8*)

Some airports have, or are considering the addition of on-airport, deicer-impacted stormwater runoff treatment capabilities into their deicer management systems. This section presents a synopsis of the treatment discussion originally presented in *ACRP Report 99: Guidance for Treatment of Airport Stormwater Containing Deicers.*

Deicer treatment is the component of a deicer management system that removes deicers from the deicer-stormwater runoff mixture. Deicer treatment can utilize physical or biological means to reduce the pollutant content of stormwater such that it can be discharged to the surface water body or sanitary sewer. Commonly used deicer treatment systems include membrane-based glycol recycling systems, evaporation-based glycol recycling systems, and biological systems that use bacteria to degrade the deicer. Deicer treatment systems are usually designed specifically to remove or breakdown the chemical constituents in deicers and are not suitable to treat all pollutants. For example, biological treatment systems are not designed to treat the types of chemicals in jet fuel, especially at high concentrations. In fact a significant fuel spill could harm deicer treatment operations. As a result, it is important that deicer treatment systems not be used as a catch-all or dumping ground for water with pollutants other than deicers.

Deicer treatment systems may also be designed to treat specific types of deicer constituents. For example, many deicer recycling systems in the U.S. are intended to produce concentrated PG. As designed, they are usually not set up to produce concentrated streams of EG or glycerin. Therefore, if changes to the type of deicer are considered, steps should be taken to ensure their compatibility with the deicer treatment operations.

Finally, deicer treatment systems have defined maximum capacities. While many deicer management systems have means for "buffering" the treatment system through upstream storage or controlled discharge of pollutants into the treatment unit, some do not. Therefore, care must be taken with the release of spike loadings of deicer that discharge to the treatment system. This includes potential spike loadings from extended mechanical snow melting operations, dumping of deicer collected from glycol recovery vehicles into the collection system, and spills of deicer.

Source: Gresham, Smith and Partners

4.4.6 Annual Operational Review

Once deicer management systems have been implemented, there is often a learning curve associated with the operation, including the compatibility between the deicer management system operation and the remainder of winter operations. While the learning curve is often most steep in the first winter of operation of deicer management systems, each winter presents its own unique circumstances. As result, it is recommended that as each year's winter operations planning is undertaken, a portion of the effort be devoted to discussing issues from the previous winter's deicer management operations to determine if any changes to the winter operations plan or the deicer management operations should be undertaken for the next season. Aspects of the operations that should be routinely considered include:

- NPDES permit violations that occurred in the previous winter and the causes,
- Whether deicer application operations were able to be contained within areas served by the deicer management system,
- Whether snow storage areas are appropriately sized to contain deicer-impacted snow,
- Whether snow storage areas are located in areas that meet operational needs,
- Whether deicer management operations affected the airport operator's ability to perform winter operations as needed,
- Anticipated changes in deicing chemicals,
- Anticipated changes in deicing locations, and
- Access and maintenance issues.

CHAPTER 5

Historical Winter Storm Event Data

An airport operator's winter operations capabilities are rarely questioned, except when they are overwhelmed by a significant winter storm event and the impacts are felt by the airport, its stakeholders, and the traveling public. This can occur at airports of any size. At a general aviation airport, the impact may involve a single corporate aircraft unable to depart when planned. Impacts may also become apparent in more spectacular fashion at large-hub airports when closed runways result in extended flight delays, hundreds of cancellations, thousands of stranded passengers, and millions of dollars of lost revenue accompanied by prolonged and often critical media attention.

An illuminating example of the value of understanding the history of meteorological events occurred following the December 17–23, 2010 winter storm that severely disrupted London Heathrow Airport (LHR). The disruption from that storm resulted in a formal inquiry that examined LHR's winter operations practices and recommended changes to avoid a similar disruption. The resulting recommendations affected the updating of the snow plan, coordination among stakeholders, and prioritization of resources, providing for passenger comfort and the organization of the airport's emergency response structure for dealing with snow emergencies. Following the inquiry, LHR invested £10 million in additional SRE and substantially revised its response to winter storm events. The enquiry noted that the snowfall amount, 7 cm, had an expected recurrence interval of 5 years based on the meteorological period of record at LHR. However the enquiry also noted that a 22-year long stretch of mild weather had created a false sense that the risk of such a storm was remote and could be handled within the existing resources.

The following sections describe how characterizing and understanding the range of historical meteorological conditions associated with winter storm events common to an airport's geography can help with better planning, communicating, executing winter operations, and managing of expectations.

5.1 Benefits of Utilizing Historical Meteorological Data

Most airport operators rely heavily on weather forecasts at the onset of a winter storm event to plan their operations, and on real-time weather observations to adjust their plans as the event unfolds. However, few utilize historical weather data as part of their annual winter operations planning process. Those that do tend to have experienced a significant and highly visible operational disruption due to a winter storm event or are airports that have learned from the experiences of other airports. The planning topics identified throughout this guidebook demonstrate how meteorological data from historical winter storm events, or summaries of statistical analyses of these data, can offer the following benefits:

- Aligning performance targets with specific winter event conditions;
- Qualifying targeted winter event conditions to facilitate a shared understanding of the investment in infrastructure, equipment, staff, and operating procedures required to achieve performance goals;
- Facilitating airport operator and stakeholder understanding of the statistical frequency that future winter storm events may exceed the airport's winter operations capabilities;
- Facilitating airport operator and stakeholder risk-based decision making on the acceptability of the airport's winter operations capabilities and associated operational implications;
- Comparing past seasonal performance outcome and efficiency measurements to past winter storm events; and
- Comparing recent winter storm events to ranked past events to understand relative magnitude.

5.2 Meteorological Data Sources

Meteorological data are widely available for most geographic regions across the United States. Because many airports are designated National Weather Service (NWS) monitoring stations, airport-specific data may be available. The National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) provides access to digital historical weather and climate data for numerous monitoring stations through its website at: http://www.ncdc.noaa.gov/data-access/quick-links. Of the accessible databases offered by NOAA, the following two databases provide hourly meteorological data: the Integrated Surface Database, Hourly, Global (ISD); and the Hourly Precipitation Data Publication/Database.

The ISD contains the following primary meteorological parameters that, in conjunction with associated data flags or codes that indicate precipitation type, can be useful in characterizing winter storm events:

- Hourly snowfall (indicator of event severity),
- Hourly ice accumulation (indicator of event severity),
- Hourly liquid accumulation (indicator of snow density in conjunction with snowfall data),
- Hourly wind speed (indicator of drifting conditions),
- Hourly prevailing wind direction (indicator of pavement surfaces impacted by drifting when used in conjunction with wind speed),
- Hourly visibility (indicator of conditions limiting SRE performance), and
- Hourly temperature (indicator of snow density).

The Hourly Precipitation Data Publication/Database contains only hourly precipitation data available to the hundredth of an inch. The greater measurement accuracy makes this data preferable to the precipitation data that may be available through the ISD. These data can also facilitate the calculation of additional parameters of interest (e.g., total event duration). The timespan of available data, or period of record, should be reviewed to determine if there are sufficient data to characterize historical winter storm events. A step-wise process for accessing meteorological data

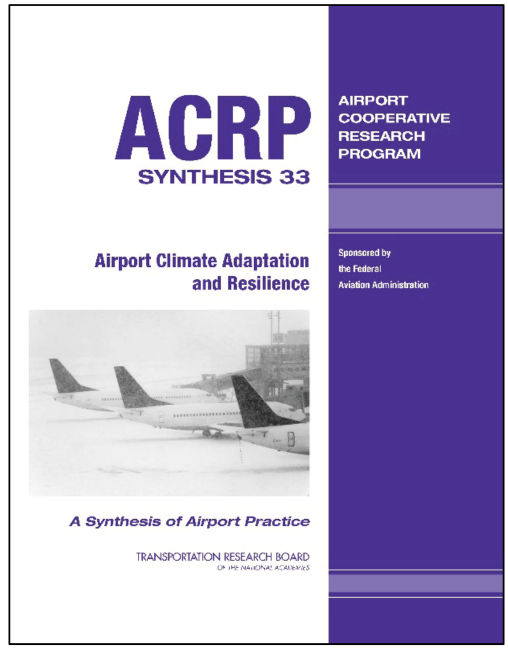
BEST PRACTICE—Weather Observation and Terminology

A basic understanding of the fundamentals of weather observation and weather terminology is of benefit to airport operations personnel. Basic meteorology courses are available at technical schools, colleges, and universities across the country. Many airports train operational personnel as NWS qualified Certified Weather Observers. In fact, the NWS has recently reached out to airports seeking to bolster the number of certified observers available at airport locations. The training guide for surface weather observations is available via the following link to the NWS website: http://www.weather.gov/om/forms/resources/SFCTraining.pdf.

from both databases is available in Appendix A. For statistical calculations of winter storm event frequency, as described later in this chapter, a large dataset of hourly records spanning at least 10 years is required. However, consideration should also be given to changing climatic conditions and the representativeness of meteorological data measurements recorded decades ago.

5.3 Climate Changes Considerations

Airports that appear to be experiencing a sustained trending of climatological change may elect to utilize data from more recent periods (e.g., the past two decades) rather than the full available period of record. While climate change and its effect on airport winter operations are beyond the scope of this guidebook, *ACRP Synthesis 33: Airport Climate Adaptation and Resilience* reviewed the range of risks to airports from projected climate change and the emerging approaches for handling them. ACRP Project 02-40, "Climate Change Risk Assessment and Adaptation Planning at Airports" (on-going at the time of this writing), is intended to develop a climate change adaptation guidebook for airports that identifies potential impacts from climate change; assesses related airport risks; and provides guidance for managing related uncertainty, developing a prioritized actions plan, and implementing the actions plan as an adaptive management process (*10*).

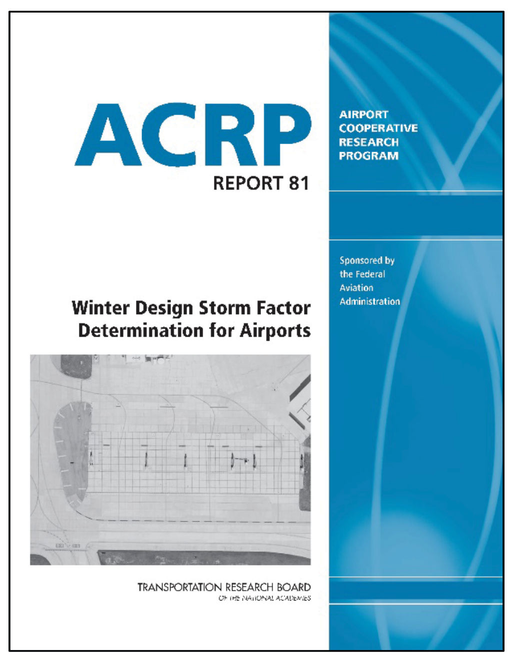


5.4 Data Manipulation and Analysis

Once historical meteorological data are downloaded into spreadsheet-type software (e.g., Microsoft Excel®), the dataset must be manipulated to eliminate unwanted data. Data manipulation and analysis can be labor intensive and may require external support, depending upon the availability and capability of airport personnel. The end goal is to identify and summarize individual winter storm events and associated event parameters documented within the dataset.

5.4.1 Steps for Manipulating Raw Historical Meteorological Data

The following steps represent a high-level overview of the steps necessary to manipulate historical data obtained from NOAA and identify individual winter events that can be later ranked:



1. Compile and relate the hourly precipitation data, if obtained from the Hourly Precipitation Data Publication/Database, into the spreadsheet containing the ISD data.
2. Maintain one parameter type per column, and all hourly parameter data occurring in the same year, month, day and hour in a single row.
3. Eliminate rows of data for location-specific non-winter season months.
4. Filter the data using accompanying snow or ice-related weather codes to locate and identify the records with the desired codes (data format documentation of the ISD data including a description of data column headers and weather codes is available at: http://hurricane.ncdc.noaa.gov/cdo/3505doc.txt).
5. Identify the beginning and end of storm events within the dataset through the use of the hourly precipitation data (see Table 5-1). Differentiating between events requires defining an inter-event period, or the period of time between the end of one storm event and the beginning of another. This

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Table 5-1. Example filtered meteorological data with highlighted winter storm event data.

YR--MO-DA-HR-MN	DIR	SPD	GUS	CLG	SKC	VSB	MW	Event Type	TEMP	DEWP	ALT	PCP01	Event Identification
200703040100	250	16	20	35	***	5	**	None	25	21	29.79	*****	None
200703040200	251	17	21	36	OVC	6	**	None	25	21	30.79	*****	None
200703040300	252	18	22	37	OVC	7	**	None	25	21	31.79	*****	None
200703040400	250	16	20	35	OVC	5	**	None	25	21	29.79	*****	None
200703040500	260	13	***	24	OVC	7	71	Snow	27	19	29.78	0.00T	Event Start
200703040600	250	16	20	35	***	5	71	Snow	25	21	29.79	0.01	Event
200703040700	260	14	20	25	OVC	5	71	Snow	26	21	29.79	0.01	Event
200703040800	240	11	***	15	OVC	5	71	Snow	25	21	29.8	0.01	Event
200703040900	240	13	***	15	OVC	3	71	Snow	25	21	29.81	0.01	Event
200703041000	290	21	32	15	OVC	1.3	71	Snow	25	21	29.82	0.01	Event
200703041100	270	21	32	14	OVC	0.1	75	Snow	23	19	29.82	0.02	Event
200703041200	270	17	32	8	OVC	0.1	75	Snow	23	19	29.82	0.05	Event
200703041300	270	17	23	10	OVC	1	75	Snow	23	21	29.82	0.10	Event
200703041400	260	17	23	8	OVC	0.1	75	Snow	23	19	29.82	0.05	Event
200703041500	270	16	23	42	OVC	2	71	Snow	25	19	29.82	0.02	Event
200703041600	260	13	22	55	OVC	3	71	Snow	24	19	29.82	0.02	Event
200703041700	260	13	***	24	OVC	7	71	Snow	27	19	29.78	0.01	Event
200703041800	260	13	***	24	OVC	7	71	Snow	27	19	29.78	0.01	Event
200703041900	250	16	20	35	OVC	8	71	Snow	27	19	29.79	0.00T	Event Stop
200703042000	250	16	20	35	OVC	9	**	None	27	19	29.79	*****	None
200703042100	250	16	20	35	OVC	7	**	None	27	19	29.79	*****	None
200703042200	250	16	20	35	***	8	**	None	27	19	29.79	*****	None
200703042300	250	16	20	35	***	9	**	None	27	19	29.79	*****	None

Note: YR = year; MO = month; DA = day; HR = hour; MN = minute; DIR = direction; SPD = speed; GUS = gust; CLG = cloud ceiling, meaning "lowest opaque layer"; SKC = sky condition; VSB = visibility; OVC = overcast; MW = manually observed present weather; TEMP = temperature; DEWP = dew point; ALT = altimeter; and PCP01 = hourly precipitation reported in hundredths of an inch (where "T" means "Trace amount").

period should be longer than the intermittent dry periods that may occur during a winter storm event. *ACRP Report 81: Winter Design Storm Factor Determination for Airports* suggests that geographically driven inter-event periods typically range between 3 and 24 hours (*11*, p. 4). The closest NWS branch office may be able to assist with determining an appropriate local inter-event period.

6. Utilize the data within the boundaries of each defined storm event to calculate the following parameters by event:
   – Total event duration (e.g., hours);
   – Total event snowfall (e.g., inches);
   – Average hourly snowfall intensity (e.g., total inches/event duration in hours);
   – Maximum hourly snowfall intensity;
   – Total event ice accumulation;

- Average hourly icing intensity;
- Maximum hourly icing intensity;
- Total event liquid precipitation accumulation;
- Average hourly liquid precipitation intensity;
- Average hourly wind speed;
- Average hourly prevailing wind direction;
- Average hourly visibility;
- Minimum hourly visibility;
- Average hourly temperature;
- Maximum hourly temperature; and
- Minimum hourly temperature.

7. Enter the above-identified calculated storm event parameters into a second separate spreadsheet with storm event start date and time as the first two column headers and each additional parameter as a separate column header. There should be only one event per row.
8. Use the second spreadsheet with individual event statistics assembled to conduct a storm event frequency analysis by event parameter.

5.4.2 Event Frequency Analysis

A recurrence interval (also referred to as a return period) for a winter storm event parameter is a statistical estimate of the probability that the given event will be equaled or exceeded in any given year. For example, a 100-year recurrence interval winter storm event snowfall total means that there is a 1 in 100 probability or 1-percent chance of the event snowfall occurring or being exceeded in any given year; whereas, a 10-year recurrence interval winter storm event snowfall total means that there is a 1 in 10 probability or 10-percent chance of the event snowfall occurring or being exceeded in any given year. Table 5-2 further illustrates the relationship between recurrence interval and probability of occurrence. However, it should be noted that in any given 100-year period, a 100-year recurrence interval event may occur more than once or not at all because weather events are independent of previous weather events.

To conduct a frequency analysis and identify event recurrence intervals for the winter storm event parameters summarized in the second spreadsheet described above, 10 or more years of data should be used. More than 10 years of data will increase the confidence level in the analysis results. Each storm event, along with all associated data, must be sorted by the parameter of interest in descending order of magnitude. For example, to determine the winter storm event recurrence interval by total event snowfall, sort the data listing the largest total event snowfall

Table 5-2. Example recurrence intervals and probabilities of occurrence.

Recurrence Interval (years)	Probability of Occurrence in Any Given Year	Percentage Chance of Occurrence in Any Given Year
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

value first. This event would receive a ranking of 1; then rank the remaining events by total event snowfall in descending order of magnitude until all of the data are ranked storm event data. Once sorted and ranked, the recurrence interval can by calculated using the following equation:

$$\text{Recurrence interval} = \frac{n+1}{m}$$

where:

n is number of years in the data record
m is the magnitude ranking

As meteorological data from subsequent winter season events are made available by NOAA, event statistics can be calculated and added to the second spreadsheet to determine recurrence intervals. Maintenance of these spreadsheets on a minimum annual frequency will require substantially less effort than the initial effort to analyze periods of record data.

Once the recurrence intervals for the winter storm events summarized in the second spreadsheet have been calculated, the information can offer perspective on past winter operations performance. For example, if an airport operator and its stakeholders understand that significant flight delays occur due to snow removal operations associated with a 2-year recurrence interval total event snowfall, they can plan around the 50-percent chance that this level of operational disruption may occur during every winter season. If the likelihood of this disruption is too high, new performance goals and objectives to reduce the likelihood of flight delays can be set and the airport operator can increase its ability to manage greater recurrence interval winter storm events. This is the concept upon which identifying threshold winter-event conditions and setting performance targets is based. Identifying threshold winter-event conditions and setting performance targets are discussed in Chapter 7.

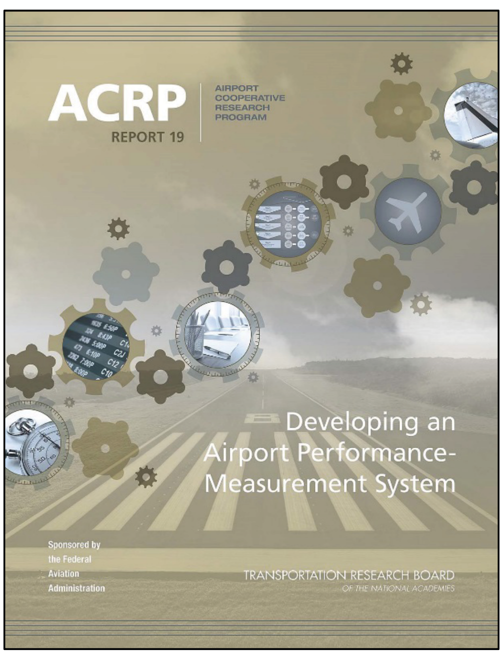
CHAPTER 6

Winter Operations Performance Measurement

Investment in winter operations to improve performance requires the identification of, collection of, review of, and action-oriented response to relevant data. Data is information, and a lack of good information leads to uninformed decisions and failure to meet expectations. This chapter presents a framework for making informed, defensible decisions based upon clear performance goals and objectives, sound data, documented baseline performance, and established winter event-based performance targets.

6.1 Identify Performance Goals, Objectives, and Measures

Many of the airports surveyed during research conducted for this guidebook had not established clear winter operations performance goals, were not measuring program elements having strategic importance to their performance, and were not using measures to guide and adjust their operational performance. Accomplishing these actions requires a structured system for goal setting and performance measurement. *ACRP Report 19: Developing an Airport Performance-Measurement System* defines performance measurement as "measurement on a regular basis of the results and efficiency of processes, services and programs" (*12*, p. 8). *ACRP Report 19* offers guidance and step-wise instruction on how to establish a formal, documented performance-measurement system. The following sections of this chapter touch on some of the many concepts presented in *ACRP Report 19*. These concepts represent key considerations for planning winter operations programs. Readers are encouraged to incorporate a performance-measurement system into the overall management system approach to winter operations outlined in this guidebook.



Goal 1: Maintain airfield pavement in safe operating condition during winter event conditions up to and including defined threshold winter event conditions.

Goal 2: Prevent injuries to personnel and damage to equipment.

Goal 3: Maintain predictable aircraft arrival rates and departure rates during winter events up to and including defined threshold winter event conditions.

Figure 6-1. Example high-level winter operation program goals.

6.1.1 Performance Goals

Goal setting for an airport winter operations program is a crucial first step toward managing performance. High-level goals should reflect the following characteristics:

- Identify a broad, desired end result;
- Originate from an airport-wide strategic goal setting process, if one exists;
- Reflect highest-level priorities for which the airport is willing to invest its resources;
- Align with other high-level airport goals;
- Reflect the input and interests of the winter operations stakeholders (see Chapter 2);
- Require the coordinated efforts of winter operations stakeholders to achieve; and
- Apply to the organization over an extended duration.

It is important to set a manageable number of goals for a winter operations program. Three to four well-conceived goals may be all that are necessary depending on airport size and complexity. Each goal may be supported by multiple related objectives, which are described in the next section. Figure 6-1 provides three examples of high-level winter operations program goals.

6.1.2 Performance Objectives

The terms "objective" and "goal" are often considered to be synonymous; however, for the purpose of this guidebook the terms are assigned unique meanings. Objectives are a subset of high-level goals. As presented earlier, a goal represents a broad, desired end result. An objective is more specific than a goal, represents a pathway to achieving a goal, and will typically be implemented over a shorter time interval. Multiple objectives may be required to support a single high-level goal (see Figure 6-2), so the total number of goals set by an airport will be driven by the number of supporting objectives. However, the total number of objectives will typically be constrained by the availability of resources (i.e., resources, capital, time) required to implement the objectives.

Figure 6-2. Relationship between goals and objectives.

Goal 1: Maintain airfield pavement in safe operating condition during winter event conditions up to and including defined threshold winter event conditions.

Objective 1-1: Maintain sufficient personnel, equipment, and materials to remove one inch of snow accumulation off priority 1 pavement within a target time duration.

Goal 2: Prevent injuries to personnel and damage to equipment.

Objective 2-1: Annually train operators on equipment operation, movement area airfield driving, and white-out conditions.

Objective 2-2: Institute a human performance factors management program for snow team operators prior to next season.

Goal 3: Maintain predictable aircraft arrival rates and departure rates during winter events up to and including defined threshold winter event conditions.

Objective 3-1: Coordinate with ATC and stakeholders to balance aircraft arrival rate with anticipated departure rate during winter events.

Objective 3-2: Maximize operational coordination between airport departments and with stakeholders.

Objective 3-3: Establish predictable priority pavement clearing process and duration.

Figure 6-3. Example objectives associated with high-level winter operation program goals.

When setting objectives, apply "SMART" criteria. While there may be alternate words assigned to each letter of this acronym, the following version is well-suited to winter operations:

- **Specific**—Is the objective specific enough to ensure consistency and avoid confusion?
- **Measurable**—Can a quantifiable measure be assigned to the objective to track progress?
- **Assignable**—Is the objective assignable to an individual or group to ensure ownership and accountability?
- **Realistic**—Is the objective within the collective capability of the airport and its stakeholders given available time and equipment, human, and financial resources?
- **Time-Based**—Does the objective have a predefined period of time during which it is to be achieved?

Figure 6-3 provides the same high-level winter operation program goals presented in the previous figure with associated example objectives.

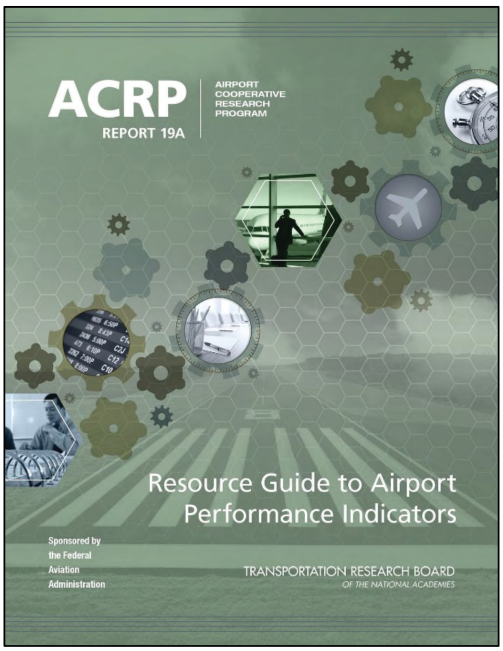
6.1.3 Performance Measures

Once objectives to support each high-level winter operations program goal are set, determine how performance can be measured so that progress toward goals and objectives can be quantified. The inability to identify clear performance measures for a goal or objective is a strong indicator that the goal or objective is not specific enough and may require further refinement.

Nearly every aspect of airport winter operations can be measured, and some airport operators collect large amounts of data over the course of a winter season. However, just because an activity can be measured does not mean that it should be. Collecting data with no pre-established purpose for how the data will be used, or how it will relate to operational goals or objectives, may result in an inefficient and ineffective use of airport resources. A fundamental concept of performance-measurement systems is to select measures that will be useful to the intended user and will offer insight into operational performance so that adjustments can be made to achieve desired results (*12*, p. 10).

Performance measurements may not be useful for all audiences within the airport organization or for airport stakeholders. For example, the average speed of a snow team on a runway covered with one inch of wet snow may be clocked at 15 miles per hour. This measurement may be useful to an airfield maintenance manager who is looking for opportunities to increase the average snow team speed. However, this measure may be of little value to the FAA ATCT or airport operations. Instead, a more useful measure may be the average SRE runway occupancy time to clear one inch of wet snow. This measure is also an indicator of snow team performance, including operating speed, but better meets the needs of this audience. The bottom line in selecting performance measures is to make sure they meet the needs of their intended audience.

As will be described later in this section, direct measures of individual activities may be most useful to personnel within an airport organization directly responsible for those activities. Measures that can serve as performance indicators for broader operations may be most useful to personnel in the organization tasked with managing overall performance to meet established goals and supporting objectives. The most beneficial strategic measures of airport winter operations are referred to as "airport performance indicators" (APIs) and are synonymous with the more familiar term "key performance indicators." The term API is used in this guidebook to facilitate consistency with *ACRP Report 19A: Resource Guide to Airport Performance Indicators*, which describes numerous performance indicators covering most facets of airport operations.



Determining which measures will be useful and offer insight requires an understanding of the various types of measures and where they originate. Figure 6-4 classifies the sources of potential measures as inputs, outputs, outcomes, and efficiencies according to their relationship to airport winter operations activities, which are driven by winter event meteorological conditions. Each classification of measure is defined below.

- **Inputs**—The resources utilized to conduct an activity (e.g., equipment capital investments, number of pieces of equipment used, number of operators required, gallons of pavement deicer applied, gallons of fuel consumed, etc.).
- **Outputs**—The results of the operational activities (e.g., square feet of pavement treated, duration of runway closures, number of aircraft operations during event, etc.).

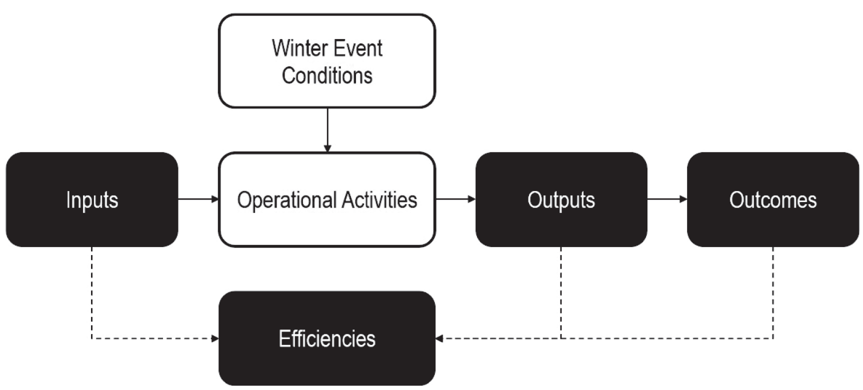


Figure 6-4. Relationship of input, output, outcome, and efficiency measures to operational activities driven by winter event meteorological conditions.

- **Outcomes**—The impacts of inputs and outputs on the airport operator and its stakeholders (e.g., increased operating costs, decreased departure delays and cancellations, no runway incursions by snow team, no go-arounds due to closed runways, etc.), which are compared to its objectives (i.e., intermediate outcomes) and goals (i.e., end outcomes).
- **Efficiencies**—Relationship of output production or outcomes to the use of inputs (e.g., total cost per square foot of treated pavement, air carrier cost per minute of runway closure, etc.).

In addition to considering the classification of measures, also consider whether measures document what has occurred in the past or indicate what may occur in the future. Measures that document what has already happened are considered lagging measures and provide data upon which to react. Most winter operations performance measures are lagging measures. Measures that indicate what may happen in the future are considered leading measures and allow proactive course corrections, as necessary, to achieve desired intermediate and end outcomes. *ACRP Report 19* suggests that few airports recognize and use leading indicators, although it advocates establishing a balance in the use of lagging and leading performance measures (*12*, p. 20). An example leading measure applicable to winter operations is average "windshield time" for SRE operators during winter events. This measure represents the average number of hours an equipment operator works during a winter event prior to a substantial rest period. As a well-documented concern for airport operators, it is an indicator of potential operator fatigue, loss of concentration and situational awareness, and other safety concerns such as vehicle collisions, runway incursions, or other undesirable performance. To be a leading measure, there should be a reasonable correlation between the measure and potential future performance.

Source: Wausau Equipment Company

Other considerations for selecting performance measures for winter operations include the following:

- **Primary**—Select primary measures that can be measured directly rather than secondary measures that must be calculated from other measures.
- **Importance**—Select measures for an aspect of an activity that is most important to, or has the most influence on, the airport's performance of that activity.
- **Control**—Avoid measuring activities when the airport does not have primary control over the activity or when the activity may be affected by multiple variables beyond the airport's control.
- **Ease of Acquisition**—Avoid measures that are difficult to capture as part of normal operations or that are labor intensive.
- **Accuracy and Precision**—Avoid measurement methods that introduce the potential for significant error in accuracy (i.e., the difference between measured and actual values) or precision (i.e., the inability to replicate measured values under identical conditions) when accurate or precise measurements are required. Conversely, avoid unnecessarily expending resources to collect accurate or precise measurements, when doing so will not increase the usefulness of the data (i.e., an indicator will suffice).

Figure 6-5 identifies possible APIs for the example high-level winter operation program goals and associated objectives presented in the earlier figures. Appendix B presents example measures that may serve as useful APIs for seven winter operations performance categories. This list does not represent all possible APIs that may be of interest to an airport. The identified APIs were the most prevalent indicators identified from airport interviews, documents, and discussion during the conduct of research for this guidebook and were included because each enables monitoring of

Goal 1:	Maintain airfield pavement in safe operating condition during winter event conditions up to and including defined threshold winter event conditions.	
	Objective 1-1:	Maintain sufficient personnel, equipment, and materials to remove one inch of snow accumulation off priority 1 pavement within a target time duration.
		API: Time to clear airside priority 1 pavement
Goal 2:	Prevent injuries to personnel and damage to equipment.	
	Objective 2-1:	Annually train operators on equipment operation, movement area airfield driving, and white-out conditions.
		API: Annual snow removal equipment operator training hours
	Objective 2-2:	Institute a human performance factors management program for snow team operators prior to next season.
		API: Snow removal equipment incursions
Goal 3:	Maintain predictable aircraft arrival rates and departure rates during winter events up to and including defined threshold winter event conditions.	
	Objective 3-1:	Coordinate with ATC and stakeholders to balance aircraft arrival rate with anticipated departure rate during winter events.
		API: Number of delayed departures
	Objective 3-2:	Maximize operational coordination between airport departments and with stakeholders.
		API: Time between runway reopening and first aircraft operation
	Objective 3-3:	Establish predictable priority pavement clearing process and duration.
		API: Number of missed approaches/go-arounds
		API: Runway occupancy time

Figure 6-5. Example APIs identified for objectives associated with high-level winter operation program goals.

airport winter operations performance. The APIs can inform decisions about whether to improve process efficiency associated with activities and/or invest in additional resources (e.g., inputs). The list will enable airports to select APIs based upon areas of interest and their own specific goals.

6.2 Plan Data Collection and Reporting

Data collection and reporting requires a potentially significant investment with the expected return being improvement in winter operations performance. The investment will include labor and may also include software and equipment to measure performance. The level of investment may vary greatly between airports based on the number of tracked performance measures. Data collection and reporting costs should be accounted for in the annual winter operations program budget. Additional considerations related to collecting and reporting performance data that may help better define the level of investment required include:

- **Who is responsible and accountable for performance data collection?** This may be the most important question because, if data are not collected as prescribed, the other questions are irrelevant. Avoid naming individuals as responsible and accountable and, instead, name a specific position(s). Staff filling these positions should then be instructed how to fulfill their responsibilities.

- **Where will performance data be recorded and stored?** Decide if data will be recorded directly into electronic format or written to hard copy and later entered into electronic format. Strive for collecting electronic data records using the most practical and efficient process possible. To accomplish this, airports need to consider what software will be used for data management and reporting. Chapter 6 of *ACRP Report 19* offers insight into software-based performance reporting.
- **How will performance data be reported?** Data reporting decisions, including how data are to be presented to management-level decision makers, are typically linked to data management software platform considerations. At a minimum, performance data should be presented in a manner that facilitates management understanding of performance trends, identifies potential performance issues, and enables management decisions to maintain or improve performance (*12*, p. 88). This is often accomplished through the use of performance scorecards or dashboards.
- **When will performance data be reported?** The frequency of performance data reporting depends upon the data and intended audience. Reporting "Time to Complete Airside Priority 1 Pavement" to an airfield maintenance department could realistically occur after each winter event, while the same API might be reported to the airport's director after each winter season. It is important to remember that performance measurements should be reported at the frequency required for decision makers to make timely, informed performance management decisions.

CHAPTER 7

Winter Operations Baseline and Performance Targets

After setting winter operations program goals and objectives, and identifying associated APIs and performance measures, a performance and cost baseline can be established to understand existing operating capabilities and set performance targets. A baseline can also be used to compare and evaluate the effectiveness of newly implemented operational strategies and tactics. This chapter presents considerations for documenting a performance and cost baseline, as well as setting performance targets once current performance capabilities and limitations are understood.

7.1 Document Performance Baseline

Available data associated with defined APIs and performance measures and data collected during previous winter seasons can be used to establish a performance baseline. However, the data should reflect the outcomes of current equipment and operational practices. Data associated with winter operations practices no longer in use offer no benefit. If no data were recorded for certain APIs during previous seasons, do not allow this lack of data to prevent moving forward with efforts to improve winter operations performance. Use the upcoming winter season to collect and document data that can then serve as a baseline for future seasons. Refer to the last section of Chapter 6 on data collection and reporting.

7.2 Associate Performance with Historical Winter Events

For performance and cost baseline data to yield their greatest value, associate them with historical winter events occurring immediately prior to and at the time the data were collected. The recommended meteorological data and winter storm event recurrence interval determinations described in Chapter 5 can support the evaluation of performance and cost baseline data and offer meaningful context. This effort can, in turn, help an airport operator and its stakeholders define target threshold winter-event conditions, as described later in this chapter.

7.2.1 ATC Runway Closure Duration

The duration of ATC runway closures due to pavement surface conditions and/or snow and ice removal operations is an effective API to use in establishing a performance baseline. As an API, ATC runway closure duration can be associated with SRE runway occupancy time and past winter event condition data following the steps identified in this section. This process can illustrate the general relationship between winter event conditions and SRE runway occupancy time, potentially supporting the estimation of SRE investment necessary to reduce runway occupancy time as described in Chapter 13. Additionally, the process can illustrate the general relationship between SRE runway occupancy time and ATC runway closure duration, potentially revealing opportunities to improve existing procedural or communication inefficiencies between the airport operator and ATC.

Considering only data collected within the period of time that best reflects current SRE capabilities, implement the following steps:

1. Review operations logs to identify runway closures over the course of a winter storm event. If multiple runways were in use, identify and separately document the data for each runway in a basic spreadsheet.
2. Identify the date, ATC runway closure time, reopening time, and closure duration (in minutes) for each runway.
3. Identify the time SRE entered and exited the runway separately from the time when ATC closed and reopened the runway.
4. Calculate the total and average closure duration for each runway during the event (see Table 7-1).
5. Identify the winter event in the list of historical winter storm events summaries (if prepared as described in Chapter 5). Add data for event duration, snow type (e.g., dry or wet), total event snowfall, and average event intensity along with recurrence interval data for each parameter to the spreadsheet (see Table 7-2).

The five steps described above should be repeated for additional winter events that led to runway closures during the historical period of review. Ideally, data is assembled for five or more seasons (barring significant changes to snow removal operations during that period). More data will enable increased understanding of the relationships between the data sets. The data in the spreadsheet can then be sorted by any column to assess event parameter magnitude on runway closure time (see Table 7-3).

BEST PRACTICE—Log of Winter Event Activities

Certificated airports are required to maintain a daily log of airport activities. Even with the additional workload created by a snow or ice event, it is important to maintain a detailed and accurate log of activities during a storm. General aviation airports also benefit from a detailed record of snow removal activities. A storm summary is often attached to the daily log to summarize important data related to the storm, including the amount and type of snow received, snow removal methodology, amount of chemicals used, frequency of runway closures, airport capacity, deicing performance, and notable events. An internal storm-to-storm comparison is likely the best benchmarking opportunity available to airport operators. The daily log becomes a short-term and long-term data source for performance review. A daily log becomes a quick reference guide when responding to tenant questions during winter event performance review meetings and can be researched when planning a response to a forecasted snow or ice event. References to decisions and performance during previous events of a similar nature may streamline the planning process for the forthcoming event. Daily log information and event summaries are excellent end-of-season resources for SICC review when considering possible revisions to the SICP.

7.2.2 Aircraft Delays Attributable to ATC Runway Closure Duration

During 2013, approximately 36.5 percent of flight delays reported by airlines were attributable to weather (*13*). During the winter months of 2013, runway closures were one of many causes of aircraft arrival and departure delays during winter weather events. Runway closures typically occur for SRE operations and subsequent pavement friction testing. Flight cancellations also present costs. However, because many airlines proactively cancel flights ahead of pending winter storm events to reduce air traffic into and out of the impacted airports, it is difficult to attribute cancellations to runway closures.

Source: M-B Companies, Inc.

Table 7-1. Example summary of ATC runway closure data for a winter storm event.

Winter Event Date	Runway 10L						Runway 10R						All Runways
	ATC Closure Time	SRE Entrance	SRE Exit	SRE Runway Occupancy Time (min)	ATC Reopening Time	ATC Closure Duration (min)	ATC Closure Time	SRE Entrance	SRE Exit	SRE Runway Occupancy Time (min)	ATC Reopening Time	ATC Closure Duration (min)	ATC Closure Duration (min)
1/17/2011	6:25	6:28	6:53	25	7:00	35	7:20	7:22	7:55	33	8:02	42	77
	8:17	8:20	8:44	24	8:48	31	9:00	9:08	9:36	28	9:38	38	69
	9:38	9:54	10:20	26	10:25	47	10:41	10:48	11:16	28	11:18	37	84
	11:32	11:38	11:57	19	11:59	27	12:22	12:30	12:55	25	12:57	35	62
	13:26	13:28	13:52	24	13:55	29	15:05	15:06	15:32	26	15:37	32	61
	16:00	16:01	16:20	19	16:22	22	17:00	17:01	17:23	22	17:28	28	50
Average Event ATC Closure Duration (min)	32						35						34
Number of Event ATC Runway Closures	6						6						12

Table 7-2. Example summary of ATC runway closure and meteorological data for a winter storm event.

Winter Event Date	Runway 10L						Runway 10R						All Runways	Event Duration		Total Event Snowfall			Average Event Intensity	
	ATC Closure Time	SRE Entrance	SRE Exit	SRE Runway Occupancy Time (min)	ATC Reopening Time	ATC Closure Duration (min)	ATC Closure Time	SRE Entrance	SRE Exit	SRE Runway Occupancy Time (min)	ATC Reopening Time	ATC Closure Duration (min)	ATC Closure Duration (min)	Hours	Recurrence Interval	Snow Type	Depth (in.)	Recurrence Interval	Inches/ Hour	Recurrence Interval
1/17/2011	6:25	6:28	6:53	25	7:00	35	7:20	7:22	7:55	33	8:02	42	77	11	1.1	Dry	4.2	2.7	0.38	0.9
	8:17	8:20	8:44	24	8:48	31	9:00	9:08	9:36	28	9:38	38	69							
	9:38	9:54	10:20	26	10:25	47	10:41	10:48	11:16	28	11:18	37	84							
	11:32	11:38	11:57	19	11:59	27	12:22	12:30	12:55	25	12:57	35	62							
	13:26	13:28	13:52	24	13:55	29	15:05	15:06	15:32	26	15:37	32	61							
	16:00	16:01	16:20	19	16:22	22	17:00	17:01	17:23	22	17:28	28	50							
Average Event ATC Closure Duration (min)	32						35						34							
Number of Event ATC Runway Closures	6						6						12							

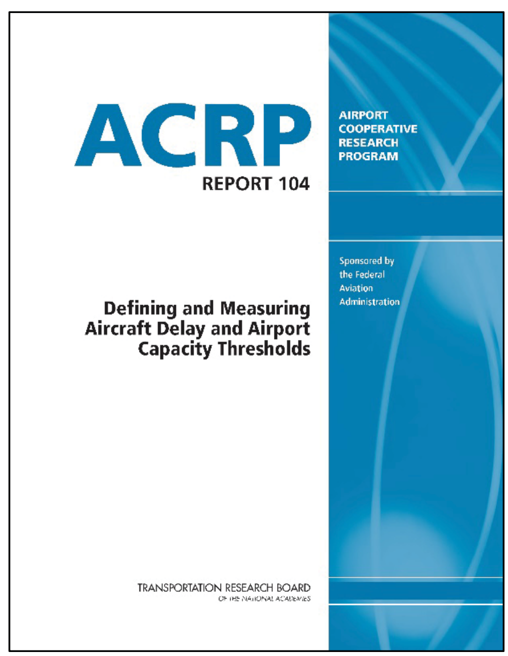
Table 7-3. Example summary of ATC runway closure and meteorological data for multiple winter storm events sorted by total event snowfall recurrence interval.

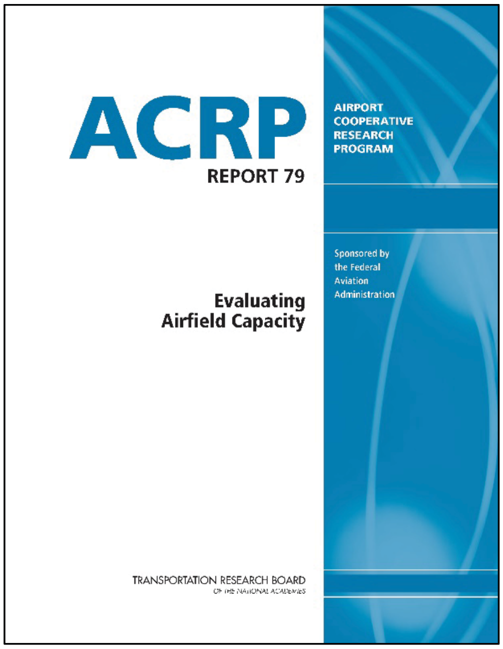
Winter Event Date	Average Event ATC Runway Closure Duration (min)	Number of Event ATC Runway Closures	Event Duration		Total Event Snowfall			Average Event Intensity	
			Hours	Recurrence Interval	Snow Type	Depth (in.)	Recurrence Interval	Inches/ Hour	Recurrence Interval
3/3/2011	71	17	14	4.0	Wet	9.9	10	0.71	7.0
1/23/2011	44	16	13	1.3	Dry	5.1	3.4	0.39	1.0
1/17/2011	34	12	11	1.1	Dry	4.2	2.7	0.38	0.9
12/11/2010	28	6	4	0.8	Wet	1.3	1.1	0.33	0.7
2/14/2011	23	3	2	0.6	Dry	0.9	0.8	0.45	1.3
12/22/2011	24	2	3	0.7	Dry	0.7	0.7	0.23	0.6

Winter conditions on pavement surfaces other than runways may contribute to ground delays during aircraft taxi-in and taxi-out. These are more difficult to measure and attribute to SRE performance. This is especially true if ramp and apron pavement snow removal responsibilities are shared among multiple parties.

Understanding the nature and impact of runway closures on flight delays will enable airports to be more informed as they engage their stakeholders about reducing SRE runway occupancy time during winter weather events. This can be accomplished by estimating aircraft delays attributable to winter weather event runway closures, and then calculating associated aircraft and passenger delay costs.

Predicting specific arrival and departure delays attributable to winter weather event driven runway closures requires the use of delay simulation models or an analysis of past delay data. ACRP guidance on delay types, measurement, and simulation can be found in *ACRP Report 104: Defining and Measuring Aircraft Delay and Airport Capacity Thresholds* and *ACRP Report 79: Evaluating Airfield Capacity.* Models such as the Total Airspace and Airport Modeler and SIMMOD are widely used, while the Runway Delay Simulation Model, the Airfield Delay Simulation Model, and the Air Traffic Optimization Fast Time Simulator are also being used (*14*, p. 43). The models use input data including aircraft flight schedule (often representing the busiest operational day) and runway closure data, including closure frequency and durations, associated with specific winter storm event conditions. Simulations can be specifically tailored to runway configurations, runway use (e.g., arrival only, departure only, mixed, etc.), demand levels, and target runway closure times. The end products are high-resolution simulations of the delays experienced during runway closures due to snow removal operations. However, preparing and running the simulations is time consuming and expensive. This technique is most feasible at large airports when significant expenditures on a new or substantially expanded SRE fleet are being considered, likely requiring external support.





A less technical (and likely less accurate) alternative to modeling delays attributable to runway snow removal operations involves developing rough estimates using historical operations data. Aircraft delay data sources include, but are not limited to, the following:

- **FAA ATCT/Airport Operations Logs:** FAA ATCT and/or airport operations logs often provide useful historical aircraft delay data resulting from snow removal operations. This data source is best suited for general aviation up to medium-sized airports with ATCTs. However, the quality of ATCT and airport operations records may vary by location.
- **U.S. Department of Transportation (U.S.DOT), Research and Innovative Technology Administration (RITA) TranStats On-Time Performance Database:** The RITA Bureau of Transportation Statistics maintains an extensive database of data, including historical on-time performance data, reported by air carriers. The RITA TranStats On-Time Performance data table allows a user to filter data for a number of fields including time period (e.g., month), origin or destination airport, airline, departure and arrival delay minutes, and cause of delay (e.g., weather) to name a few. However, delay data is only recorded for delays that occur in excess of 15 minutes. Recent delays can be compared to snow removal operations logs to identify when snow removal operations contributed to the delay. TranStats data are complex and likely require staff training or external assistance to extract the desired information. The database is available at: http://www.transtats.bts.gov/Fields.asp?Table_ID=236.

Despite the volume of delay data that may be available for historical flight operations, sorting through it to assemble data corresponding to winter storm events when runways were closed may be challenging. There may be no means to differentiate the cause of late-arriving aircraft. For example, a delay record coded as a non-extreme weather-related National Aviation System delay may have been attributable to weather occurring at the departure airport rather than the destination airport. Aircraft departure delays, if tracked by the airport or ATCT, may be difficult to attribute to runway closure time, as well. Departure delays are commonly attributable to circumstances within an airline's control: ramp and centralized aircraft deicing operations congestion; inadequate coordination between airlines, deicing vendors, airport operations, and the ATCT; and missed deicer holdover times requiring repeated deicing.

Understanding that there are limitations with using available data, a rough estimate of flight delays attributable to runway closures during winter event conditions can be prepared by building upon the three steps used in the example for preparing a runway closure duration performance baseline. This process is best suited for hub airports and airports with substantial cargo traffic. It is less applicable to smaller airports where runway closures affect fewer flight operations. Similarly, airports without scheduled commercial service may find the approach of limited value because of the potential lack of delay data. (*Note: this example process can also be used to support the estimation of SRE investment to reduce runway occupancy time as described in Chapter 13.*) The additional steps for estimating flight delays include the following:

1. For each identified winter event during which runway closures were quantified, obtain and review the planned flight schedule for that date, and records of actual arrival and departure times. Estimate the number of delays associated with each closure.
2. Estimate the number of delays associated with each event and document in the spreadsheet as shown on Table 7-4.

Table 7-4. Example summary of ATC runway closure, estimated aircraft delay, and meteorological data for multiple winter storm events sorted by total event snowfall recurrence interval.

Winter Event Date	Average Event ATC Runway Closure Duration (min)	Number of Event ATC Runway Closures	Estimated Aircraft Delayed/ATC Runway Closure	Event Duration		Total Event Snowfall			Average Event Intensity	
				Hours	Recurrence Interval	Snow Type	Depth (in.)	Recurrence Interval	Inches/ Hour	Recurrence Interval
3/3/2011	71	17	12	14	4.0	Wet	9.9	10	0.71	7.0
1/23/2011	44	16	7	13	1.3	Dry	5.1	3.4	0.39	1.0
1/17/2011	34	12	6	11	1.1	Dry	4.2	2.7	0.38	0.9
12/11/2010	28	6	5	4	0.8	Wet	1.3	1.1	0.33	0.7
2/14/2011	23	3	4	2	0.6	Dry	0.9	0.8	0.45	1.3
12/22/2011	24	2	4	3	0.7	Dry	0.7	0.7	0.23	0.6

7.3 Document Cost Baseline

The fiscal pressures facing every airport and stakeholder drive the need for financial accountability and cost efficiency. This, in turn, drives the need to establish and document a cost baseline for current operations. Like the performance baseline, a cost baseline will help in the assessment of future changes to a winter operations program. The cost baseline should not only include the airport operator's equipment and operating costs but also, where possible, airline and passenger delay costs driven by the airport operator's winter operations performance. General considerations related to documenting these costs are described further in this section.

7.3.1 Airport Winter Operations Costs

It is important to understand the cost of a current SRE fleet in terms that are relevant to the decision-making process, including decisions to replace equipment or invest in additional equipment. If airside and landside costs are currently tracked separately, keep the costs separate throughout the following process.

Annualized Capital Cost

For each piece of SRE, calculate the annualized capital cost as illustrated in Figure 7-1. Although no simple formula for establishing a lifetime cost will suffice for all cases, a combination of past experience with similar equipment, peer input, and manufacturer data can be used. FAA established that the normal useful life for SRE is about 10 years, although equipment can be maintained for longer periods (*15*). A simple spreadsheet can be used to track the aggregate annualized capital cost of the SRE fleet. Identify each piece of significant equipment in a column header, and then enter the annualized capital cost for each year of useful life in the rows below with each row signifying a year. As each piece of significant equipment is acquired or retired, update the spreadsheet to reflect the new

Source: Gresham, Smith and Partners

Annualized Capital Cost = (Capital Cost/$A_{t,r}$)
Where:
$A_{t,r} = (1 - 1/(1 + r)^t)/r$
t = expected useful life
r = percentage cost of capital rate expected (finance rate)

Example:
$A_{t,r} = (1 - 1/(1 + 0.05)^{10})/0.05$
t = 10 years
r = 5%
Capital Cost = $750,000
$A_{t,r} = 7.72$
Annualized Capital Cost = $750,000/7.72
Annualized Capital Cost = $97,150

Figure 7-1. Example calculation of annualized capital cost.

fleet make-up. For any given year, the current annualized capital cost of all the significant SRE can be found by totaling across all entries in the row representing the year of interest.

Annual Operations and Maintenance Cost

Because the number and duration of winter events in any given winter season is variable, and SRE is used only intermittently, actual annual SRE usage can vary substantially year to year. Likewise, the annual cost of operating and maintaining the SRE will vary. Thus, multiple years of operating cost data are needed (up to 10 years is ideal) to develop a reasonable annual average estimate. However, these costs should reflect the current winter operations program. Operations and maintenance costs may include:

- Wages and benefits (full-time and seasonal hourly employees);
- Meals, if provided;
- Lodging, if provided;
- Fuel, oils, and lubricants;
- Routine consumables (e.g., filters, wipers, etc.);
- Periodic replacement parts (e.g., broom cassettes, plow moldboard cutting edges, tires, etc.);
- Chemical deicers and sand; and
- Contractor snow removal and/or melting.

BEST PRACTICE—Computerized Maintenance Management System

Airport operators should utilize a computerized maintenance management system (CMMS) or procure and operate fleet management computer software. Computerized systems streamline maintenance activities on a per-vehicle basis. The use of vehicle mileage or engine hours as the primary consideration for vehicle replacement is no longer cost effective. Actual maintenance and repair costs provide far better justification when determining whether or not to keep or replace a vehicle.

Equivalent Annual Cost

Equivalent annual cost will facilitate a comparison of airport winter operations baseline costs to costs for proposed changes in equipment or tactics. It may also facilitate the estimation of potential benefits. The method of calculating equivalent annual cost is shown in Figure 7-2.

Annualized Capital Cost + Annual Operating Cost = **Equivalent Annual Cost**

Figure 7-2. Calculation of equivalent annual cost.

7.3.2 Airline Delay Costs

While unavoidable to a certain extent, aircraft flight delays present real costs to airlines, commercial and private operators, traveling passengers, and the U.S. economy. The U.S. Travel Association, a national, non-profit organization representing all components of the travel industry, determined that every hour a flight is delayed costs the U.S. economy an average of $3,300 in passenger-related economic activity (*16*). The FAA Office of IP&A estimated fiscal year (FY) 2014 average hourly aircraft direct operating costs for passenger and cargo air carriers, as well as general aviation aircraft. These costs are summarized in Table 7-5. The term "block hour" used in the table is an hourly increment of "block time." Block time is synonymous with the following regulatory definition of "flight time" which states, ". . . time that commences when an aircraft moves under its own power for the purpose of flight and ends when the aircraft comes to rest after landing" (*17*).

The average total block hour costs for the applicable aircraft type can be used to quantify the runway closure delay costs to airlines, aircraft owners, and the passengers. However, these data may overestimate or underestimate actual costs depending upon if the aircraft delay was at-gate, taxi-out, in-flight, on-approach, or taxi-in. In-flight delays are most costly due to fuel burn, followed by ground and gate delays. Determining when to apply the variable cost types presented in Table 7-5 may be difficult, except for departure delays for which airborne hour costs would not apply.

Delay costs can also be overestimated or underestimated depending upon the size of the aircraft. The costs presented in Table 7-5 represent averages for many of the aircraft in use. To identify more specific cost data for airlines and their aircraft, airports can access the RITA TranStats database, which provides Form 41 financial data containing information on large certified U.S. air carriers including balance sheet, cash flow, employment, income statement, fuel cost and consumption, aircraft operating expenses, and operating expenses. These data are available at: http://www.transtats.bts.gov/Tables.asp?DB_ID=135&DB_Name=Air%20Carrier%20Financial%20Reports%20%28Form%2041%20Financial%20Data%29&DB_Short_Name=Air%20Carrier%20Financial.

The TranStats data can be used to calculate aircraft block time costs in dollars per aircraft per unit time. However, like the on-time performance data described earlier, filtering, extracting, and manipulating data from the database can be labor intensive. However, much of this work has already been done through the Airline Data Project (ADP) established by the Massachusetts Institute of Technology (MIT) Global Airline Industry Program. The ADP is available online at: http://web.mit.edu/airlinedata/www/default.html.

The ADP provides downloadable spreadsheet summaries of airline-reported Form 41 financial data that calculate total annual block time costs, among other items. Spreadsheets are available for major domestic carriers at no cost, and the block time cost data are subtotaled by one of

Table 7-5. FY 2014 average hourly variable and fixed aircraft direct operating costs (*1*).

FY 2014 $	Variable Cost				Fixed Cost per Block Hour	Total Cost Per Block Hour
	Per Airborne Hour	Per Ground Hour	Per Gate Hour	Per Block Hour		
Air Carrier—Passenger	$4,456	$2,148	$1,443	$4,103	$857	$4,959
Air Carrier—Cargo	$8,597	$4,149	$2,798	$8,038	$1,964	$10,001
General Aviation	$729	$351	$234	$659	$909	$1,567

Source: FAA Office of IP&A

Table 7-6. 2013 airline block hour costs by aircraft category (*18*).

Airline	Total Cost Per Block Hour (FY2013 $)		
	Small Narrow-Body	Large Narrow-Body	Wide-Body
Alaska	$5,003	$4,130	–
American	$4,689	$5,048	$9,231
Delta	$5,066	$5,285	$9,048
Frontier	$4,035	N/A	N/A
Jet Blue	$4,141	N/A	N/A
Midwest	$1,380	N/A	N/A
Southwest	$4,035	$4,054	N/A
United	$4,797	$5,235	$10,686
US Airways	$4,395	$4,559	$8,465

Data Source: MIT Global Airline Industry Program ADP

three pre-defined aircraft fleet categories including small narrow-body aircraft, large narrow-body aircraft, and wide-body aircraft. Use the ADP spreadsheets to calculate an airport-specific weighted block hour cost based on the individual carriers and aircraft fleet mix serving the airport. Table 7-6 illustrates the variability of passenger air carrier block hour costs by airline and aircraft category.

Aircraft delay costs can be estimated for the data previously illustrated in Table 7-4. (*Note: this example process can also be used to support estimating the benefits of SRE investment to reduce runway occupancy time as described in Chapter 13.*) To estimate aircraft delay cost, the following example builds on Table 7-4 and includes the following additional steps:

1. Use the average passenger air carrier block hour time, or calculate an airport-specific block time cost per hour as the cost basis for generating an aircraft delay cost. Convert the block time cost per hour to block time cost per minute by dividing by 60.
2. Calculate the total delay cost per aircraft, total event delay cost per ATC runway closure, and total delay cost per event (see Table 7-7).
3. Associate the delay costs per event with the event meteorological and recurrence interval data (see Table 7-8).

Table 7-7. Example summary of ATC runway closure duration, estimated aircraft delay per runway closure, and associated aircraft delay cost data.

Winter Event Date	Average Event ATC Runway Closure Duration (min)	Number of Event ATC Runway Closures	Estimated Aircraft Delayed / ATC Runway Closure	Weighted Average Aircraft Block Time Cost / Minute	Total Delay Cost / Aircraft	Total Event Delay Cost / ATC Runway Closure	Total Event Delay Cost
3/3/2011	71	17	12	$74.39	$5,282	$62,500	$1,062,500
1/23/2011	44	16	7	$74.39	$3,273	$24,003	$384,051
1/17/2011	34	12	6	$74.39	$2,529	$14,332	$171,990
12/11/2010	28	6	5	$74.39	$2,083	$9,720	$58,322
2/14/2011	23	3	4	$74.39	$1,711	$6,559	$19,676
12/22/2011	24	2	4	$74.39	$1,785	$7,141	$14,283

Table 7-8. Example summary of ATC runway closure, aircraft delay cost, and meteorological data for multiple winter storm events sorted by total event snowfall recurrence interval.

Winter Event Date	Average Event ATC Runway Closure Duration (min)	Number of Event ATC Runway Closures	Total Event Delay Cost	Event Duration		Total Event Snowfall			Average Event Intensity	
				Hours	Recurrence Interval	Snow Type	Depth (in.)	Recurrence Interval	Inches/ Hour	Recurrence Interval
3/3/2011	71	17	$1,062,500	14	4.0	Wet	9.9	10	0.71	7.0
1/23/2011	44	16	$384,051	13	1.3	Dry	5.1	3.4	0.39	1.0
1/17/2011	34	12	$171,990	11	1.1	Dry	4.2	2.7	0.38	0.9
12/11/2010	28	6	$58,322	4	0.8	Wet	1.3	1.1	0.33	0.7
2/14/2011	23	3	$19,676	2	0.6	Dry	0.9	0.8	0.45	1.3
12/22/2011	24	2	$14,283	3	0.7	Dry	0.7	0.7	0.23	0.6

7.3.3 Passenger Delay Costs

FAA IP&A also estimated the FY 2014 average value of a delayed business traveler's time to be $63.00 per hour, and a delayed personal traveler's time to be $35.10 (*1*). These values can be manipulated in a similar manner as described for aircraft block time cost per hour to estimate a cost per winter event and event recurrence interval.

7.4 Define Target Threshold Winter-Event Conditions

After performance and cost baseline data have been compiled and associated with past winter-event conditions, convene the SICC, including air carrier stakeholders, to assess past performance (see Chapter 12) under varying winter-event conditions. The SICC should then establish target threshold winter-event conditions that define the desired maximum winter operations performance capabilities of the airport operator. Target threshold winter-event conditions represent a set of specific, measurable meteorological conditions beyond which an airport operator's capabilities to maintain a pre-established operating condition (e.g., keeping all runways open) will be exceeded. Multiple target threshold winter-event conditions may be set for increasingly severe weather conditions (e.g., maintaining two active runways during 5-year recurrence hourly-snowfall intensity, and maintaining one active runway under 10-year recurrence hourly-snowfall intensity).

Defining the threshold winter-event conditions that exceed an airport operator's capabilities to achieve established performance objectives is a fact-driven process. It is based on the current capabilities and practices of the winter operations team (e.g., runway clearance times) and the winter-event recurrence intervals for key meteorological conditions (e.g., total event snow depth or average hourly-snowfall intensity) as described in Chapter 5. The acceptability of these capabilities and the associated operational implications and outcomes as the best an airport can do is a risk-based decision for the airport operator and its stakeholders and one that should be considered before setting performance targets. It is essential that all stakeholders agree on what is acceptable so that no single entity is served at the expense of the others.

Once defined, threshold winter-event conditions can provide reference points for establishing or raising winter operations performance goals and objectives. Defined threshold winter-event conditions can also facilitate a shared understanding of the investment in infrastructure, equipment, staff, and operating procedures required to achieve performance goals.

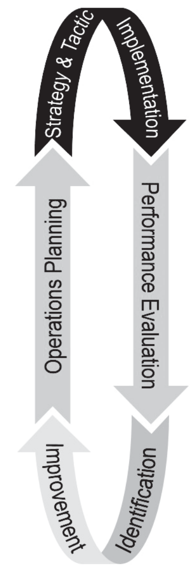
7.5 Set Performance Targets

Use performance and cost baseline data and defined threshold winter storm event conditions to identify long-term and interim performance targets for each established API and performance measure, as described in Chapter 6. Long-term targets should be set first. They should align with established performance goals and supporting objectives and be representative of the airport operator's and airport stakeholders' collective desired outcomes. Once long-term targets are set, establish interim targets and dates by working backward from the long-term target date toward present day (*12*, p. 77). Interim targets should reflect a realistic rate of performance improvement. The number of interim targets to be set is dependent upon what is being measured. For example, interim targets for APIs that measure seasonal performance should be set annually, while APIs measuring winter event performance may be set monthly or on a per-event basis.

If current performance data are not available for an API, an airport should establish a reasonable estimate for its long-term and interim performance targets, which should then be revisited as new data are collected to determine if the targets require adjustment.

CHAPTER 8

Winter Operations Best Practices



Winter operations planning translates winter operations performance goals and objectives described in Chapter 6 into winter operations strategies and tactics. The definition of each term includes the following, and the relationship between each term is illustrated in Figure 8-1:

- **Goals:** Desired broad long-term end results that provide direction and purpose.
- **Objectives:** Shorter-term, specific pathways to achieving a related goal.
- **Strategies:** The general approaches used to achieve complicated goals or objectives.
- **Tactics:** The actions taken or tools used to help implement the strategies, achieve objectives, and attain goals.

Chapter 3 also described how certificated airports located where snow and icing conditions occur are subject to FAR §139.313, *Snow and Ice Control*, and must prepare, maintain, and carry out an SICP in a manner authorized by the FAA Administrator. The requirements for the content of an SICP are contained in AC 150/5200-30C, *Airport Winter Safety and Operations.* The document also presents a considerable amount of guidance on the development of winter operations strategies and the planning for the implementation of various supporting tactics. However, AC 150/5200-30C only establishes the minimum industry practices for preparing an SICP and planning winter operations. Airports and their stakeholders have taken these practices and improved upon them through implementation of the AC, planning of winter operations strategies, and execution of winter operations tactics.

Through the conduct of research for this guidebook, winter operations strategies and tactics representing industry "best practices" were shared by airports of all sizes in broad geographic areas and winter climates. These best practices do not focus on all winter operations practices consistently implemented across the industry (i.e., standard operating practices). Instead, the best practices, while potentially impractical to implement at any one given airport due to the wide variability of airports and operating conditions, represent new or alternative methods for achieving winter operations performance objectives and attaining performance goals.

To assist with understanding how and where the best practices presented in this chapter relate to winter operations, they are presented in general accordance with the contents of AC 150/5200-30C Chapter 1, "Introduction." Each practice title is followed by a description of the airport type(s) in brackets to which the practice may be most applicable. Chapters 9 through 11 of this guidebook are similarly organized like subsequent chapters of AC 150/5200-30C. This organizational methodology will enable incorporation of applicable practices into an existing SICP or other winter operations documentation.

Figure 8-1. Relationships between goals, objectives, strategies and tactics.

8.1 Airport SICC

Snow Committee [All Airports]

The formation of an active and functional Snow Committee is imperative at any airport that experiences snow and ice events, no matter the frequency of those events. Airport tenants, partners, and stakeholders are offered representation on the Snow Committee with the acknowledgement that membership may be more heavily weighted toward critical tenants and service providers. Meeting frequency and individual committee member responsibility varies from airport to airport. At a minimum, the Snow Committee should conduct post-season planning meetings, SICP review meetings, pre-season planning meetings, and meetings during the winter season at a frequency dictated by the SICP. Snow Committee input to an airport's SICP is critical to the formulation of a comprehensive and workable document, and is the foundation for successful implementation of the snow plan.

Many airport operators have found success in considering a Snow Committee as a year-round element of operational planning. It is a general observation that a full-time commitment to winter operations planning tends to result in more successful implementation of the SICP. Regularly scheduled meetings are conducted throughout the year, with a seasonal adjustment to meeting frequency—weekly meetings during the winter season and monthly meetings during the off-season. The weekly meetings at some facilities can eliminate the need for hastily-scheduled post-event review meetings. Snow Committee member commitment to a routine meeting schedule enhances attendance and participation. Active engagement in a Snow Committee tends to result in more frequent stakeholder presence at an SCC or Snow Desk during a winter event. Full-time Snow Committee members also tend to be more responsive to the need to alter or revise operational procedures, resulting in more efficient snow removal operations.

Methods to Foster Stakeholder Relationships [All Airports]

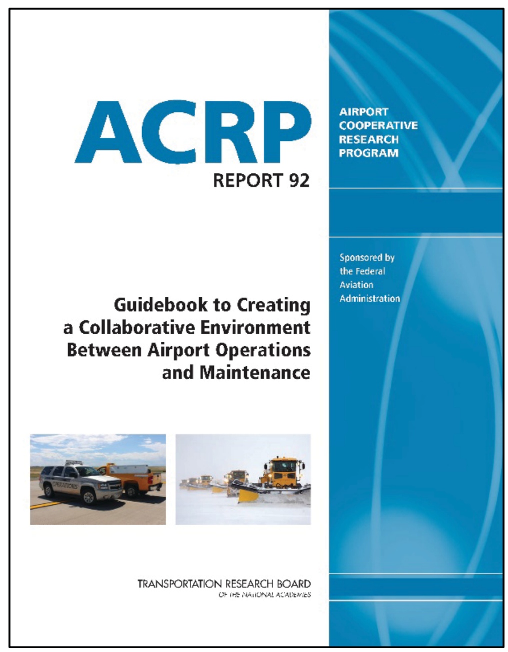
Airports that invest in cooperative relationships with the ATC, key airport tenants, and stakeholders have a higher probability of coordinated, effective and successful snow removal operations. Most large airports conduct daily operational teleconferences to maintain communication throughout the year. Some airports host daily face-to-face briefings. Airport operators at smaller facilities cultivate working relationships with FBOs and pilots. Some airports host on-airport events as a means to meet persons who might otherwise be only voices on the telephone. Many airports invite front-line air traffic controllers along during routine airfield inspections. Many controllers appreciate being able to observe airport operations from a ground perspective, as the viewpoint is quite different than from an elevated position. Air traffic control reciprocates by offering airport personnel access to the ATCT. Airport operators also benefit from the development of inter-departmental relationships. It is imperative that airfield operational groups maintain productive and collaborative relationships. Invitations to planning and finance department representatives to join operational groups while conducting routine tasks or for airfield tours provide those parties with valuable insight as to how their responsibilities affect airport operations. Strong personal relationships are key to successful snow and ice control events.

Cooperative Relationships with Stakeholders [All Airports]

Airports that invest in 365/24/7 cooperative relationships with ATC and key airport stakeholders have a higher probability of coordinated, effective, and successful snow removal operations. Most large airports conduct regularly scheduled daily operational teleconferences to maintain communication throughout the year. Some airports host daily face-to-face briefings. Airport operators at smaller facilities cultivate working relationships with FBOs, key tenants, and pilots. Some airports host on-airport events as a means to create and improve important relationships. Investment in personal relationships pays dividends during a snow and ice control event.

Relationship between Maintenance and Operations [Small, Medium, and Large Hub]

A positive working relationship between airport maintenance and airport operations is an absolute key to success during winter operations. Frequent communication throughout all phases of planning and execution in an environment of trust facilitates that success. The departments should have a clear understanding of their respective duties and responsibilities. Some airports create documents that list those responsibilities. Disagreements should be addressed with timely mitigation and cooperative problem solving. One airport specifically noted the need to "check egos at the door and realize the two departments are one team with a goal to maximize passenger and customer service." Airports that assign joint oversight of operations and maintenance departments at a level below the senior management level appear to be more flexible in dealing with problems and issues. A common department director at an operational level has proven to be successful in moving both departments in the same direction and in achieving common goals and objectives. Additional information is available in *ACRP Report 92: Guidebook* to *Creating a Collaborative Environment Between Airport Operations and Maintenance.*



Airport Executive Staff and Board Members [Small, Medium, and Large Hub]

Airports should consider the role of airport executive staff and, as appropriate, appointed airport board members during winter events. Those persons should be included in pre-season winter operational briefings in order for all parties to have a clear understanding of their roles and responsibilities. Airports have reported conflicts when, during a weather emergency, executive staff or other ranking individuals appear at the Incident Command Post (ICP) or the Snow Desk and feel the need to assume command. General consensus is that executive staff and political appointees are best suited for liaison roles and working in concert with a Public Information Officer (PIO) or airport PR staff. Airport operators may also wish to invite high profile airport tenants to pre-season briefings, where procedures and priority pavements can be identified and outlined in advance of an actual event. Expectations identified during pre-season planning will result in fewer issues during an actual event. Overall performance is enhanced when airport operators conform to pre-established plans and procedures. Vehicle operators report fewer mistakes and less stress when allowed to follow standard operating procedures without deviation. The adage "plan the work and work the plan" applies during winter operations.

8.2 Snow Control Center

8.2.1 Pre-Event Planning and Coordination

Adjustment of Flight Schedules in Advance of Winter Event [Medium and Large Hub]

Source: Gresham, Smith and Partners

Air carriers have experienced significant costs savings, reduced their exposure to excessive tarmac delays, and improved customer relations by adjusting flight schedules in advance of a winter event. Demand on the affected airport is reduced through cancellations and rerouting of aircraft. Schedule adjustments allow air carriers to control the location of aircraft and crew assets, thus facilitating rapid recovery from storm-related service disruptions. Air carriers attempt to make decisions in a time-frame most convenient for their customers; usually the night before a forecasted event, so passengers can be advised well in advance of rerouted flights, expected delays, or canceled flights. Although an imposition to customers, flight cancellations limit passenger exposure to lengthy stays at diversion airports.

Airport operators have become valuable resources to air carriers in determining the appropriate level of service relative to airport capacity by providing forecasted runway capacity, outbound deice capacity, expected impacts to ground movements, and other valuable data needed by the air carriers in their decision-making process. Teleconferences to establish airport capacity are necessary and usually begin 12 to 24 hours in advance of a forecasted event. Key players include the airport operator, major air carriers, deice pad operators, weather forecasters, local ATC facilities, and enroute ATC centers. The inclusion of the FAA ATCSCC in the coordination process is appropriate for large-hub facilities. It is also advisable to keep local Transportation Security Administration (TSA) officials apprised of changing flight schedules for possible modification of security checkpoint operating hours. Each party provides input based on forecasted conditions, experience, and past performance, and consensus is reached on forecasted airport capacity, with air carriers expected to make appropriate adjustments to their flight schedules. At airports with multiple carriers, the airport operator may be able to exert influence over equitable schedule adjustments based on their knowledge of terminal, taxiway, apron, and deice and runway snow removal capabilities. Many airports have developed written programs outlining equitable assignment of departure slots during periods of reduced capacity.

The flow of information should continue throughout the event in order for the air carriers to make the appropriate adjustments. It is in the airport operator's best interest to encourage full participation and cooperation by all parties. A single carrier's inability to properly manage flight operations may lead to airfield overload and gridlocked operations. Remotely parked aircraft impede snow removal operations. Airport gridlock leads to excessive tarmac delays and the exposure to possible fines for the air carrier and for the airport by the U.S.DOT.

Establishment of Hourly Aircraft Arrival Rate [Medium and Large Hub]

Factors that affect the establishment of an hourly aircraft arrival rate (AAR) by ATC include forecasted runway capacity, forecasted frequency of runway snow removal operations, ground movements, aircraft parking gate accessibility, remote aircraft parking capacity, and deice pad capacity. Airport operators should coordinate closely with ATC to provide input to AAR during winter storm events. It is generally good practice to establish the AAR at a level that does not exceed the outbound deicing rate. Work with tenants and ATC to establish procedures between all applicable parties to meter deiced aircraft to the runway in a manner to avoid the expiration of deice holdover times. Many airports require tenants, including fixed-base and corporate operators, to coordinate outbound aircraft movements with the Snow Desk. Airports that operate a centralized deicing facility often establish procedures that permit direct coordination between ATCT and the deice facility operator. The Snow Desk and/or deice facility operators should provide ATC with updated outbound deicing rates. AARs should be adjusted accordingly.

Communication with ATC on Changes to Forecasted Airport Capacity [Medium and Large Hub]

Changes to forecasted airport capacity need to be immediately forwarded to ATC, since failure to reduce the aircraft arrival rate may result in gridlock conditions and create excessive tarmac delays.

Inclusion of ATC and ARTCC in Pre-Event Planning [General Aviation and Small Hub]

The ATC facility with responsibility for aircraft movements at an airport should be included in pre-event planning meetings or teleconferences. Airports without 24/7 ATC operations should consider the inclusion of the appropriate approach control facility or enroute ARTCC in pre-event coordination meetings. Communication will likely be with the traffic management unit (TMU) at the facility.

Pre-Event Planning Participation by Reliever and Diversion Airports [General Aviation and Large Hub]

Representatives of reliever airports and primary diversion airports should be invited to participate in pre-snow event planning meetings or teleconferences. Reliever airports contribute to available capacity within the local area. An alternative would be to ensure that potential diversion airports are communicating directly with the appropriate approach control or enroute ATC facility to identify their airport capability and capacity.

8.2.2 Ground Movement Coordination

Third-Party Surface Management Software [Large Hub]

Subscribing to a third-party surface management software program will likely provide a return on investment (ROI) relative to more efficient aircraft ground movements and the mitigation of potential fines for violation of the U.S.DOT three-hour and four-hour tarmac delay regulations. Available software programs can help manage ground capacity by allowing better coordination of aircraft push-backs, taxi clearances, deice queue lines, and end-of-runway queue lines. The programs can graphically depict aircraft experiencing tarmac delays. Alerts can trigger airport operator coordination with the aircraft operator to minimize delays and to prevent violation of U.S.DOT rules. A surface management software subscriber reported a significant increase in terminal concessions revenue after implementing a surface management system. The assignment of firm gate departure times created more efficient and timely aircraft boarding processes. Increased terminal dwell times resulted in increased concessions sales. Customer service was enhanced by allowing passengers to remain in gate hold areas as opposed to waiting onboard aircraft in long departure queues.

Coordination of Aircraft Ground Movements [General Aviation and Small Hub]

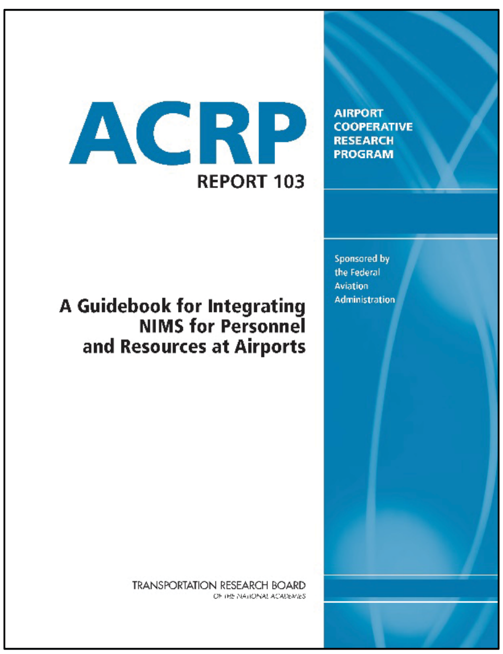
Establish communication protocols with FBOs and corporate flight departments to facilitate aircraft ground movements during winter operations. Airport operators can often work around scheduled flight operations. The sharing of flight schedules, proposed arrival and departure times, and proposed aircraft deicing operations results in more efficient snow removal operations on all paved areas: runways, taxiways, and ramps. Tenants should keep the airport and/or the Snow Desk apprised of revised schedules.

8.2.3 Command Center/Snow Desk

Mobile Command Post [General Aviation and Small Hub]

Not all airports have the resources to furnish and operate a physical Snow Desk or winter operations command center. Airports have been successful in operating mobile command centers, preferably staffed by at least two persons: the Incident Commander or Snow Boss and a liaison or communications specialist. A mobile command post will require technology to support communications and information sharing. Some type of communications node will be required to support the issuance of NOTAMs, field condition reports, airport status reports, and to receive airport tenant and user information requests. An airport wireless network system would support 365/24/7 communications.

Use of the Airport Operations Center (AOC) as the ICP or Snow Desk [Medium and Large Hub]



Most large airports maintain an AOC to support daily, routine airport functions. An AOC has proven to be an effective location for an ICP or Snow Desk during a winter event. Some airports initiate formal National Incident Management System (NIMS) Incident Command protocols to coordinate snow removal activities under the SICP (for additional information on NIMS, see *ACRP Report 103: A Guidebook for Integrating NIMS for Personnel and Resources at Airports*). The AOC may be an excellent location in which to convene Snow Committee meetings in advance of and during a winter event, and the SICP should identify key partners and stakeholders that are expected to report to that location. The SICP should also outline assignments, duties, and expectations of persons assigned to a Snow Desk.

Snow Desk Contact Phone Number [All Airports]

Tenants must have the ability to contact an airport operator on a 24/7 basis. Snow Desk contact telephone numbers are routinely advertised and made available to tenants prior to the winter season. It may be practical to utilize a well-known phone number, such as the normal 24/7 airport operations number. Since a Snow Desk may be mobile at a smaller facility, a mobile phone contact number is also of importance to airport tenants.

8.2.4 Staffing

Designated Snow Boss or Incident Commander [Small, Medium, and Large Hub]

Under NIMS Incident Command protocols, a designated incident commander is the final authority regarding decisions at an incident scene. Snow removal operations benefit from the same principle. One individual should be designated as the Incident Commander or Snow Boss, with responsibility for implementation of the snow plan. Delegation of authority is a key element of incident command. Effective snow bosses delegate decision-making authority as appropriate to managers and supervisors. Airports have reported success in designating an individual to a liaison position to assist the incident commander with communications during an event. Multiple persons should be trained for the role of Snow Boss or Incident Commander to facilitate rotating shifts. NIMS protocols recommend that at least three persons be trained for each position within the incident command system.

Co-location of Operations and Maintenance Representatives During a Snow or Ice Event [Medium and Large Hub]

Communication and coordination between operations and maintenance is enhanced by co-locating representatives of the respective departments during a snow or ice event. Maintenance should be represented at an Incident Command Center or at a Snow Desk. An alternative arrangement may have maintenance and operations representatives riding together in an airport vehicle or the lead vehicle of the snow removal team. As staffing levels might prevent those arrangements at smaller facilities, concise protocols should be in place to facilitate communications between operations and maintenance.

Stakeholder Positions at Snow Desk [All Airports]

Key stakeholders of an airport's snow and ice control operation should have a seat at an Incident Command Center or at a Snow Desk to facilitate communication, coordination, and cooperation. Representatives who have been trained on NIMS Incident Command protocols and who are familiar with the airport's SICP are more likely to be valuable contributors to the coordination process. If physical representation is not feasible, procedures should be instituted for rapid communication. Many smaller airports compile and disseminate 24/7 contact phone numbers, with the telephone numbers of key stakeholders programmed into a phone's speed dial function.

Source: Gresham, Smith and Partners

PR Involvement in Daily Operational Conference Calls [Small, Medium, and Large Hub]

Public Relations personnel should make every effort to join daily operational conference calls facilitated by operations departments, especially in advance of winter events. Air traffic control and air carriers routinely participate on daily calls and share operational planning decisions. The daily briefing is often the best source for accurate, airport-specific weather forecasts. Daily participation, regardless of the weather, will provide PR departments with timely airport operational information.

Collaborative Decision Making [Small, Medium, and Large Hub]

Airports have reported success in utilizing collaborative decision-making (CDM) techniques as a routine method in which to communicate with tenants, and have noted particular success in utilizing CDM during winter events. CDM invites input from key partners and stakeholders during a decision-making process. Participation can be in person at an Incident Command Center or Snow Desk, or via teleconference. CDM communication protocols should be defined in the SICP, with a pre-season discussion to establish expectations for tenant participation in snow event decision making.

8.2.5 Runway Closure Coordination

Partnering with Local ATC to Disseminate Runway Closure Information [General Aviation, Small, and Medium Hub]

At airports with a single runway or single runway operations during snow and ice events, airport operators may wish to partner with local ATC in an effort to provide timelier runway closure information to tenants and airport users. NOTAM dissemination efficiency has improved in the eNOTAM system. However, an aircraft operator may already be beyond flight planning and in final preparation for departure when a decision is made to close a runway for treatment or an already coordinated runway closure time is revised. One airport reported success in having ATC broadcast impending runway closure times on clearance delivery and ground control frequencies. Aircraft operators or flight crews monitoring either frequency could, therefore, take appropriate action regarding deicing and taxi-out or could communicate their readiness for departure in advance of the runway closure.

Airport ATCT Representative [Medium and Large Hub]

An airport representative assigned to the ATCT during snow and ice events facilitates immediate communications between the airport and ATC. The airport ATCT representative becomes an immediate communications conduit for surface closure coordination, the sharing of local information, and the sharing of National Airspace System information from air traffic facilities, up to and including the FAA ATC System Command Center. An airport ATCT representative also alleviates the need for air traffic supervisors to take coordination phone calls, allowing those individuals to focus on their primary responsibilities. However, caution should be exercised when coordinating runway closures, as other parties often need to be included in runway closure coordination communication (i.e., sole reliance on an airport ATCT representative may circumnavigate critical communication paths). The ATCT representative can also immediately coordinate with ground control to hold or reroute aircraft in a manner to expedite snow removal operations.

Source: Gresham, Smith and Partners

Coordination with Other ATC Facilities [Medium and Large Hub]

Airport operators may wish to include ATC facilities other than the local ATCT in the runway closure coordination process. TRACON facilities and ARTCC can provide valuable information to enhance decision making. Similarly, larger airports may wish to consider the inclusion of local air carrier gate control or deice control centers and Operations Control Centers (OCCs) or Systems Operations Centers (SOCs) in the runway closure coordination process. Air carriers can identify critical flights that they may wish to get on the ground or to get airborne in advance of a runway closure. It should be noted to airport operators that ATCT and air carrier gate or deicing control will tend to favor departure operations, while OCC/SOC and ARTCC facilities will lobby for priority to land aircraft. Frequent conference calls keep key stakeholders informed of the short-term plan for the airport.

8.2.6 Information Dissemination

Inclusion of PR in Airport Information Dissemination Networks [Small, Medium, and Large Hub]

Airport operations groups should ensure the inclusion of the PIO or a designated PR representative in airport information dissemination networks. It is important for operational groups to keep communication teams immediately aware of airport status and developing events. The PIO or a PR representative should be assigned a seat at the snow removal ICP or at the Snow Desk.

Stakeholder Communication [All Airports]

Stakeholders, including airlines, government agencies, concessionaires, FBOs, ground transportation providers, overnight accommodations (hotels, churches, Red Cross), tenant military installations, emergency response elements, and regional diversion airports, not represented at an Incident Command Center or at a Snow Desk need to be kept informed of decisions and airport status. Airport operators must maintain a robust two-way communication network in order to maintain consistent airport-wide service levels. Telephone communication remains the mainstay in interaction between airports and stakeholders. Broadcast fax and text messaging are viable communication tools for disseminating airport status messages. Large-hub airports have experienced success with utilizing web-based tools via internal websites or web portals provided by a third-party service provider. Consistent performance in the area of information sharing during routine airport operations leads to more successful communication during winter operations. A staff point-of-contact should be designated for tenants to provide updated contact information, as well as to conduct periodic verification of existing phone numbers and email addresses.

Regularly Scheduled Event Conference Calls with Stakeholders [Medium and Large Hub]

Larger facilities will benefit from regularly scheduled conference calls to coordinate and communicate with airport tenants and stakeholders. Twice daily calls are common, with increased call frequency as dictated by storm conditions. Proactive dissemination of information reduces calls from tenants seeking to pull information from an airport operator.

Information Dissemination via Airport Website [Large Hub]

Enhance airport websites with current airport status information above and beyond aircraft arrival and departure information. Such a program will require a commitment of personnel to maintain website information in real-time. Although smaller airports may not have the staff to provide this service, the push of information by an airport out to tenants and other airport users can reduce the need for telephone communication.

Information Dissemination via Email Notification [All Airports]

Airports may wish to consider pre-loaded email notification lists for rapid dissemination of information. Airports should have immediate access to current and accurate 24/7 contact information for air carrier operations or systems control centers, air traffic facilities, regional airport managers, FBOs, local public safety agencies, and other key airport tenants.

Information Dissemination via Commercial Web-Based Products [Medium and Large Hub]

Commercial web-based products are available that provide airborne and on-ground aircraft situational display. Systems can be programmed to alert airport operators of aircraft diversions and length of ground delays, enhancing response to irregular operations (IROPS) events.

Wireless Communication Systems [All Airports]

The installation and operation of a system to facilitate wireless communications will enhance the ability to issue timely airport condition reports. Mediums may include radio frequency transmission or an airport-wide wireless computer network. The former will likely require associated proprietary hardware and software, while the latter can be accomplished with laptop computers or tablets loaded with commercial software. Wireless communications systems allow the operation of mobile Snow Desks, which are of great benefit to smaller airports with limited personnel.

Rapid Information Dissemination Systems [Medium and Large Hub]

Commercial web-based products are available to disseminate information in a mass communications format. Systems can be programmed to alert airport operators of aircraft diversions and length of ground delays, enhancing response to IROPS events. They can provide multimedia dissemination of information in a format chosen and programmed by the individual users of the system. These systems can deliver voice and text messages at a rate and volume that exceed local airport capability.

Use of Web-Based Information Portals [Medium and Large Hub]

Medium- and large-hub airports have experienced success with the dissemination of airport conditions and other critical airport information through commercial, web-based information portals (e.g., PASSUR OPSnet™, ITT Exelis Symphony® and multiple platforms that provide situational awareness and graphical displays). The contracted service enhances customer service by allowing airport tenants and air carrier systems OCCs to pull airport information from a website, as opposed to waiting for the airport operator to push information to interested parties through the NOTAM system or through internal airport information dissemination systems.

Web-based information service providers create web pages specifically for an individual airport. Predetermined information fields are populated by the airport operator. Most systems facilitate one-touch information dissemination to both the airport website and to the NOTAM system. Web page access is password protected and controlled by the airport operator. Systems can display real-time information to include airport status, surface conditions, current NOTAMs, runway configuration, flight operations information, weather information, diversion information, IROPS conditions, and other information as determined by the airport operator through system configuration. Systems also provide an interactive, online chat function for all authorized users. Subscription rates are based on airport size and computer transaction volume. Some airports have also established a means by which to integrate and operate such systems remotely from the airfield. Access to wireless communications systems and the availability of portable computer hardware is required for those functions.

Local NOTAMs [All Airports]

Airport operators should be cognizant of the limited type of NOTAMs that are disseminated through the FAA's eNOTAM system, which restricts material to those of a national interest. Airports must, therefore, augment the national NOTAM distribution system with a system to disseminate local NOTAMs and other critical information. Cost-effective mediums include broadcast fax, group text, and email lists. Broadcast fax and email distribution lists are cost-effective means in which to disseminate information to local outlets. Airports must be cognizant of the need to maintain current and accurate user contact information. Airports routinely identify a single point-of-contact for tenants to interact with when providing new or updated contact information.

8.3 Airfield Clearing Priorities for the SICP

Priority Pavement Designation [All Airports]

Airport operators should not attempt to maintain the entire airport during a significant snow/ice event. Airports that try to maintain too large an area invariably fail, which results in unscheduled airport closures and lengthy recovery timeframes. Airports should include in the planning process active coordination with ATC and major air carriers to determine an appropriate number of surfaces to designate as priority pavements. Priority designation should not focus solely on runways and parallel taxiways. Critical non-movement areas, such as deice pads, are often included in priority designation. Consensus should be reached on airport capacity associated with the maintenance of priority pavements. A separate pavement prioritization list may be needed for ice events. Some airports formally close non-priority runways and taxiways to prohibit aircraft operations on the surface. Operations along unattended areas often lead to compacted snow and ice that bond with the surface. Surface closures eliminate potential conflicts between aircraft and snow removal vehicles. The FAA snow plan requirement of identifying priority one, two, and three movement-area surfaces can be applied to all sections of the airport. Priorities can be established for aprons, leasehold areas, and landside areas. Airport operators should maintain strict adherence to the priority snow removal plan, even in the face of pressure from key tenants. Pre-season education of the priority pavement plan may mitigate disagreements during a snow event.

Source: Oshkosh Corporation

Optimizing Runway Clearing and Treatment Procedures [All Airports]

When determining the number of connecting taxiways to clear and treat during a closure, airport operators should consider locations that minimize SRE runway occupancy time. Consideration must be given for the range of aircraft expected to use the surface during a snow event. High-speed taxiways are usually located to support air carrier operations. It may be beneficial to also consider other taxiways that would facilitate more efficient runway exit for corporate or general aviation operations.


Source: M-B Companies, Inc.

Post-Event Snow Removal Schedule [All Airports]

The order in which airport surfaces are addressed after a snow or ice event should follow snow removal priorities as listed in the SICP. This applies to both airside and landside facilities. Post-event snow removal should be scheduled in a manner that provides the greatest amount of rest for the snow removal team, with timing often dictated by the next forecasted snow or ice event. It is also good practice to communicate priorities and schedules with airport tenants. Many airports continue to operate their Snow Desks until completion of clean-up activities.

Snow and Ice Control Considerations in Capital Project Planning and Design [Small, Medium, and Large Hub]

Planning and design of airport capital projects must consider impacts on snow and ice control operations. Management and operating costs should be identified and incorporated into operating budgets as appropriate. Operations and maintenance personnel need to be briefed on expectations for any new aircraft movement surfaces. Air traffic control and tenant expectations may justify the hiring of additional personnel, the procurement of additional SRE, or the arrangement for contracted snow removal services. The alternative to additional personnel and equipment is to prioritize snow removal services and to clearly communicate expectations to airport tenants and users.

8.4 Terminal and Landside—Ground Side Priority

Segregation of Airside and Landside Snow Removal [All Airports]

The decision to integrate or segregate personnel between airside and landside (ground side) snow removal assignments is likely determined by the size of the airport. Training requirements and the importance of operator familiarity with the airside environment and associated tasks usually result in dedicated airside crews at larger airports. Smaller facilities may require the same crew for airside and landside snow removal. Those airports that need to place a higher priority on airside tasks have enlisted the assistance of other airport employees to address landside snow removal. Airports report augmenting field maintenance staff with fleet mechanics, skilled trade personnel, and building maintenance workers.

Landside Pavement Priority [All Airports]

Landside pavements should be assigned priorities in a manner similar to airside pavements. Prioritization should be made for arterial roadways, emergency vehicle access roads, revenue-generating parking areas, service roads, remote parking areas, and other landside pavements.

Third-Party Contracts for Landside [Small, Medium, and Large Hub]

Priorities and safety considerations often warrant the assignment of full-time airport personnel to airside snow removal assignments. Yet there are passenger movement and revenue considerations that dictate expedited snow removal from landside roadways and surface parking lots, as well. To address those considerations, the vast majority of airports enter into third-party contracts for landside and parking lot snow removal services. It is standard for a professional parking management company to be responsible for snow removal from within their leasehold areas. Third-party agreements identify equipment type and specifications, minimum number of vehicles, response time requirements and performance standards. Airport operators can facilitate expedited snow removal by providing on-airport storage for the contractor's SRE. It has also been shown to be beneficial for the airport operator to conduct annual inspections and/or licensing of contractor's SRE.

8.5 Airfield Clearance Times

8.5.1 Consistency and Predictability

Maintaining Consistent Runway Reopening Times [Medium and Large Hub]

A concerted effort to establish and maintain runway reopening times maximizes airport capacity during snow and ice events. Consistent performance in reopening runways at a prearranged time creates predictable operation performance and builds confidence with ATC facilities and airport users. With confidence in runway availability, ATC can begin sequencing both arrival and departure aircraft for the runway in advance of the scheduled runway reopening time. Aircraft operators can also conduct deicing operations in a more efficient manner. If past performance has been inconsistent, ATC will likely hold aircraft at outer fixes until assured a runway is available. Excessive holding increases controller workload and results in a significant expense to the affected aircraft operators, as do missed approaches should a runway reopen time be missed with an aircraft on approach.

Repeatable performance requires significant levels of planning and practice. Predictable runway closure timeframes require consistency in the number of vehicles assigned to the operation, a snow removal routine that is well known by all vehicle operators, and contingency planning for unforeseen circumstances, such as equipment failures or communication failures. If it is determined that a scheduled reopening time cannot be met, immediate communication and coordination are necessary to maintaining confidence in the operation. Generally speaking, if given 15 minutes of notice, ATC can adjust to a rescheduled runway reopening time without a significant increase in controller workload. Airport past performance is considered when estimating airport capacity in advance of a snow or ice event. Consistent performance equates to higher capacity and higher capacity results in fewer impacts to the traveling public, enhancing an airport's reputation for being able to operate during inclement weather.

Circuit Routes [Medium and Large Hub]

Established snow removal circuit routes allow SRE to conduct edge-to-edge snow removal following predetermined and standardized routes along runways and parallel taxiways. Circuit routes facilitate predictable vehicle movements and have shown the propensity to be completed in repeatable timeframes. Generally speaking, snowfall intensity dictates the frequency of circuit route snow removal operations. Pavement geometry may limit the ability to implement circuit routes at some airports.

Source: Fortbrand Services, Inc.

Dedicated Taxiway Snow Removal Team [Large Hub]

Many airports have created taxiway snow removal teams to operate in support of, or independent of, runway snow removal teams. Independent taxiway teams are assigned to maintain core taxiway routes. Those teams may be called to augment a runway team to enhance runway snow removal operations. Taxiway teams can operate behind the primary group of runway snow removal vehicles to plow high-speed exit taxiways and other critical runway exit points. The taxiway team reduces the amount of time required to conduct a runway snow removal operation. The availability of multiple runway exit points provided by the taxiway team reduces runway occupancy times and increases airport capacity. When procuring new SRE, larger airports have been increasingly likely to keep older equipment that can be used to build taxiway or other specialty teams. Procurement of high-speed, multi-function vehicles addresses staffing issues as the single-operator vehicle makes available an operator that can be assigned to another vehicle.

8.5.2 Multi-Function Equipment

Multi-Function Equipment to Reduce Runway Closure Time [Medium and Large Hub]

High-speed, multi-function SRE have become the industry standard at large-hub airports and are becoming more common at some medium-hub, small-hub, and high-volume general aviation airports. These units provide the capability to plow, broom, and blow (forced air) snow with a single vehicle. As airports retire individual plows and rotary brooms, they are replacing them with multi-function vehicles. In addition to the

Source: Wausau Equipment Company

purchase of new multi-function units, airports may wish to consider the availability of tow-behind broom equipment, which can be attached to existing plow vehicles, essentially creating a high-speed, multi-function vehicle.

Source: M-B Companies, Inc.

Source: Oshkosh Corporation

Runway teams of multi-function equipment have reduced runway closure times to 10 to 15 minutes, down from what used to be 30, 45 or 60-minute runway closures. The reduction in the time on the runway is made possible by vehicle speed and the implementation of one-pass, edge-to-edge methodology. The deployment of additional equipment behind and in support of the primary runway team further reduces the time on a runway. The support team plows high-speed taxiways or other critical runway exit points. The total number of vehicles required to meet 10 to 15 minute runway closure timeframes is variable based on airport configuration. Many airports have designed circuit routes to maximize the efficiency of multi-function snow removal operations. Procurement and deployment of the equipment may be of benefit to operators of medium hub and applicable general aviation airports due to the ability to perform two functions with one operator made possible by the use of multi-function vehicles. The availability of the additional vehicle operator can then facilitate the deployment of additional equipment.

High-Speed, High-Capacity Snow Blowers [Medium and Large Hub]

A runway snow removal team is only as fast as the rotary snow blowers, which are usually the slowest pieces of equipment in the team. Airports that have invested in high-speed, multi-function SRE also need to invest in high-speed, high-capacity snow blowers. Machines rated at 5,000 tons/hour and greater are now on the market.

8.6 Sizing and Staffing Snow and Ice Control Equipment Fleet

8.6.1 Equipment Procurement and Disposition

SRE Procurement Analysis [Small, Medium, and Large Hub]

Close coordination is required between maintenance staff and airport finance staff in the procurement of SRE and in the development of an equipment replacement program. The lowest priced vehicle may not be the most cost-effective vehicle. Maintenance can assist finance by providing guidance, equipment performance reliability, actual maintenance costs, and other data (e.g., airline delay costs) that could be used to conduct more thorough analyses when considering the type and number of vehicles required to meet snow removal goals and objectives. In addition to standard financing costs, other factors that must be considered when specifying equipment include airport geometry, vehicle maneuverability, airfield egress and ingress, fueling requirements, warranty periods, life-cycle maintenance costs, and additional required maintenance and storage facility space and layout. It is highly recommended that initial and ongoing training costs be written into equipment specifications and into subsequent purchase agreements.

Coordination with Stakeholders on Equipment Purchases [Large Hub]

Some airports have reached out to ATC and key tenant stakeholders in advance of a major equipment purchase to determine expectations for performance and capacity during snow and ice events. Airport operators can then better determine the appropriate number and type of vehicles needed to perform to customer expectations. Collaboration with air carriers regarding financing options has led to positive outcomes at several airports. Lease terms often obligate air carriers to finance airport vehicle purchases through rates and charges, so air carriers become interested in a proper return on their investment. An effort by airport operators to educate air carrier personnel on equipment options and performance factors will enhance air carrier support of needed equipment. For instance, when considering the cost of a high-speed, multi-function snow removal vehicle, cost savings associated with one operator doing the work of two operators can be factored into life-cycle costs. The speed of the vehicles will result in less SRE runway occupancy time and increased airport capacity. Reduced delays and fewer cancellations are obvious cost savings for air carriers.

Performance Requirements for Equipment Purchase [All Airports]

Airport operators should have a predetermined list of performance requirements when evaluating equipment for potential purchase. Vendors should be asked to provide client lists. Equipment owners, including vehicle operators and mechanics, can provide valuable information to manufacturers on equipment performance and equipment maintenance. Airports may wish to consider a formal engineering evaluation of any new equipment being considered for purchase.

Standardized Fleets [Small, Medium, and Large Hub]

Low-cost air carriers have found success in operating a single type of aircraft. Standardized aircraft configuration, crew training, and maintenance procedures have resulted in lower operating costs. The same principle can be applied to airport snow removal operations. Major equipment manufacturers build different types of vehicles on a standard tractor chassis. With minor changes to the functions of operating controls, the same operator cab can drive a plow, sweeper, rotary snow blower, or multi-function vehicle. Operator training costs, maintenance costs, and parts inventory costs are reduced. Airports with access to cooperative purchasing ventures or state or federal contracts may have a greater ability to maintain standardized fleets.

Hooklift Chassis [All Airports]

Airport operators have seen an excellent ROI in the purchase of multi-purpose equipment for all-season use. The hooklift chassis concept is an option that allows airport operators to use a single vehicle for multiple purposes. Hooklift attachments include dump boxes, solid dispensers, and liquid spreaders. A variety of new skid steer attachments are also available, including hydraulic plows that can be configured by a vehicle operator to operate either as a blade plow or as a box plow. Preventive maintenance and reconfiguration of equipment procured primarily for winter operations, but used year-round, should be scheduled so as to ensure immediate availability for the snow season.

Equipment Procurement at Small Airports [General Aviation and Small Hub]

Equipment procurement at smaller airports provides unique funding opportunities not always available to large airports. Because larger airports have multiple financing options, federal and state grants are more frequently targeted for smaller airports. Matching grants may also be available. Airport operators should enlist the assistance of government grant officers in identifying available funding. State or local legislation may allow for unused operating funds to be set-aside for future capital equipment purchases. Capital equipment funds may be earmarked for expenditure over periods in excess of a single budget year or calendar year.

Source: Gresham, Smith and Partners

Purchase of Used Equipment [General Aviation and Small Hub]

Consider buying used equipment only if you have top quality mechanics that can ensure the reliability of the older equipment. Operators should discuss this issue with their finance department when making decisions on equipment purchases.

Cooperative Purchasing Ventures [All Airports]

Governmental agencies have created cooperative purchasing ventures that provide airports with the opportunity to procure equipment at a federal or state-contracted price. The advantages of participating in these joint ventures include the delegation of the formal bid process to a third party and the ability to select equipment by category at lower prices associated with high-volume sales. Airports should investigate the existence of state-to-state reciprocity agreements. Airports may be able to purchase equipment through contracts of an adjacent state agency.

Industry Peer Networking [All Airports]

Airport operators should not underestimate the value of networking with industry peers. The best method in which to build those networks is attendance and active participation at regional and national conferences and seminars. In an era of tight budgets, senior management may be reluctant to authorize travel for mid-level managers and equipment operators. However, the returns are well worth the investment. Personal relationships facilitate communication and cooperation. Testimonials and recommendations result in better decisions when considering new equipment purchases. Common problems can be quickly addressed and mitigated, resulting in more efficient and effective operations.

Equipment Lease Options [All Airports]

Equipment leasing and lease-to-own are options airport operators may wish to consider for financial flexibility, as well as the opportunity to utilize the equipment without a long-term commitment. Some airports establish leases for the sole purpose of field-testing equipment. Leases are advantageous for equipment with little or no value at the end of its useful life. Sweeping equipment was noted by one airport as a target for leases with a minimal buy-out at the end of the contract.

Options for Equipment Being Replaced [All Airports]

Options exist for equipment being replaced other than trade-in or sale by auction. Several airport operators assign used equipment to affiliated reliever airports. Other airports noted success in providing right-of-first-refusal to local FBOs when selling used SRE. An FBO's ability to procure used SRE will likely enhance the tenant's snow removal capability and reduce impacts on an airport's winter operations.

8.6.2 Equipment Maintenance

Broom Wafers, Broom Cassettes, and Plow Blades [Small, Medium, and Large Hub]

Airport operators have the choice of specifying broom wafers or broom cassettes when purchasing rotary broom equipment. Airports that selected wafers noted the flexibility in configuring the broom core for specific tasks. Alternating poly and steel tines (3:1 ratio) is a popular winter configuration. All steel broom cores have winter and non-winter applications. Airports that selected the cassette configuration noted the shorter time period needed to replace worn components. To address the time needed to replace cores of either design, many airports order and prepare spare cores for expedited replacement. One airport reported they also maintain an inventory of spare plow blades. A vehicle can simply switch plows when cutting-edges require replacement, resulting in a rapid return to service of a critical vehicle.

Source: Gresham, Smith and Partners

Computerized Maintenance Management System [Small, Medium, and Large Hub]

It is strongly recommended that airport operators utilize a CMMS or procure and operate fleet management computer software. Computerized systems streamline maintenance activities on a per-vehicle basis. The use of vehicle mileage or engine hours as the primary consideration for vehicle replacement is no longer cost effective. Actual maintenance and repair costs provide far better justification when determining whether or not to keep or replace a vehicle.

Operator Input for Maintenance Procedures [All Airports]

Vehicle operators are often the best people to identify innovative operational procedures or new maintenance procedures. Managers are encouraged to allow operators the opportunity to present and/or review proposed procedural changes. Many airports will facilitate round-table discussions between equipment operators and equipment manufacturers or their representatives.

Protection of Windshields from Debris [Large Hub]

Snow removal equipment can be exposed to jet blast blown sand and other debris while operating in aircraft movement areas. The debris is extremely abrasive to windshields and other glass surfaces. Since replacement of heated windshield equipment is costly, airports have reported the use of adhesive plastic filament sheets to reduce the frequency of full glass replacement.

Inspection of Equipment After Use [All Airports]

It is an important practice to inspect SRE after each use to determine if repair or maintenance is required and to maintain equipment readiness. Some airports assign commercial vehicle log books to each piece of SRE. Other airports prepare post-event maintenance checklists for each vehicle type (e.g., verifying that contents in liquid and solid chemical spreader equipment are emptied if the equipment is not stored in a climate-controlled facility). Responsibility for post-event inspection differs from airport to airport. Responsibility may rest with the individual who

Source: Gresham, Smith and Partners

last operated a vehicle, an equipment mechanic, or an equipment superintendent. Management must clearly communicate responsibilities and expectations.

Prioritization of Repairs [Small and Medium Hub]

Airport vehicle maintenance at smaller facilities may be conducted at a facility shared with other departments of a municipal agency with one team of mechanics working on all vehicles. Priority must be established for the repair of SRE during a winter event. If work is accomplished on a first-in first-out basis, airport snow removal efficiency may suffer with a significant cost to airport tenants.

Disabled Vehicles [All Airports]

To immediately address disabled vehicles, some airports have created chase teams of mechanics that follow runway and taxiway snow removal teams. The teams operate out of specialized vehicles equipped with tools to facilitate rapid repair or recovery of disabled vehicles. Tow vehicles should be readily available to address disabled vehicles or vehicles that may become stuck in an airfield location. Winter preparation should include a plan on how to tow each vehicle in the fleet, including vehicles with sensitive equipment, such as friction testing vehicles. Several airports mark vehicles to identify tow points while others have installed tow hooks to facilitate rapid recovery.

Efficient Fueling of Multi-Function Equipment [Medium and Large Hub]

Multi-function vehicles are equipped with multiple fuel tanks. Efficiencies could be gained if fueling facilities are configured or designed for simultaneous fueling operations. Several airports augment fixed fueling facilities with mobile tankers to reduce multi-function vehicle fueling time.

8.6.3 Warranties

Equipment Warranties [All Airports]

Most equipment manufacturers provide warranties over a period of months or years. Airports may wish to negotiate warranties based on operating hours instead of the calendar format.

8.6.4 Staffing/Shift Management

Scheduling and Shift Management [All Airports]

There is no one-size-fits-all approach to crew scheduling. An in-depth analysis of all options should be conducted to evaluate 6-hour, 8-hour, 12-hour, or around-the-clock crew scheduling. Procedures for crew scheduling and call-back to the airport should be outlined in the SICP. Pre-event planning includes an analysis of the appropriate level of personnel necessary for effective snow removal operations. Many airports have multiple call-back levels that are based on the forecasted intensity and duration of a storm. When calling personnel back to the airport, consideration must be given to the status of personnel with regard to their regular assigned shifts. The majority of airports implement a 12-on and 12-off shift schedule. Several airports noted success in creating 12-on and 12-off coverage by adding 4 hours of overtime to routine 8-hour shifts. An airport noted high crew performance and high morale associated with a 6-on and 6-off schedule. A few large airports call in all personnel at the start of a snow event, but each of those airports have facilities to support 24/7 crew operations. General aviation airports tend to operate in the "all hands on deck" mode during snow removal. Those airports, however, have fairly well designed work and rest schedules.

Pay for Rest Time [Large Hub]

The choice of whether or not to pay employees during sleep periods is an individual airport decision. Airports that keep personnel on the clock during sleep periods report high morale, high motivation, and loyalty that results in excellent performance with extremely low turnover. Airport operators, air carriers, or airport tenants that question the cost of keeping personnel on the clock may wish to consider a cost-benefit analysis based on enhanced performance, increased airport capacity, lower employee turnover, and reduced recruitment and training costs.

Allocation of Tasks to Full-Time, Part-Time, and Contracted Employees [General Aviation]

Operators of smaller airports must consider airport-specific factors when determining the assignment of tasks to full-time, part-time, or contracted employees. Those factors may include desired hours of operation, type of flight activity, airport tenant expectations, and available personnel.

Staff Specialization [Medium and Large Hub]

Operators of larger airports may wish to consider specialization when making equipment assignments. There is usually adequate depth of crew size to support the assignment of an employee to a specific piece of equipment for the duration of a winter season. Some airports also assign personnel to a specific geographical area of the airport. Specialization reduces training time and associated costs. Proficiency in a single piece of equipment results in more efficient and effective performance.

Source: Gresham, Smith and Partners

Equipment Assignments [Small, Medium, and Large Hub]

Efficiencies are gained by assigning equipment by operator proficiency. If union contracts mandate equipment assignment and associated pay strictly by seniority, an airport operator may consider negotiating a single wage for SRE. A single wage scale would permit flexibility in equipment assignments. Incentives or additional compensation for lead positions may result in competition and improved performance.

Tasks for Probationary Employees [Medium and Large Hub]

Probationary employees or those not certified for snow removal operations can be assigned other duties, such as equipment fueling duties and support of equipment repair operations.

Coordination with Air Carriers to Determine Staffing Needs [Medium and Large Hub]

Airports reported success in coordinating with air carriers on financial assumptions and financial modeling in determining appropriate staffing levels for snow and ice control operations. The identification of airline expectations for capacity and operations during winter events is a key factor in determining airport crew complements. A subsequent cost-benefit analysis comparing airport staffing costs against airline delay and/or cancellation costs will lead to better decision making regarding the optimum crew size necessary to meet customer expectations.

8.7 Storage of Snow and Ice Control Equipment

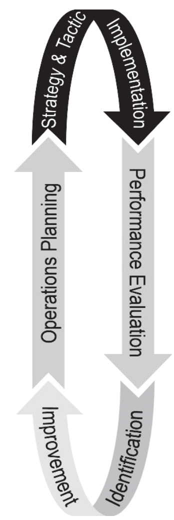
Storage of SRE [Medium and Large Hub]

Source: Gresham, Smith and Partners

Operability and longevity of SRE is enhanced by storage in heated, indoor facilities. Garages need to be designed in a manner to facilitate efficient movements. Modern design includes drive-through capability and wide access doors (roll-up or folding). The lack of an adequate storage facility was a factor noted by some airports in their decision not to pursue the procurement of multi-function vehicles. Although inconvenient, multi-function units can be broken down for storage, which was observed at several airports, including a general aviation airport. Since airport vehicle storage facilities are eligible for federal funding, airports have included building costs in vehicle procurement financing plans. If repair facilities are included in building design, additional amenities, such as extended lubrication pits and overhead cranes, should also be considered, as well as an adequate amount of space to accommodate winter repair operations in a climate-controlled environment.

CHAPTER 9

SICP Best Practices



This chapter continues the presentation of best practices related to, and in general accordance with the contents of AC 150/5200-30C Chapter 2, "Snow and Ice Control Plan." Each practice title is followed by a description of the airport type(s) in brackets to which the practice may be most applicable.

9.1 Safety Requirements

Airport Closure or Suspension of Flight Operations for Safety [All Airports]

The goal of maintaining continuous airport operations, regardless of the weather conditions, has been replaced at the vast majority of airports with a safety-first culture. An airport closure or suspension of flight operations is an acceptable safety measure and does not indicate a failure of the snow removal team or the airport's SICP. Pre-season training at some airports includes a simulated airport closure and recovery scenario. Tenants are briefed by airport operators during pre-season meetings on the conditions that may lead to an airport closure. Air carriers have shared operational guidelines for when aircraft will not fly and for when ground crew activities will be suspended. Airports with SMGCS plans are using restrictions triggered by prevailing visibility readings as the basis for decision making during a snow or ice event. Most SMGCS plans list a visibility at which an airport will suspend aircraft movements and vehicle operations and issue a NOTAM indicating airport closure. The "safety-first" message needs to be communicated to all airport tenants and stakeholders starting at the first meeting of an airport's Snow Committee and continuing throughout the winter season.

Airport Surveillance Detection Equipment [Medium and Large Hub]

Reduced visibility and obscured lights and pavement markings are hazards to vehicle operator situational awareness. Airport surveillance detection equipment (ASDE) Model X will detect aircraft and track vehicles operating on the movement area. The FAA has deployed ASDE-X at 35 airports. ASDE-X data can be made available to airport operators through third-party product vendors. The FAA has approved the use of ADS-B out-squitter equipment for airport vehicles (see AC 150/5220-26). A squitter will broadcast a unique code that is interrogated by the ASDE-X system. The benefit of a squitter broadcast is that a vehicle call sign can be tagged to the primary target on ASDE-X displays, allowing air traffic controllers to immediately identify the vehicle. The equipment is eligible for FAA funding.

Commercial Vehicle Tracking Products [Medium and Large Hub]

Airport operators should consider the use of commercial vehicle tracking products to enhance safety during winter operations. Multiple GPS-based products are available that can track vehicle movements. Some of these products have the ability to create "electronic fences" around runways or other areas of concern with audible and visual alarms that can alert an operator when a vehicle is approaching the "fence-line." Multi-lateration and triangulation based products are also available for vehicle tracking on all airport surfaces.

Runway Crossings [All Airports]

Avoid runway crossings whenever possible by using airport service roads, perimeter roads, and tunnels. If runway crossings become necessary, standard crossing points should be established with ATC and identified in a letter of agreement (LOA). The proper use of radio procedures, as presented in airport vehicle driver's training, is imperative. There should be zero tolerance for any deviation to procedures by vehicle operators. A runway crossing is one of the most dangerous situations on an airport and should be afforded the commensurate level of attention and care.

Adequate Staffing for Event [All Airports]

Too few personnel available for snow and ice control operations results in a rush to job completion and the higher probability of an accident or incident. Err on the side of safety when determining the number of employees needed for a snow event. The opposite shift or relief crews should be available on a timely basis. Airport operators should also consider roadway conditions that airport employees will face on the drive to the airport. Congestion and snow or ice-contaminated surfaces will require additional travel time.

Non-Punitive Reporting Procedures [All Airports]

Accident and incident investigations are enhanced by instituting non-punitive reporting procedures. Future accidents are often prevented by forthright and honest reporting of circumstances leading up to an incident. Multiple airport operators discouraged immediate termination of an employee for a runway incursion or for a vehicle accident, except in the case of willful misconduct or prior history. Airports noted the significant investment in operator training and the loss of a valuable resource associated with unnecessarily rigid disciplinary action.

9.2 Topics for Pre- and Post-Season SICC Meetings

Post-Season Evaluation to Kick Off Pre-Season Planning [All Airports]

A post-season meeting of the SICC with airport stakeholders is likely the most important meeting of the winter season. Many airports consider the post-season meeting as the start of the planning process for the following winter season. The last post-event meeting and/or critique should not be confused with the post-season review meeting. It is important to have access to minutes from all post-event meetings from the snow season for the post-season review. Procedural changes are often dictated by lessons learned during individual snow or ice events. A comprehensive post-season review of procedures becomes the basis for revisions to the SICP and updates of related procedural documents. Changes are incorporated into the appropriate documents with publication scheduled for late summer or early fall, as appropriate, to support annual, recurrent winter operations training.

Post-Event Snow Committee and Stakeholder Meeting [All Airports]

There is general agreement that a post-event meeting of the Snow Committee and airport partners and stakeholders is of vital importance to successful winter operations. These meetings, which may also be referred to as event critiques or hot washes, are usually scheduled one to three business days after a snow or ice event. Although all stakeholders are invited, it is important to have a knowledgeable representative from key stakeholders (ATC, air carriers, FBOs, pilot safety groups, and deicing service providers) present at the meeting. Individual event performance is evaluated by identifying the good and not-so-good in an open, respectful forum. Any significant disagreements are identified and discussed at a separate meeting involving only the affected parties. Meeting minutes are kept by the secretary of the Snow Committee or by a representative of the airport, not only for post-meeting dissemination, but also for review at the end of the winter season. Lessons learned and potential changes to snow and ice control procedures are identified and considered for implementation. Minor procedural changes may be implemented prior to the next snow or ice event. It should be made clear to partners and stakeholders that major changes or any proposed changes to the airport's SICP require FAA review and approval.

9.3 Outlining an SICP

Winter Operations Plan [All Airports]

An FAA-approved airport SICP addresses regulatory requirements listed under FAR 139.313, "*Snow and Ice Control.*" Similar to more detailed internal documents that support the Airport Certification Manual (ACM), a detailed Winter Operations Plan, including procedures and checklists, should be prepared to augment the SICP. The Winter Operations Plan is airport-specific and should clearly define the roles and responsibilities of key airport positions, airport departments, airport contractors, and stakeholders. It should outline airside and landside snow removal procedures and protocols. The internal document should be the basis for winter operations training for all airport personnel assigned to winter operations duties. The document should be readily available for reference during a snow or ice event. Some airports prepare separate procedural documents for contracted employees. Documents and procedures should be reviewed annually upon completion of the snow season. Revisions of the internal documents are often the impetus for a revised FAA SICP.

Weather Conditions Triggering Procedures [All Airports]

The SICP or Winter Operations Plan should identify the weather conditions that will initiate the execution of SICP procedures. Snow removal crew response is a factor of the forecasted type of precipitation, the forecasted rate of accumulation, total amount expected, and timing of the event. Snow removal personnel can become familiar with SICP triggers and, therefore, can recognize forecasted conditions in which they can expect to be called to the airport for snow and ice control duties.

SICP Contributors [All Airports]

Participation in original preparation and subsequent revision of the SICP should not be limited to operations or planning personnel. Any internal airport department or external agency that will be assigned tasks within the SICP should be afforded the opportunity to provide input and suggestions on plan content. The individuals conducting the work often have the best perspective as to the most effective and efficient means in which to complete their assigned tasks. With ownership comes accountability; with accountability comes performance.

SICP for a General Aviation Airport [General Aviation]

An FAA-approved SICP is not required at non-certificated airports. Nevertheless, many general aviation airports have established a goal to maintain FAR Part 139 standards during winter operations and have created snow plans in support of that goal. The dissemination of an SICP provides tenants and airport users with written expectations for airport operability during a snow or ice event. Established standards and procedures provide clear guidelines for airport operations and maintenance personnel. The general aviation airports with snow plans noted staff willingness not only to meet FAR Part 139 standards but to exceed those standards and, therefore, exceed tenant and user expectations.

Impacts from New Construction [All Airports]

Airport construction routinely requires revisions to an airport's SICP. Consideration must be made for new or altered pavements and new or expanded structures. Operations staff participation in construction planning processes as well as the availability of construction plans and documents means that the identification of potential impacts to snow removal operations may begin prior to actual construction. Post-construction airport layout drawings should be made available as soon as is practical for incorporation into winter documents and for use in pre-season planning and training. Snow Committee membership should include a representative of the airport's engineering, planning, and development department.

9.4 Topics for Writing Instructions and Procedures for Winter Operations and Notification

Pre-Event Meetings in Response to Weather Forecasts [All Airports]

An airport operator's SICP and/or internal procedural documents should clearly define procedures for reviewing and analyzing forecasted weather conditions in advance of a snow or ice event. Most airports concur that a meeting or teleconference with critical airport stakeholders 12 to 24 hours in advance of an event is key to a successful response to the event. A pre-event meeting or teleconference agenda should include a detailed weather forecast review and the expected impact of the weather on airport capacity. Airports commonly provide their best estimate as to the frequency and type of runway treatment expected during the event, which helps facilitate a discussion of event-specific, predictable airport arrival rates and departure rates. At a minimum, participants should include airport operations, airport maintenance, ATC, air carriers, and key aircraft operators serving the airport. Larger airports convene a full meeting of their Snow Committee and/or IROPS Committee. Detailed notes of the meeting should be prepared for dissemination to all airport tenants, in addition to those who attended the meeting.

Response Levels for Forecasted Weather Conditions [All Airports]

An airport's SICP and/or internal procedural documents should clearly define procedures for response to forecasted weather conditions. Many of these plans are structured or tiered, based on forecasted weather conditions, and define response times and the number of personnel required to report to the airport depending on the level of the event. Too often, response plans are based on forecasted snowfall alone. However, snow type, snowfall rate, and event duration should also be considered in determining response levels. Response checklists are of particular value for airports with infrequent snow or ice events.

Source: Epoke North America, Inc.

Snow Removal Procedures to Avoid Aircraft-Vehicle Conflicts [All Airports]

The runway environment should be protected at all times to avoid aircraft-vehicle conflicts. Airports strongly recommend the establishment of formal procedures to outline runway snow removal operations. Those procedures should be listed in the SICP and in an LOA with the appropriate ATC facility. Another strong recommendation is the closing of the runway to facilitate snow and ice control operations. Airports that conduct snow removal between flight operations on an open runway need to pay particular attention to established safety protocols. Conducting snow removal on an open runway when the local ATCT is closed is not recommended. Remote approach control facilities or enroute ATC centers will not be as familiar with established procedures.

TSA Security Procedures for Stranded Passengers [Small, Medium, and Large Hub]

Outside of normal TSA operating hours, consider establishing procedures to allow for the escorting of screened passengers into non-sterile areas to meet immediate needs and then returning to the sterile area without additional screening.

9.5 Runway Incursion Mitigation and Operations During Non-Towered ATC Periods

Use of Supplemental ATC Frequencies for Communications [General Aviation and Small Hub]

Most airports utilize internal company radio frequencies to facilitate communications during snow or ice control events. Airport operators at smaller facilities have reported success in utilizing a supplemental ATC frequency for snow and ice control communications. The process allows ATC personnel to monitor transmissions, track the movement of snow removal teams, and immediately participate in transmissions to coordinate surface closures. The volume of routine air traffic transmissions should be considered before pursuing the use of an available ATC frequency for snow removal communications, as well as the possibility that such transmissions may distract controllers from their primary tasks. Approval to use an ATC frequency and detailed procedures should be codified in a LOA.

Snow Removal Coordination When Local ATCT Is Closed [General Aviation, Small, and Medium Hub]

Airports that do not have a high demand for runway capacity may benefit by preparing for runway assessments or by scheduling runway snow and ice control closures when reported braking action deteriorates to medium (fair) from good braking. Communication protocols between the airport operator and ATC should be defined in an LOA, including procedures for when the local ATCT is closed. Many airports report conditions to the next available ATC facility, either a TRACON or an Enroute Traffic (Center) facility, as appropriate. When a local ATCT is closed, it is a best practice for airport snow removal crews to be monitoring the local common traffic frequency (CTF). Some airports will report conditions on the CTF upon request from an inbound flight crew when the ATCT is closed.

9.6 Staff Training and Recordkeeping

Summer Training [All Airports]

Snow removal skills training and operational briefings should not be limited to immediately prior to the winter season. Vehicle operators will benefit from off-season table-top exercises, operational briefings, and “dry-run” snow removal vehicle training sessions. The off-season timeframe will allow managers and operators the opportunity to experiment with new or revised strategies and tactics, including procedures or vehicle movement options. Summer training sessions may also provide an opportunity for key partners and stakeholders to ride along for the purposes of becoming more familiar with airport snow removal operations.

Source: Oshkosh Corporation

Pre-Season Dry-Run Training [All Airports]

Most airports conduct dry-run winter operations training in advance of the winter season. A simulated runway snow removal operation is coordinated with ATC, providing each agency with an opportunity for refresher training and refamiliarization of winter operations. A dry run provides the opportunity for air traffic controllers, airline personnel, and airport administrative staff to ride along with snow removal operators. The chance to ride in a snow removal vehicle on the airfield is appreciated and valued. Some airports take the dry-run concept one step further by conducting a "snow rodeo," where operators are put through a series of driving tests and obstacle courses. Certain airports score performance and present awards, often at a social event that immediately follows the rodeo.

Formalized Annual Training [Large Hub]

Larger airports with available training resources have formalized annual, recurrent winter operations training for all appropriate internal employees. This level of training exceeds FAR Part 139 requirements, as not all participants have tasks identified in the ACM. Topics include SICP review, SMGCS plan review, incident command or Snow Desk training, communications training, and other pertinent operational topics.

Training for Contracted Personnel [All Airports]

An intense training program is required for contracted personnel assigned to airside snow removal tasks. In addition to basic airport vehicle driver's training and the education of personnel on expectations and desired snow removal methodology, contracted personnel need to be educated on the unique nature of the airport environment. Hazards exist that are not encountered at a normal job site, especially hazards associated with working in and around aircraft.

Outside Stakeholder Involvement in Training [Small, Medium, and Large Hub]

Airports may wish to provide familiarization training to ATC, airline, FBO, and other tenant personnel to outline basic snow removal tactics and to identify equipment and its use. The effort will likely enhance inter-agency coordination and cooperation, as well as provide the opportunity to define snow removal goals and objectives. Airport personnel would also benefit from any reciprocal training and/or familiarization programs made available by key airport partners.

Stakeholder Ride-Alongs [Medium and Large Hub]

Some airports provide stakeholders with the opportunity to ride along with snow removal teams. It was suggested that the experience not be a quick orientation, but a full 2 to 3 hour shift on the airfield. The experience will educate stakeholder personnel on the difficulty and hazards experienced by the snow removal team. This may facilitate an understanding of and an appreciation for the snow team's efforts that will pay off with more cooperative interaction between the airport and its tenants. Additionally, stakeholders may enjoy and benefit from the opportunity to participate in "dry-run" snow removal training sessions.

Sleep Disorder Training [All Airports]

Airports should provide snow removal crews with sleep disorder training and circadian rhythm training. Online training and printed materials are readily available. This training will allow employees to recognize the symptoms of fatigue and the pre-event personal activities that could lead to fatigue on the job.

Training on Human Performance Factors and Situational Awareness [All Airports]

Airport operators should provide snow removal personnel with training and presentations on human performance factors and situational awareness. Training leads to safer outcomes.

An overwhelming number of aircraft accidents and airport incidents have been attributed to the loss of situational awareness. Vehicle operators need to be reminded to slow down and add following distance when operating on contaminated surfaces and when operating in reduced visibility. Operators should be trained to avoid vehicle operation when fatigued and to immediately report the condition to a supervisor or manager. Data has shown the majority of snow removal related vehicle accidents occur during clean-up operations when less stressful conditions may lull a driver into a false sense of security. Airport operators should maximize crew rest periods by scheduling clean-up operations based on the next forecasted snow event and not be in any rush to complete that work as soon as possible. Airports with a safety or risk management function may wish to consider inviting a representative of that department to act as a safety officer during weather events, observing operations from a supervisory or lead vehicle.

Radio Communications Procedures [All Airports]

It is imperative to train vehicle operators on proper radio communications procedures. Operators should be proficient in operating the type of radios installed in their vehicles. Proper radio communication protocols should be included in a vehicle driver's training program. Assigned channels or frequencies need to be clearly delineated with requirement that vehicle operators must monitor assigned frequencies. A radio's scan function leads to distractions and, therefore, its use should be prohibited. Radio transmissions should be strictly limited to safety- or business-related calls only; idle chatter should be prohibited. Airport operators may wish to consider the recording of critical radio channels for incident review and future training.

Radio Frequencies [All Airports]

Vehicle operators should be trained to have working knowledge of all ATC frequencies used on the airport. At minimum, a list of air traffic positions and assigned radio frequencies should be available in all vehicles. ATC assigns frequencies by type of surface (runway or taxiway), by geographical area, and by task (e.g., metering or clearance delivery). Persons assigned to communicate with ATC must know the correct radio frequency associated with the specific movement-area surface. It is highly recommended that communications associated with runway operations be conducted on the appropriate local control or tower frequency. Communications related to taxiway operations should be broadcast on the appropriate ground control frequency. Procedures should be identified in the LOA with ATC, including the identification of an emergency telephone number in the event of radio communication failure.

Vehicle-Specific Training [All Airports]

Develop a comprehensive and practical training program for each vehicle in the fleet. Ensure that personnel have adequate training on each piece of equipment they are expected to operate. An appropriate amount of behind-the-book and behind-the-wheel training is necessary in order for safe operation. Almost every piece of SRE is equipped with dual-operator cab seats, which facilitate training with an experienced operator on board. Simulator training may be of benefit for airport driver's training and airport familiarization, but an operator will need to learn the handling characteristics of a particular vehicle. For instance, most airports operating multi-function vehicles noted the need for extended training periods due to the size, weight, and unique design of the equipment. The training program should identify standards that must be met before an employee

Source: Oshkosh Corporation

is allowed to operate a vehicle on his or her own. Completion of training is documented in writing by management. An airport's vehicle training program should include annual, recurrent training with an associated competency evaluation for each piece of equipment an employee is expected to operate. Airports that implemented a formal vehicle certification program reported reduced accident rates.

FAA TMU Training [Medium and Large Hub]

The FAA ATC Command Center provides TMU training courses for internal staff on a routine basis. The FAA has made seats available at these courses to airport representatives for the purpose of education and familiarization with FAA traffic management and flow control procedures. Participation is on a space-available basis. Interested airports should make inquiries with the TMU office at the ARTCC with jurisdiction over local airspace.

Web-Based Training Services [All Airports]

Airports with a high demand for winter operations training utilize web-based training services and, at a few airports, are utilizing a vehicle training simulator. Each option can generate an on-demand winter environment for training purposes. Airports that operate a simulator reported a number of employees experienced motion sickness while training in a full-environment simulator. Video game consoles were deployed to offset this problem and to train employees who were unable to participate in simulator training.

Field Maintenance Personnel Training [Medium and Large Hub]

FAR Part 139.303 requires airport personnel with ACM compliance duties to complete annual, recurrent training. Due to assigned ACM compliance duties, operations personnel experience a higher volume of training than maintenance personnel. In an effort to increase proficiency and awareness of ACM compliance duties, airports have offered field maintenance personnel the opportunity to take training classes above the level required of their job duties.

Snow Desk Training [Small, Medium, and Large Hub]

Airports that establish an ICP or operate a Snow Desk during a winter event should conduct annual, recurrent training for airport staff and tenant representatives who are routinely assigned to those facilities. Off-season table-top exercises offer excellent training opportunities. Individuals assigned to an ICP or Snow Desk may benefit from NIMS training, especially if NIMS procedures are used in snow removal operations. Various online courses are available from the Department of Homeland Security or Federal Emergency Management Agency: http://training.fema.gov/IS/NIMS.aspx.

9.7 Other Related Items

9.7.1 Lease Agreements

Maintenance Responsibility Matrix [General Aviation, Small, Medium, and Large Hub]

Airport operations and maintenance personnel should have a clear understanding of snow removal requirements as defined in airport lease agreements. Many airports prepare a maintenance responsibility matrix that is an attachment to an airport lease. The matrix identifies where the tenant is responsible for snow removal or other general maintenance items and is a valuable field reference for snow removal supervisors. Areas of responsibility can be depicted visually on a leasehold diagram or listed in a database format. A map depicting all airport leasehold areas and related responsibilities is an excellent resource for on-field snow removal managers and supervisors.

9.7.2 Contracted Snow Removal

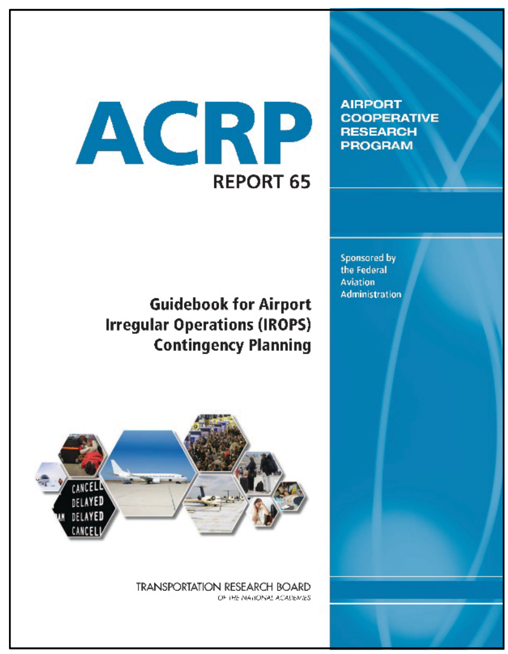
Third-Party Contractors for Aircraft Parking Gate and Cargo Ramp Snow Removal [Small, Medium, and Large Hub]

Safety and efficiency considerations may necessitate the assignment of aircraft parking gate and cargo ramp snow removal to third-party contractors. When working with a limited number of full-time vehicle operators, airports will likely assign those individuals to snow removal duties on movement-area surfaces and other critical areas. It is common for air carriers and cargo operators to be responsible for snow removal from within their leasehold areas. In some cases, airport operators enter into contracts for snow removal from aircraft parking gates and cargo aprons. Cost recovery methodology is routinely noted in tenant leases.

9.7.3 IROPS and Tarmac Delays

Tarmac Delay Contingency Planning [Small, Medium, and Large Hub]

Snow and ice events can and will likely lead to IROPS conditions. Recently enacted federal legislation requires airports to submit to the U.S.DOT a Tarmac Delay Contingency Plan. Airport operators should ensure that the SICP is in concert with Tarmac Delay Plans or other related IROPS procedures. The requirement for the airport to work with air carriers to provide passenger accommodations during periods of excessive tarmac delays is a major component of the federal legislation. Airport operators are required to facilitate communication with airlines, ground handlers, and FBOs who may have the facilities or the necessary equipment to safely deplane passengers on behalf of airlines that have incurred excessive tarmac delays. The Tarmac Delay Plan must also identify procedures to share aircraft parking gates and facilities. However, terminal parking gates may not always be immediately available, resulting in the need for remote aircraft parking facilities.



It is in the best interest of airport operators to have a pre-determined remote aircraft parking plan and to determine the number of aircraft that can be accommodated under the plan. Communication of that capacity in advance to partners, stakeholders, and ATC may very well reduce the probability of untenable and unmanageable IROPS events. It should be noted that the U.S.DOT documents use the term "safe" deplanement of passengers. Conditions during snow and ice events may prevent the safe deplanement of passengers from remote airport locations. Airport operators may wish to include procedures in the SICP that would address access to remotely parked aircraft for the purpose of deplaning passengers as well as for emergency medical response, food and beverage delivery, or the transportation of personnel for general aircraft services.

For additional information on IROPS planning, see *ACRP Report 65: Guidebook for Airport IROPS Contingency Planning.*

Coordination with Customs and Border Protection for International Flight Diversions [Small, Medium, and Large Hub]

Tarmac Delay Contingency Plans and IROPS Plans should address procedures for accommodating diverted aircraft, with special attention necessary for international diversions requiring close coordination with air carriers and Customs and Border Protection (CBP). Airports without an on-airport CBP facility should have procedures to address special circumstances associated with international flights. It would be of great benefit to coordinate with CBP and local law enforcement on a plan to deplane and hold passengers in a secure facility.

Prior authorization from CBP is required for deplanement of passengers without the immediate presence of CBP officials. Operational departments should include PR in any notification process associated with an international diversion.

Gate Sharing [All Airports]

If not specifically referenced in an existing plan, develop formal agreements with tenants for the sharing of leased gates during irregular aircraft operations. Establish plans for off-gate or hard-stand deplanement procedures to include ground service equipment personnel access to remotely parked aircraft and passenger/crew transportation to terminal facilities. Consideration must be given for the movement of handicapped or special-needs passengers. Airports should identify and communicate to air carriers and ATC the number of aircraft that can be parked on airport surfaces. That number should be further refined to identify the number of aircraft that can be processed for passenger deplanement within the domestic three-hour and international four-hour tarmac delay requirements.

Airport Closure Planning [All Airports]

Pre-season planning should include discussions regarding airport closure during a severe snow or ice event. Parameters and conditions most likely to cause a suspension of operations should be identified and communicated to all tenants and stakeholders. Many airports refer to operating restrictions or suspension of operations triggered by specific visibility readings as identified in an airport's SMGCS plan. Post-airport closure recovery plans and procedures should also be addressed. One airport noted success in conducting a mock airport closure and recovery table-top exercise to drill airport tenants on procedures and expectations during a severe weather event.

Remote Aircraft Parking Planning [Small, Medium, and Large Hub]

Airports with limited deicing capacity would benefit from a well-defined remote aircraft parking plan, including the identification of queue line space and taxi routes to and from designated deicing locations. Remote parking locations may already be identified through IROPS planning; however, consideration must be made for winter conditions. Designated deice areas are often also identified for IROPS-related remote aircraft parking. The use of those pavements for deicing operations will affect remote parking capacity. Airports may wish to consider separate remote aircraft parking plans for winter and non-winter conditions.

Notification of Regional Airport Operators Receiving Diverted Aircraft [Large Hub]

Excess aircraft volume, sudden and unpredicted changes to the intensity of a snow event, an unscheduled runway closure, or a disabled aircraft are situational examples of what may create aircraft diversions from a hub airport to regional alternate airports. Past incidents indicate there has been little or no notification to regional airport operators that they will be receiving diverted aircraft. Hub airports in several areas of the country have formed regional networks to facilitate relationship building and to enhance communications among the hub airport, regional airports, and the air carriers that may utilize those airports. Hub airports have compiled and disseminated 24/7 telephone or email contact lists for use by all parties to the network. Those parties include governmental agencies, airline operations control or systems control centers, airport managers, FBOs, and local public safety agencies. The contact information becomes the data source for pre-loaded email or telephone notification lists that can be used to inform regional airports of potential or imminent diverted aircraft. The advanced notification assists regional airports in providing a coordinated response to an IROPS event, including possible implementation of the airport's Tarmac Delay Contingency Plan.

9.7.4 Passenger Assistance

Stranded Passenger Plan [Small, Medium, and Large Hub]

Maintain a Stranded Passenger Plan as part of the IROPS plan. The plan should include ways to address passengers' five basic needs during an event: information (airport, airlines, government agencies), overnight accommodations (local lodging and airport amenities), food and water (concessions), facilities (life, safety, and security considerations, clean restrooms), and special services (ground transportation, services for special-needs passengers).

Accommodations for Passengers with Disabilities [All Airports]

In coordination with airline tenants, develop a plan for assisting them with providing special-needs passengers support as required by 14 CFR Part 382, *Nondiscrimination on the Basis of Disability in Air Travel.* This plan would include procedures for responding to passenger medical needs and for the care and feeding of service animals and animals in transit. It is recommended that all airport employees undergo customer service training in order to be better able to assist the public during winter weather operations. This should include CPR and first aid training in case of medical emergencies within the terminal.

Concessionaire Involvement in Winter Operations [Medium and Large Hub]

Airport operators should actively engage concessionaires during winter events. Participation by food/beverage and retail tenants is critical to the successful implementation of IROPS plans. Agreements should be in place to extend operating hours later into the evening and earlier the following morning, as necessary to accommodate stranded passengers. Key concessionaires should be included in airport information dissemination networks, as it will be a challenge to make staffing arrangements on short notice.

Additional Support Staff for Passenger Assistance [All Airports]

Utilize appropriate and available non-operational staff to support terminal operations during periods of mass disruption. Consider third-party contractors who can provide support to passengers on short notice and train this group prior to winter weather operations. Equip staff in terminals with mobile devices, including laptops and tablets, to help provide relevant airport, flight, and hotel information to passengers. The devices help staff offer a more personal service via a multilingual translation application that enables assistance to non-English speaking customers. Airport operators need to make it readily obvious how such services can be found.

Passenger Support Literature [All Airports]

Many airports have produced pamphlets and other printed materials to assist passengers affected by IROPS conditions. Materials publicize available airport amenities including available retail and food/beverage concessions, special-needs items, medical and pharmaceutical supplies, onsite or nearby overnight accommodations, transportation options, security requirements, airline contact information, and emergency contact information. IROPS planning includes steps to make terminal spaces more amenable for overnight accommodations. Additionally, the customer experience and PR are enhanced by the continuous presence and availability of airline and/or airport representatives during IROPS events.

Hotel Hopper Buses [All Airports]

Consider mobilizing free "hotel hopper" buses to transport passengers around the airport during adverse weather conditions and consider contracting with a specific provider for this purpose. Airports should also ensure that people who are using airport parking facilities are not charged for overstays in the event of major disruption.

Passenger Communications [Medium and Large Hub]

During a winter event, communication with the traveling public involves two groups: the internal audience (passengers already at the airport) and the external audience (passengers on their way to the airport). For the internal audience the airport should use Flight Information Display System monitors and public address systems to notify passengers of winter weather related information. For external audiences the airport should use news media, the airport website, and social media to release winter weather information. Additionally, the FAA will provide delay information at major airports on the www.fly.faa.gov website. Air carriers provide real-time flight information on their websites.

9.7.5 Winter Event Public and Media Relations

Crisis Communication Plan [All Airports]

Prepare a Crisis Communication Plan (CCP) to provide a communications protocol for all airport employees in any emergency event. The CCP strategy is to provide as much information as possible as soon as the airport is aware of a crisis situation. The plan should include protocol for airport employees in an emergency event, identification of a media relations plan, strategy for social media engagement, and direction for stakeholder outreach and management. The CCP should identify how to conduct media relations and social media engagement. It should provide direction for stakeholder outreach and management, including international, domestic, and community relations. If an airport reports to a board or an authority, the communication plan can give directions to expedite approvals that are needed from cities, municipalities, and boards.

An airport PR representative should handle communications with city or county officials and the media. Airports should provide professional media training for any airport spokesperson and assign a PR representative to the AOC during severe events to stay abreast of events as they unfold and to release information to the public in a timely manner.

Media Protocol Guide [All Airports]

Develop a Media Protocol Guide that details a plan for communicating information regarding a crisis or event within the first hour. A Media Protocol Guide is a companion piece to the CCP and its purpose is to detail how to deal with print and electronic media in times of crisis, including operation during extraordinary winter events. Utilize the Media Protocol Guide for communication workshops and table-top drills so that communication transpires smoothly during an actual event or crisis. The goal for media relations during a crisis is to release a statement within the first 60 minutes that communicates what the airport knows about the crisis at that point in time and what the intended actions are. The benefit of having a formalized Media Protocol Guide is that it details an existing plan that can be implemented. It provides a format for communication workshops and table-top drills, and ensures a smoother flow of communications.

The written plan should include a mission statement, general information, access restrictions, inquiry response, weather and airline contact information, and protocols for coverage of emergency events. This written plan should be evaluated annually after the winter weather season to review what worked and what did not.

24/7 Point-of-Contact for Media [Medium and Large Hub]

PR departments should maintain separate 24/7 point-of-contact for media outlets. Many airports utilize websites as the primary means of communicating with the general public during a winter operations event. If it is the airport's goal to provide an attended phone number, personnel should be made available through the PR department and not operational departments. If PR personnel are not represented at an ICP or at a Snow Desk, regularly scheduled airport status updates should be provided to a PR representative by the operations group.

Links to Air Carrier Websites for Flight Status [Small, Medium, and Large Hub]

An "airport is open" media notification or website posting during a snow and ice event may be interpreted by the public that the airport is operating with little or no effect to published flight schedules. It is good practice to include a "check with your air carrier" disclaimer to encourage passengers to verify flight status with their airline. Links to air carrier websites are a convenient and widely used function on airport websites. Airport operators may also wish to conduct annual briefings to educate the media on airport operations during inclement weather. The media tends to take a black and white, airport open or airport closed point of view. The media may not know that even though reduced visibility may prohibit aircraft from landing, conditions may permit departures. A proactive educational program will likely result in more accurate media reports on airport status during ice and snow events.

Regular Updates to Airport Website [All Airports]

The airport website should regularly be updated with information about current conditions or situations at the airport (e.g., construction closures, weather conditions, delays, weather conditions affecting parking). Websites are critical tools for customer outreach. When winter weather notifications are necessary they should be linked to the airport website as well as all social networks that are active for the airport. Websites should be used for passengers to access flight information as well as airline contact information. During winter weather operations, websites should be updated as soon as new information about the changing event is available. Alerts and/or crawls should be added to websites to alert passengers to winter weather advisories or changes to air traffic due to the weather. In addition, other tools directly connected to websites and social media can be used to connect with passengers who are signed up to receive alert notifications.

9.7.6 Passenger Outreach Through Social Media

Social Media Program [Medium and Large Hub]

To have a responsive, successful social media program at a large airport, social media must be monitored approximately 18 hours per day. Large airports with more staff members in the communications department are able to monitor multiple social networks, especially through the use of mobile devices. The PR staff's sole focus, during winter events, should be to respond to social media inquiries and post information when they are not connected to a multi-platform network operation.

Social Media Outreach [All Airports]

In order for an airport's intended audience to receive posted messages they need to know that their local airport participates in social media forums. There are several ways an airport can attract their audience, or followers, and let them know they partake in social media outreach. A couple of ideas include a signage campaign at an airport, or a news story on local television about friending or following their airport on the appropriate social media site. Consider reaching out to other airports that engage in social media for tips and tricks on how to most effectively use these tools. Press releases/events announcing the use of social media are necessary prior to launching social media. This will help the airport gain followers or fans. Icons for social media used should also be displayed on the front page of a website and link directly to the airport's social media sites.

Smart Phone Applications (Apps) [Medium and Large Hub]

It is anticipated that, beyond 2015, apps and website services will be the top two methods of customer service contact. Airports should consider investment in an app to guide customers to concession offerings in the terminal complex, particularly during extended winter event-induced delays. The apps should provide easy access to the airport's website and winter weather notifications. Wireless Internet should also be easily accessible for passengers to log on to websites and social media networks with their laptop computers or smart phones.

Few airports currently have apps, but many commercial airports are considering or are in the process of developing them. Some airports justify the expense of creation and maintenance of an app because they believe it will drive more customers to their revenue-producing points. For example, it can aid passengers with airport parking information, remind a passenger where they parked, provide information about concessions, and give passengers discounts on concessions. Even though this information may be on the airport's website, an app provides more flexibility.

Facebook® [Large Hub]

Facebook is social networking's largest communication tool. It is highly interactive and allows people to set up individual profiles and exchange messages. However, it is seldom used by airports' communications departments because it can require a constant dialog, which airport staff members have difficulty participating in because of time and staff constraints. Maintaining a Facebook page as part of an airport's digital strategy is very time consuming to do correctly. It operates continuously, and posts may accumulate quickly. Few small airports have the budget necessary to designate an employee strictly for maintaining a page.

Facebook should primarily be used as a promotional tool for airports. However, it can also be used for passenger concerns and responses. It can make a significant impact on the passenger experience. Prior to the winter season, airports should promote the tools and plans that they have in place for winter weather events or emergencies. Facebook can also be used to remind passengers about potential winter weather threats, where to locate additional information on the airport website, or to direct passengers to airline websites. For smaller airports, where staffing is an issue, Facebook should be used as a communication tool to keep relationships with passengers at a more personal level. Although it has limited value for timely communication during an event, it has great potential as an outreach tool for connecting with the public in general and directing them to more viable information links. Facebook is most effective when one person is assigned to all airport social media. If it is not regularly updated, passengers can become frustrated at the lack of a timely response, which reflects poorly on airport management. Small airports may not have adequate staff to utilize Facebook effectively.

Twitter® [Small, Medium, and Large Hub]

Another valuable promotional tool that allows an airport communication team to quickly distribute information about an upcoming winter event is Twitter. It allows the airport communication team to be proactive with weather advisories for passengers and facilitate the airport's advance planning. Twitter is a faster method to announce a news release than print or other electronic media. The account should be linked to the airport's website and Facebook page so messages are consistent. Twitter also provides airport customers a venue to voice their concerns and obtain a speedy response. While limited in message length, it can deliver helpful information in near real time. Airport experience indicates that a Tweet needs to be responded to within one to two hours to be beneficial. Short messages can be instantly delivered to airport followers. With relevant and identified hash tags, users can also find previous messages related to the topic. Only one or two people should have access at any time to the Twitter account during winter weather operations in order to keep messages consistent and not repetitive.

YouTube® [Large Hub]

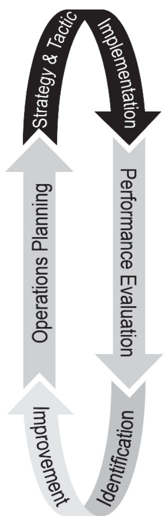
YouTube allows airports to display informational videos online for educational or entertainment value. For example, one airport has a large audience that views how the airport handles snow removal. It highlights the equipment utilized in the process, maintenance, actual removal, and deicing. These videos provide the general public with a better understanding of certain airport operations. With this knowledge, passengers may be more accepting of delays or other perceived inconveniences associated with winter events.

Coordinated Social Media Use [Small, Medium, and Large Hub]

Coordinate use of social media tools to send a consistent message (e.g., provide links to the Twitter account on the website for updated information). Airports can effectively post the same message on multiple social media sites with the use of a social media dashboard (e.g., Hootsuite™, HubSpot™).

CHAPTER 10

Snow Clearing Operations and Preventive Measures/ Ice Prevention Best Practices



This chapter continues the presentation of best practices related to, and in general accordance with the contents of AC 150/5200-30C, Chapter 3, "Snow Clearing Operations and Preventive Measures," and Chapter 4, "Snow Clearing Operations and Ice Prevention." Each practice title is followed by a description of the airport type(s) in brackets to which the practice may be most applicable.

10.1 Weather Forecasting

Weather Observation and Terminology [All Airports]

A basic understanding of the fundamentals of weather observation and weather terminology is of benefit to airport operations personnel. Basic meteorology courses are available at technical schools, colleges, and universities across the country. Many airports train operational personnel as NWS-qualified Certified Weather Observers. In fact, the NWS has recently reached out to airports seeking to bolster the number of certified observers available at airport locations. The training guide for surface weather observations is available via the following link to the NWS website: http://www.weather.gov/om/forms/resources/SFCTraining.pdf.

Relationship with Weather Forecast Service Provider [All Airports]

Timely and accurate weather forecasts are of vital importance during winter operations. Airport operators who invest in a full-time, year-round relationship with a specific weather forecast service provider are more likely to receive enhanced weather forecasting services during the winter season. Some airport operators experience the benefit of an on-airport weather service, be it an office of the NWS or a private service provider. Those airports have reported success in scheduling regular or seasonal meetings between the respective agencies, including invitations for staff to spend time in the other agency's work environment. Face-to-face meetings facilitate the opportunity for weather service providers to explain their procedures, processes, workload, and time constraints on a season-by-season basis. Likewise, airport operators have the opportunity to discuss their needs and expectations in an informal, casual setting. In other cases, the physical location of respective offices and operations may not be conducive to face-to-face meetings. However, communication technologies are available to address limitations associated with disparate physical locations. Regardless of the methodology, the investment in personal relationships pays dividends during weather events when there is a need for information during periods of heavy workloads.

Site-Specific Weather Forecasting [Medium and Large Hub]

Weather forecasts prepared by public agencies or by broadcast media outlets historically encompass broad geographical areas. Due to the nature of winter weather events, conditions may vary within that area. Airport operators have become dependent on detailed, site-specific weather forecasting, albeit at a cost. Contracted services are usually required for site-specific weather forecasting, although there are a limited number of airports that have retained an in-house meteorologist. Operational cost savings may justify salary or contract expenses. Timely and accurate forecasts can lead to reduced costs in the following areas: personnel costs associated with timely and appropriate scheduling of full-time and contracted employees, personnel costs associated with the appropriate number of employees scheduled or called back to the airport commensurate with the level of the snow or ice event, airline delay costs associated with timely snow removal runway closures, and chemical costs associated with the proper application based on atmospheric conditions. A key advantage of most every weather forecasting contract is the ability to conduct on-demand consultation with a weather forecaster.

Web-Based Weather Forecasting Tools [All Airports]

A significant number of weather forecasting and weather reporting tools are available via the Internet. Airport operators should build a list of web addresses for ready access during a snow or ice event. Each local NWS office maintains a website that provides a wide range of historical, real-time, and predictive weather information. In partnership with the FAA, the National Center for Atmospheric Research provides winter weather forecasting and monitoring tools, which can be researched at: http://www.rap.ucar.edu/projects/deicing/.

10.2 Forecasting Runway Surface Conditions

Atmospheric Condition Information [All Airports]

Accurate atmospheric condition information and surface condition data are critical components of the winter operations decision-making process. Most large- and medium-hub airports have installed remote surface and atmospheric condition reporting equipment that transmits real-time data to airfield operations centers or Snow Desks. Data provided include air temperature, sub-surface temperature, surface temperature, freezing point and/or chemical factor, and presence of surface contaminant (moisture, frost, snow, ice). System alarms can be established to warn airport operators of deteriorating or critical conditions.

Automated systems such as the Weather Support to Deicing Decision Making System analyze and forecast short-term winter weather conditions in the vicinity of an airport. Multiple data sources enable software algorithms to produce graphical and text depiction of current weather conditions along with one-hour weather forecasts. Data can be archived for future reference. A thorough knowledge of system operation, the ability to interpolate reported metrics, and the proper application of data could lead to significant cost savings with regard to runway closures and chemical applications.

Source: Marcel Boschung AG

Manufacturers provide deicer and anti-icer use and application criteria often based on surface temperatures and not ambient temperatures. Airport operators should avoid relying on air temperature as an indicator of the effect of atmospheric conditions on paved surfaces. During daylight hours, convective heating will raise surface temperatures above the air temperature even when skies are overcast. A bituminous surface will retain more heat and will usually be warmer than adjacent concrete surfaces. At sunset, surface temperatures will lag behind the decrease in air temperature. It may be well into the evening before the surface temperature equals the relative air temperature. Access to surface temperature and surface condition information will provide valuable input when determining the proper course of action to address surface conditions. Warm pavements will likely delay the accumulation of light or moderate wet snow. Knowing those conditions, airport operators can limit activities to monitoring surface conditions, perhaps even delaying the call-back of personnel to the airport.

10.3 Snow Clearing Principles

10.3.1 LOA

Agreement with ATCT for Airport Vehicles Operations on Taxiways [Medium and Large Hub]

Agreements between airport operators and the local ATCT allowing airport vehicle operations on taxiways without positive ATC clearances have significantly improved overall airport operations during a snow or ice event. Such a procedure is of particular importance at large- and medium-hub airports. Procedures should be outlined in an appropriate LOA. Factors to consider when seeking such an agreement include air traffic controller workload, ground control frequency congestion, airport geometry, availability or operation of ASDE radar, vehicle movements, vehicle operator status (full time, part time, or contracted) and vehicle operator training and experience. The level of training required to safely operate a vehicle on the movement area usually limits taxiway access to full-time airport employees. Vehicle operators must be trained that aircraft always have the right of way. Air traffic controllers should be trained to expect flight crews to question the presence or intentions of a snow removal vehicle operating on a taxiway. Air terminal information service message content should include information regarding SRE operating on taxiway surfaces.

Communication of Runway Treatment Procedures to ATCT [All Airports]

The LOA between the airport and ATC should list standard operational procedures for conducting runway snow and ice control operations, including a list of surfaces to be treated during a runway closure. If the full width of a runway is not included in an operation, standard post-closure dimensions should be identified. A listing of connecting taxiways to be treated should also be identified. Procedures should be supported with maps and attachments.

Use of Supplemental ATC Frequencies for Communications [General Aviation and Small Hub]

Most airports utilize internal company radio frequencies to facilitate communications during snow or ice control events. Airport operators at smaller facilities have reported success in utilizing a supplemental ATC frequency for snow and ice control communications. The process allows ATC personnel to monitor transmissions, track the movement of snow removal teams, and immediately participate in transmissions to coordinate surface closures. The volume of routine air traffic transmissions should be considered before pursuing the use of an available ATC frequency for snow removal communications, as well as the possibility that such transmissions may distract controllers from their primary tasks. Approval to use an ATC frequency and detailed procedures should be codified in an LOA.

10.3.2 Damage Prevention and Repair

Snow Removal Around Edge Lights and Signs [Small, Medium, and Large Hub]

Due to the frangibility requirements of edge lights and guidance signs, snow removal from the immediate area around these fixtures is usually accomplished by manual shoveling by a large contingent of employees. Equipment specifically designed to remove snow from lights and signs is available on the market. Equipment cost can be justified by calculating the labor hours saved by implementing mechanical snow removal in lieu of manual snow removal. When investigating potential edge light SRE, consideration should be given to the environment in which the equipment will operate. Whether or not lights and signs are in paved or unpaved areas may dictate the use or type of equipment to be considered. Some equipment operates over the top of the fixtures, while other equipment is offset from the drive vehicle.

Although in-pavement lighting is beneficial in maintaining capacity during snow events and periods of low visibility, airports should compare the cost-benefit of in-pavement lighting against associated expenses to protect the fixtures. Airports with in-pavement lighting have switched from steel plow blade cutting edges to polyurethane cutting edges. Steel cutting edges are more effective in removing snow but have a higher probability of damaging in-pavement light fixtures. In-pavement lights invite snow and compacted snow and ice. Rotary runway brooms are more effective at removing snow from in-pavement lighting fixtures than plow blades. Chemicals may be required to remove compacted snow from in-pavement light fixtures. However, extensive chemical use may damage in-pavement light fixtures and underground electrical components resulting in additional electrical maintenance requirements and costs.

Source: Fortbrand Services, Inc.

Polyurethane Cutting Edges on Field Plows [Medium and Large Hub]

With the increased installation of in-pavement lighting, most airport operators are using polyurethane cutting edges on field plows. Poly cutting edges are, obviously, less damaging to pavement and equipment than steel cutting edges. Many airports are specifying caster equipment on plow blades. The casters allow the plow blade to be set slightly above ground level to protect light fixtures and to protect vehicle operators from uneven pavement joints and edges. It has become standard operating procedure to follow a plow with a rotary broom to increase surface friction. The design of high-speed, multi-function SRE was based on that premise.

Design Considerations for Snow Removal Around Lights and Signs [Medium and Large Hub]

The movement of snow removal vehicles around edge lights and guidance signs should be considered in airport design and construction. Paved shoulders will reduce the likelihood of vehicle operations on unpaved areas, thus reducing the probability of ruts and depressions that violate FAR Part 139 safety area standards. Design engineers should consider pavement on both sides of the edge lights. Paved shoulders 35 feet in width have become the standard at most airports that operate large pieces of SRE. That width allows space for vehicle operations on the back side of the edge lights. That design standard is also beneficial in reducing erosion associated with engine jet blast.

Source: Gresham, Smith and Partners

Use of Reflective Tape on Lights and Signs [All Airports]

The application of reflective tape to light standards and to the sides of guidance signs will aid SRE operators in identifying the fixtures and will reduce the likelihood of lights and signs being damaged or destroyed.

Pre-Event Inspections [All Airports]

A thorough pre-event inspection of airfield surfaces to identify foreign object debris contaminant and other hazards may prevent injuries to vehicle operators and may prevent damage to SRE.

Electrician Support Vehicle [Large Hub]

To immediately address lighting and signage damage, some airports allow electricians to accompany the snow team. Repairs are made during the time interval between the snow removal team passing and the completion of the post-clearing pavement friction measurement.

10.3.3 Snow Clearing Operations

Snow Removal Team Lead Vehicle [Medium and Large Hub]

The majority of airports employ the use of a vehicle to lead the snow removal team. Usually driven by an airport operations representative or by an airfield maintenance supervisor, the lead vehicle allows maintenance personnel to focus solely on equipment operation. If a lead vehicle is not feasible, at some airports a second person is assigned to the lead plow to handle all coordination and communication with the Snow Desk or with a manager or supervisor.

Just-in-Time Runway Treatments [General Aviation and Small Hub]

Runway snow removal operations can often be delayed until immediately prior to a known aircraft operation, however, snow removal crews need to account for the accumulation of additional contaminant. Corresponding adjustments to normal snow removal timeframes will likely be required. Just-in-time runway treatments reduce demand on both snow removal operators and SRE. Although the procedure is generally associated with smaller facilities, larger airports may wish to consider just-in-time operations during overnight hours, thereby affording the opportunity to address other areas or to provide additional rest for snow removal personnel.

Safety Area Snow Removal During Standard Snow Removal Operations [General Aviation, Small, and Medium Hub]

Airports have gained efficiencies by including safety area snow removal in standard snow removal operations as opposed to waiting to conduct safety area operations during post-event or clean-up time periods. If time and adequate snow storage space are not limiting factors, safety margins would be increased by immediately removing snow to distances that exceed AC standards for the most critical aircraft operating at the airport.

10.3.4 Managing Human Factors

Provisions for Breaks and Food [All Airports]

Airport operators need to pay special attention to human performance factors in preparing for winter operations. A large volume of subject matter material is available for review and reference. Training is available. Airport operators need to provide for basic human needs to support snow removal operations. The provision of food, beverages, and comfortable rest/break facilities has a positive effect on crew morale and crew performance. It is important to keep crews rested and alert during extended storms. Crews need to be given routine breaks or be empowered to take breaks as conditions allow. Some airports establish a maximum amount of time an operator can be at the controls of a vehicle. Studies have proven the advantages of short, 10 to 15 minute naps. Crews should be encouraged to take advantage of available breaks and take a quick nap in a vehicle while parked in a safe location. Personnel cannot be expected to maintain continuous operations. The onset of fatigue leads to complacency, errors, and accidents. Personnel should be trained to immediately report to a supervisor or manager when fatigue begins to affect their performance.

Advance Scheduling and Overnight Accommodations [All Airports]

Manage human performance factors by scheduling employees for snow removal duty as far in advance as possible, by providing food and beverages, and by providing accommodations for rest or sleep. Locker rooms, shower facilities, and kitchen facilities are necessary to support on-airport sleeping quarters. Airports may wish to consider agreements with local hotels to provide staff with sleeping facilities during extended snow events. Sleeping quarters and nearby sleeping arrangements may be of value even when operating rotating shifts. Difficult travel conditions may prevent crew members from returning to the airport for their next shift. Keeping personnel nearby during work breaks ensures maximum crew availability. The availability of onsite or nearby sleeping facilities enhances safety by being able to immediately address crew fatigue.

Distractions [All Airports]

Vehicle operators need an environment free of distractions in order to more safely operate under stressful and difficult conditions. Most airport operators will follow applicable state laws regarding the use of personal electronic devices (e.g., cell phones, MP3 players) while operating a vehicle. However, due to the dangers inherent with operating a vehicle in the airport environment, most airport operators impose additional restrictions. The use of personal electronic devices while conducting snow removal operations is usually either prohibited or severely restricted. Some airport operators have an “anytime and anywhere” restriction while a vehicle is in motion, while other airports prohibit the devices only while conducting snow removal operations on aircraft movement area surfaces or in aircraft parking areas. Cell phone use is usually permitted in a stationary vehicle. Airport operators can counter an employee claim of the need to be available for family emergency calls by publishing a 24/7 emergency contact telephone number and requiring its use instead of personal cell phones. Multiple radio frequencies can also be a distraction. The majority of airport operators restrict radio use to two frequencies—an internal company frequency and an appropriate ATC ground control frequency. The use of AM/FM radios is usually prohibited.

10.3.5 Tracking and Reviewing Performance

Benchmarking to Industry Peers [All Airports]

Although it has proven difficult to identify common numerical benchmark metrics between airports, it is of value to establish and maintain relationships with industry peers in order to be able, at any time, to discuss performance factors and to identify and remedy common problems. Reasons for incompatible metric comparison between airports include unique airport geometry, disparate traffic levels, disparate weather patterns, disparate deployment of staff, different equipment fleets, different methodologies, varying internal measurements, and differing management principles. Airports have found some success in identifying airports of similar size when comparing performance metrics. International airports should not be ruled out when seeking compatible facilities. Runway occupancy time during snow removal operations is one of the few performance metrics tracked by airports. The value in comparing runway occupancy time may be in determining the type and number of vehicles to be assigned to runway teams, identifying the methodology utilized, and establishing the ROI for the number of assets deployed. ROI analysis is critical during discussions with users, specifically air carriers, to determine acceptable costs associated with snow and ice control.

Airports noted the importance of benchmarking when seeking solutions to identified problems. The ability to contact an industry peer to seek mitigation options or resolution of a problem is invaluable. Airports specifically identified the importance of attendance and participation at key industry seminars and conferences. Trade shows and conferences present the opportunity to meet and network with industry peers. Personal relationships established at those events facilitate future communication networks whereby an issue can be discussed with peers at any time.

Standard Metrics [All Airports]

Consider the use of standard metrics as developed by internationally recognized organizations, such as the International Organization for Standardization, the Society of Automotive Engineers, and the International Facility Management Association. Metrics and measures established by these organizations are widely recognized by industry professionals.

Log of Winter Event Activities [All Airports]

Certificated airports are required to maintain a daily log of airport activities. Even with the additional work load created by a snow or ice event, it is of vital importance to maintain a detailed and accurate log of activities during a storm. General aviation airports also benefit from a detailed record of snow removal activities. A storm summary is often attached to the daily log to summarize important data related to the storm, including the amount and type of snow received, snow removal methodology applied, amount of chemicals used, frequency of runway closures, airport capacity, deicing performance, and notable events. An internal storm-to-storm comparison is likely the best benchmarking opportunity available to airport operators. The daily log becomes a short-term and long-term data source for performance review. A daily log becomes a quick reference guide when responding to tenant questions during winter event performance review meetings and can be researched when planning a response to a forecasted snow or ice event. References to decisions and performance during previous events of a similar nature may streamline the planning process for the forthcoming event. Daily log information and event summaries are excellent end-of-season resources for SICC review when considering possible revisions to the SICP.

Snow Removal Performance Reviews [All Airports]

Many airports conduct snow removal performance reviews at the department or unit level to identify discussion points or procedural matters specific to their area of responsibility. The departmental reviews often lead to internal snow critiques. These forums allow airport operators to identify and mitigate internal issues prior to discussion with the tenants or the SICC at a post-event review.

Participation in Regional Snow Removal Conferences [All Airports]

Most state governments have departments or agencies that support the development of commercial and general aviation. Those agencies host conferences and workshops throughout the year. Airports are encouraged to be active participants in regional snow removal conferences. Networking with regional airports offers airport operators the opportunity to review plans, procedures, and performance with airports that likely experience similar weather conditions and share common problems. Participation in regional events is of benefit to smaller airports that may not have the resources or budgetary support to attend national conferences and trade shows.

10.4 Snow Disposal

10.4.1 Snow Piles

Reference Marks for Snow Piles [Medium and Large Hub]

Use of reference marks assists in the measurement of snow piles when verifying compliance with AC guidelines. Install pavement markings prior to the winter season to indicate snow pile limits in storage areas. Install frangible markers or snow sticks in safety areas at set distances from pavement edges, runway centerlines, and taxiway centerlines. These multiple points of reference can be installed to indicate the need for aircraft size restrictions or surface closures. Airports reported the use of a surveyor's laser to more accurately measure and mark snow piles. Caution is advised when using any laser-based tool. Laser use is usually restricted to overnight hours or at times with no flight operations. Air traffic control should be advised of the use of lasers on the airport.

Source: Gresham, Smith and Partners

Coordination of Snow Handling Near Aircraft Parking Positions [Medium and Large Hub]

Airports that must stockpile snow in or near aircraft parking positions should schedule hauling operations at time periods that do not conflict with aircraft movements. Haul routes should be clearly marked and controlled to prevent vehicle deviations along the route. Trucks with large-capacity dump boxes should be considered to maximize per-vehicle loads and to reduce the number of vehicle movements needed to clear an area. Airports that utilize portable snow melting equipment should locate stockpiles in close proximity to storm drains. The movement of loading equipment must also be considered when determining stockpile locations, whether in support of snow hauling or snow melting operations.

Snow Compaction [General Aviation and Small Hub]

Snow compaction is an alternate method in which to control snow pile heights at the edges of movement area surfaces and in safety areas. "Snow cat" equipment used to groom ski slopes and ski trails can be used to level snow piles. The equipment can also be used to provide a level surface within localizer and glide slope critical areas.

10.4.2 Snowmelters

Snow Melting [Large Hub]

The use of portable snowmelters eliminates the need to haul snow and reduces potential conflicts between aircraft and the vehicles used in hauling or trucking operations. Snow melting can be accomplished in numerous areas with relatively small footprints. Very few vehicles are required to support melting operations, resulting in reduced fuel use and reduced emissions, even when considering fuel use associated with the melting equipment. Airport and environmental planners can assist in the development of snow melting site plans, utilizing available drainage systems and

Source: Trecan Combustion Limited

other airport infrastructure to support more efficient operations. Many airports print and disseminate graphical snow melting plans for use by contractors, tenants, and other interested parties.

Landside Snow Melting [Medium and Large Hub]

Snow melting is a viable, cost-effective option for landside snow removal. Portable snowmelters and snowmelters engineered and built into the top levels of parking garages eliminate the stockpiling of snow and the hauling operation that requires the use of height-restricted, low-capacity vehicles. The loss of revenue-generating parking spots is an obvious result of stockpiling, and parking structure weight-bearing load factors must also be considered when stockpiling heavy, wet snow. The restricted size of vehicles used for both loading and hauling results in the need for multiple trips between parking garages and snow dump areas. The movement of snow directly to a snowmelter significantly reduces vehicle movements, which increases safety and reduces fuel use and vehicle emissions. Airports that utilize parking garage snowmelters report a rapid return on capital investment and significant cost reduction over time. The use of portable snowmelters at the ground level provides similar benefits. Parking spaces are quickly returned to service and hauling costs are eliminated. Not having to consider glycol-impacted snow provides flexibility in the ability to discharge melt water at most storm drains, and the operation is mobile and easily moved from point to point. Airport operators did, however, note the higher frequency of debris being introduced into snowmelters during landside melting operations versus airside.

Source: Trecan Combustion Limited

10.5 Methods for Ice Control and Removal

10.5.1 Chemical Application

Effective Chemical Application [All Airports]

The proper use and application of pavement anti-icing and deicing chemicals are critical in maintaining a safe airfield environment during winter operations. Airport operators should be trained on proper use and application, and should have a clear understanding of the difference between anti-icing and deicing chemicals. Use parameters, application, and product performance differ. Improper chemical application can result in unnecessary expense and can worsen pavement surface conditions. Chemical use training should be included as a required service in contract specifications and/or purchase agreements.

The timing and scope of chemical application should be determined by pavement temperature. Pre-treatment of pavement surfaces with anti-icer to prevent frozen contaminants from bonding to the surface is a conventional preventive measure best suited for when pavement temperature is at or below freezing and when high moisture content precipitation is expected. Liquid anti-icer application should be avoided prior to a forecast for dry snow conditions. The pre-application of anti-icer onto surfaces that are above the

Source: Batts, Inc.

freezing point should be determined by the presence of surface moisture or the forecasted moisture content of frozen precipitation. Pre-application onto pavement surfaces that are above freezing and that have low surface moisture can be operationally beneficial and cost-effective. However, pre-application of liquid anti-icers during or immediately prior to rainfall will likely be ineffective and costly, as the product will quickly dilute and be rendered ineffective. Eventually, frozen precipitation falling onto warm pavement surfaces will melt and create moisture that will dilute applied chemicals. Until surface monitoring equipment begins to indicate ineffective chemical concentrations, reapplication onto surfaces that are maintaining accumulated moisture above the freezing point is unnecessary.

Source: Gresham, Smith and Partners

Pavement anti-icers should not be used in lieu of deicers. The application of an anti-icer on top of a thick, frozen, contaminant layer will likely be ineffective. However, deicer application preceding liquid anti-icer application can create a pathway to the pavement surface for the anti-icer, allowing it to break the bond of the frozen contaminant. This may facilitate more efficient break-up and removal of the contaminant.

Many pavement deicing chemicals are ineffective when surface temperatures fall below specific thresholds identified by chemical manufacturers. Chemical applications under such conditions tend to be excessive with minimum effectiveness and the potential to detrimentally impact stormwater runoff. Maintaining an acute awareness of surface temperatures will result in reduced costs and more efficient operations during snow and ice events. Remote runway surface condition reporting systems may be cost prohibitive for installation at smaller facilities, but a variety of less expensive handheld temperature sensing equipment is also available and can provide the desired temperature data.

10.5.2 Chemical Storage

Liquid Pavement Deicer and Anti-Icer Storage Container Spill Containment and Inspection [All Airports]

Airport operators and tenants should store liquid pavement deicers and anti-icers in bulk storage containers compatible with the chemical constituents, and in conformance with applicable bulk liquid chemical storage regulations. For bulk storage containers not subject to regulation, secondary containment for the container contents should be provided in a manner that will prevent a leak, spill, or catastrophic failure of the entire container from causing environmental harm by entering nearby stormwater catch basins or surface water bodies. Additionally, airport operators and tenants should develop and implement a bulk storage containers inspection checklist to visually inspect the exterior condition and function of containers, appurtenances, and secondary containment infrastructure on a periodic basis (e.g., monthly). Bulk storage container inspection and integrity testing by a

Source: Gresham, Smith and Partners

contracted service provider should also be considered, particularly when secondary containment is not provided. Scheduled professional inspection and integrity testing is especially important for plastic tanks susceptible to ultraviolet degradation when stored outdoors.

Location of Liquid Pavement Deicer and Anti-Icer Storage [Medium and Large Hub]

Locate liquid pavement deicing and anti-icing chemical storage facilities in a manner to facilitate landside product delivery. A landside port to airside storage eliminates the need for a security escort during what is often a time-consuming operation.

10.6 Approved Chemicals

Next-Generation Pavement Chemicals [Large and Medium Hub]

Some pavement chemicals have been found to be incompatible with aircraft braking components and external electrical wiring systems. Next-generation chemicals are being advertised as having a lesser effect on aircraft components. Airports should coordinate with local air carriers on the cost-benefits of using the more expensive next-generation pavement chemicals.

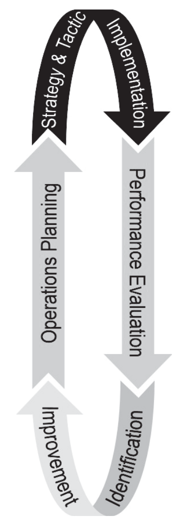
10.7 Sand

Use of Sand on Airside Surfaces [All Airports]

Airport operators should consider operational and environmental implications and the costs associated with airside sand applications. Many airports are reassessing sand application frequency and application rates. Sand is susceptible to aircraft engine ingestion and damage, despite the use of AC-specified sand gradients. It can also obstruct in-pavement light fixtures and accumulate in snowmelter melting pits and stormwater catch basins. In addition to procurement costs, airport operators must also consider ancillary and residual costs: storage building maintenance and building environmental controls, liquid anti-icer chemical use as a pre-wetting agent, sand recovery, safety area restoration, and snowmelter and stormwater catch basin maintenance. Several airport operators favor the use of chemicals in lieu of sand. The above-noted costs should be considered when conducting cost-benefit analyses to evaluate sand versus chemical use.

CHAPTER 11

Runway Surface Assessment and Reporting Best Practices



This chapter continues the presentation of best practices related to, and in general accordance with the contents of AC 150/5200-30C, Chapter 5, "Runway Surface Assessment and Reporting." Each practice title is followed by a description of the airport type(s) in brackets to which the practice may be most applicable.

11.1 Runway Condition Reporting

Pilot Braking Action Reports [General Aviation and Small Hub]

Airport operators should be familiar with the primary users of the facility and should consider those parties when determining the method in which to report surface conditions. Since general aviation airport users are more familiar with pilot braking action reports, operators of that category of airport may wish to augment mechanically-generated friction reports with pilot braking action reports. Aircraft type and time reported should always accompany a pilot braking action report. FAA AC guidance prohibits the conversion of μ values to subjective braking reports of good, fair (medium), poor, or nil.

Runway Location References for Pilot Braking Reports [All Airports]

Pilot braking action reports most often do not encompass the entire length of the runway, but airport operators must monitor conditions on the unused portion of the surface. Therefore, airport users, especially air carrier operators, often question airport operators on the need to close a runway when pilot braking action reports are trending in the medium (fair) category or better. Because conditions at the end of the runway, for example, may warrant treatment, it is good practice to have air traffic controllers include a runway location reference when forwarding pilot braking reports. Air traffic control can also provide trending information as to where aircraft are exiting the runway. Airport users should be briefed during pre-season winter operations planning meetings on all factors that go into determining the timing of runway closures for snow and ice control, with emphasis that pilot braking reports alone do not determine the need for a runway assessment.

Protocols for ATC Reporting of Pilot Braking Reports [All Airports]

Expectations for ATC reporting of pilot braking reports to the airport operator should be clearly stated in an LOA. Terminology, reporting triggers, and reporting frequency should be defined, including ATC reporting of improving braking conditions. Some airport operators also request that ATC forward the location of the report, i.e., mid-point, roll-out, or abeam a specific exit taxiway. Reporting is especially critical if the airport is utilizing two consecutive poor braking procedures for initiating runway assessments. Defined actions for nil braking reports should be included in the LOA, since AC guidance requires the closure of the surface prior to the next flight operation. Air traffic managers have been reluctant to accept the term "closure" in their

LOA-defined areas of responsibility, claiming that only the airport operator has the authority to close an airport surface. Instead, the term "suspend" or "suspension of flight operations" has been used to define ATC requirements upon receipt of a nil braking action report. It is also worthwhile to note that in the event of a nil braking report, location may mean the difference between closing a runway or an exit taxiway, as the nil condition may not be on the runway proper. Airports with a well-coordinated communication plan report that, upon agreement, controllers will automatically query a pilot upon receipt of a nil braking report in order to ascertain whether or not the nil condition was on the runway proper or on an exit taxiway. The latter will allow continued runway operations while limiting a surface closure to the exit taxiway.

Commercial Systems for Dissemination of Information [Small, Medium, and Large Hub]

Commercial systems are available that facilitate real-time dissemination of surface conditions and friction values. Such systems emphasize the importance of providing timely and accurate information to cockpit crews and other airport users. The Canadian government has sanctioned such systems for use at all commercial Canadian airports.

11.2 Runway Friction Surveys

Friction Measurement Prior to Snow Removal [Medium and Large Hub]

Source: Metropolitan Airports Commission

Airport operators have found benefit in taking friction measurements immediately prior to conducting runway snow and ice control operations. The results of these measurements can be used to determine optimum intervals between scheduled runway closures. Friction readings higher than targeted minimum values would support continued operations on that airfield surface that might, otherwise, have been scheduled for closure and treatment. Conversely, readings lower than targeted minimum values would indicate the surface should have been closed at an earlier time. Measurement results would also facilitate friction trending analysis. Intervals between runway closures and changing weather conditions must be considered when conducting trend analyses. It is important to note that surface contaminant may prohibit friction testing; measurements must be conducted within parameters identified by the equipment manufacturer and by FAA AC guidance.

Friction Testing Frequency [Medium and Large Hub]

The airport SICP should identify when runway friction tests are conducted, including parameters for post-event friction tests. Only those persons properly trained and qualified should conduct friction tests. Airport operators at large-hub and medium-hub airports have found value in placing airfield inspection personnel in ride-along status in friction measuring equipment during active snow and ice events. While conducting routine airfield inspections, the friction measuring equipment is staged on the airfield and readily available to conduct runway friction tests. This assignment is of particular value at airports that employ continuous monitoring procedures in lieu of conducting runway assessments after two consecutive poor pilot braking action reports. Regular runway friction tests are acceptable to the FAA under continuous monitoring procedures.

11.3 Friction Assessment Reporting

Reporting Continuous Friction Measuring Equipment and Decelerometer Measurements [All Airports]

FAA AC 150/5200-30C states that 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. Based on that position, the FAA no longer recommends that airports provide friction measurements to pilots. However, as pilots and dispatchers still see value in receiving such data to track the trend of changing runway conditions, the industry encourages airport operators to have available continuous friction measuring equipment (CFME) or decelerometers to measure surface friction and to report those values. Airport operators are not challenging the FAA's position on friction measurement versus aircraft performance. However, airport operators expressed confidence in the ability of CFME and decelerometers to provide an objective measurement of surface friction for use in winter operations planning and decision making. Airport operators noted concerns with perceived subjectivity of pilot braking action reports due to varying types of aircraft, varying aircraft performance on contaminated surfaces, pilot familiarity when operating in winter conditions, and pilot skill level in assessing aircraft braking performance. Mechanically-derived friction values may also be subjective in nature, as assessments may vary from device to device. Therefore, if airports choose to disseminate friction data, the SICP should clearly state when friction measurement values will be reported, to whom, and by what means of transmission.

Standardized Reporting Systems [All Airports]

Source: Oshkosh Corporation

Multiple surface condition reporting systems and formats are used by airports world-wide. Debate continues regarding the establishment of a globally-accepted, standardized condition reporting system. The FAA is reviewing industry recommendations made through the Takeoff and Landing Performance Assessment Aviation Rulemaking Committee that would replace the multiple reporting methods with a numerical code representative of surface conditions. FAA recommends that airports no longer provide mechanically-derived friction measurement values to pilots. However, pilot groups and flight operations departments encourage airport operators to report friction measurements and braking action report information in any available format. Airport users value the information to identify trends in braking action. Several airports continue to report μ values to ATC immediately upon reopening a runway after a snow/ice control operation, with the dissemination of μ values restricted by LOA to the first aircraft to land following a snow or ice control operation. Pilot braking reports are then disseminated to subsequent arrivals. Airports include friction value information in NOTAMs and field condition reports, noting with emphasis that the reports must be time stamped, as reports quickly become invalid during periods of active precipitation. Airports noted the importance of verbiage in airport and ATC LOAs specifically requiring controllers to include the time of a braking report or friction measurement when reporting such information to cockpit crews. LOA language can also outline the frequency with which ATC should report pilot braking reports to the airport operator. To align field operations with current AC guidance, an LOA should outline the requirement for ATC to report to the airport operator when it receives a nil braking action report or two consecutive poor pilot braking action reports.

CHAPTER 12

Winter Operations Performance Evaluation

The unpredictability of winter events and their potential to impact airport operations will at times challenge even the best winter operations plans. As a result, recurring evaluation of the operational procedures, strategies, and tactics outlined within the plans will facilitate adapting to changing conditions and finding opportunities for improvement. Chapter 6 identified the need for measuring performance of airport winter operations. Performance evaluations are important means to engage SICC representatives and other stakeholders. They can facilitate a common understanding of current problem areas, performance limitations, opportunities for improvement, and planned operational changes among all stakeholders. In short, regular performance evaluations enable effective expectations management. This chapter presents a structured and systematic winter operations performance evaluation process that relies upon documented performance measurement data. It will enable factually supported decision making on winter operations strategies, tactics, and procedures: those that are meeting established performance targets and those that are falling short.

12.1 Conduct Performance Evaluations

Integrate performance evaluations as part of regular SICC meetings (e.g., after each event, weekly, etc.). The evaluation process is similar whether it follows a significant winter event or occurs at the conclusion of a winter season. However, post-season evaluations offer the additional opportunity to evaluate performance trends and the effectiveness of operational changes implemented prior to and during the season. Performance evaluations can include a qualitative and quantitative component. Both components can be merged into a single effort, but the need for supporting data may limit the value of a quantitative evaluation if relevant event data are not compiled and available. Similarly, quantitative evaluations conducted early in the season to identify seasonal performance trends may not offer the desired insight. These limitations should be considered when scheduling performance evaluation meetings.

12.1.1 Qualitative Evaluation

A qualitative evaluation of winter operations performance should cover the preceding winter event(s) that occurred since the last SICC meeting. During a post-event evaluation conducted with the SICC, elicit the committee's opinions and perspectives on the recent performance. This qualitative assessment will enable a quick overview of the winter event and should identify if any airport departments or stakeholders were negatively impacted and, if so, in which operational areas. Example questions that can be asked as part of a qualitative evaluation include:

- What worked well?
- What did not work?

- Did the event exceed target winter-event threshold conditions?
- Where can we improve?
- Who needs to be involved?

Conduct a follow-on, data-supported, quantitative evaluation as part of an end-of-season review, or, if an event raises performance concerns.

12.1.2 Quantitative Evaluation

A quantitative performance evaluation differs from a qualitative evaluation in that documented performance measurements are reviewed and compared to performance targets to validate specific performance shortfalls, quantify their magnitude, and fully understand their impact. A performance shortfall is the difference between a performance target and an actual performance measurement (provided the actual value did not exceed the target value), as illustrated in Figure 12-1. If no concerns were raised during a qualitative evaluation, there may be little need for the full SICC to review event performance in greater detail. However, the airport should still review available data for trends that indicate the potential for future performance shortfalls. Example questions that can be asked as part of a quantitative evaluation include:

- Were measures and APIs sufficiently documented?
- How do APIs compare to established performance targets?
- How do APIs compare to data from the current and past seasons?
- Were there any problematic performance areas despite existing performance targets being met?
- Are performance targets still appropriate?
- Were there performance shortfalls that require further investigation?

BEST PRACTICE—Post-Season Evaluation to Kick Off Pre-Season Planning

A post-season meeting of the SICC with airport stakeholders is likely the most important meeting of the winter season. Many airports consider the post-season meeting as the start of the planning process for the following winter season. The last post-event meeting and/or critique should not be confused with the post-season review meeting. It is important to have access to minutes from all post-event meetings from the snow season for the post-season review. Procedural changes are often dictated by lessons learned during individual snow or ice events. A comprehensive post-season review of procedures becomes the basis for revisions to the SICP and updates of related procedural documents. Changes are incorporated into the appropriate documents with publication scheduled for late summer or early fall, as appropriate, to support annual, recurrent winter operations training.

12.2 Examine Significant Performance Shortfalls

Upon completing a post-event or end-of-season performance evaluation, potentially significant performance shortfalls may warrant further investigation. To understand when an investigation is necessary, establish significance criteria giving consideration to the actual or potential impact of the shortfall (e.g., near miss, incident, airport closure, etc.); similar prior shortfalls, if any; likelihood of recurrence; and the effort and resources required to conduct an investigation. Consider conducting an investigation when there is a recurring winter operations performance shortfall, or when a significant procedural, mechanical, or human factor-related failure occurs. Example incidents that may justify investigation include an aircraft go-around caused by a missed runway reopening time, an equipment runway incursion, or a snowbank with the potential to damage a taxiing aircraft. Investigating insignificant issues, while well-intentioned, may tie up staff resources, impede progress on understanding incidents with far greater potential

Figure 12-1. Illustration of a performance shortfall.

to impact the winter operations, and potentially drive investigation teams to cut short the investigation process.

The overarching reason to investigate performance shortfalls is to seek out the root cause(s) and implement a permanent fix or a series of permanent fixes (rather than short-term, quick fixes that only address symptoms and not the root cause) for shortfalls where the risk and consequences of recurrence are unacceptable. For this to occur, personnel assigned to investigate a performance shortfall must fully understand the nature of the concern prior to initiating the investigation. Failure to fully understand the shortfall may result in an ineffective response and continued recurrence.

12.2.1 Performance Shortfall Investigation

A performance shortfall investigation is the process of identifying, collecting, and assembling those facts and circumstances that contributed to the shortfall. This step must occur before a root cause(s) is determined. To investigate a specific incident, designate an investigation team leader with the authority to make assignments and having the backing of airport management. The team should consist of representatives of each stakeholder group directly affected by or involved with the problem. The team should investigate organizational areas and functions, as summarized in Table 12-1. For investigations of complex issues, a written summary of the investigation and relevant facts should be prepared.

Considerations for conducting an investigation include the following:

- Align the time and effort to be spent on the investigation with the severity or consequences of the shortfall.
- Perform the investigation in collaboration with staff who are subject matter experts. This will prevent an investigator's lack of expertise from limiting the investigation or leading to incomplete or faulty conclusions.
- Encourage differing perspectives to avoid "group think," preconceived outcomes, and unexplored contributing factors.
- Gather facts rather than opinions, judgments, or interpretations of facts.
- Seek to identify acts of omission or commission by personnel, equipment, or processes that led to the shortfall.

Table 12-1. Organizational areas and functions for consideration in a performance shortfall investigation.

Areas	Functions
Management responsibility	Organization or person who determines the course of action for a process, who owns the process, and who is accountable for the quality of the process.
Procedures	Documented or prescribed methods of accomplishing processes.
Controls	Checks or restraints that are designed into a process to ensure that a desired result is achieved.
Process management	Measures or information assessments to identify, analyze, and document potential problems with a process.
Interfaces	Interactions between independent processes.

Source: *DOT/FAA/Aviation Regulation-03/70 – Continuing Analysis and Surveillance System Description and Models* (*19*, p. 9).

- Seek out potential hidden or latent contributing factors rather than focusing on just the most apparent factor(s).
- Ask the following straightforward questions to begin the collection of facts:
  - What happened?
  - When did it happen?
  - What was the sequence of events?
  - What was affected?
  - What should have or not have happened?
  - What conditions led to the problem?
  - What actions could have prevented the event?
  - Were there unusual circumstances?
  - What records are available?
  - What policies and procedures were applicable?
- Seek relevant data sources including operating logs, observations, photos, staff interviews, and other records.
- For safety issues or issues that developed over an extended period of time, classify facts along a timeline leading up to the occurrence and identification of the shortfall.

12.2.2 Root Cause Determination

The process for determining a root cause begins after the facts about the circumstances that led to a performance shortfall have been assembled. A root cause can be defined as "the most basic cause (or causes) that can reasonably be identified that management has control to fix and, when fixed, will prevent (or significantly reduce the likelihood of) the recurrence of an issue" (*20*). There are numerous methods for determining root cause, each of varying complexity and effectiveness. Select a method that best meets organizational needs and limitations. It is important that the process lead to reasonably identifiable causes of an incident that are specific, controllable, and correctable so that effective corrective measures can be identified and put into place (*21*). It is also important to emphasize that for most incidents the root cause is likely a series of causal events collectively contributing to the incident, not a singular cause. Considerations for determining root causes include the following:

- With the investigation facts compiled, ask the following questions to begin identifying potential root causes:
  - Why did this happen?
  - What are the causes?
  - How do the causes relate to the shortfall?
  - How were these causes identified?
  - What data or evidence points to these causes?
- Avoid determining an event as a root cause (e.g., "the friction tester got stuck in a snow drift" is an event, not a root cause).
- Avoid confusing symptoms with root causes (e.g., "failure to follow the procedure" is a symptom of something else, not a root cause).
- Avoid assigning individual blame or identifying human error as a root cause. Root cause will likely involve systems or process failures, in addition to human factors.
- Consider individual factors when evaluating human factors, such as:
  - Lack of knowledge,
  - Lack of skill, and
  - Existing distractions.
- Consider influencing factors when evaluating human factors, such as:
  - Consecutive hours worked,
  - Time constraints,

- Change in procedures,
- Management of change,
- Lack of training materials, and
- Competing priorities.
- Separate root causes from those secondary causal factors which, alone, would not have caused the shortfall.
- Focus on the fewest number of and most impactful root causes that, if corrected, will prevent or significantly reduce the likelihood of shortfall recurrence.
- Define each root cause in a clear and concise problem statement, without extraneous information.
- Review facts uncovered during the investigation that did not directly contribute to the shortfall but are still relevant. They may indicate a previously unknown problem or potential problem requiring a separate corrective action.

12.2.3 Corrective Action Identification

Corrective actions are the reactive steps necessary to quickly mitigate an identified shortfall. They may not, however, prevent it from recurring. Corrective action considerations include the following:

- Define new or additional steps that can correct the shortfall.
- Ask the following questions to evaluate proposed corrective actions:
  - Will the corrective action resolve the shortfall?
  - What staff and resources are required to implement the corrective action?
  - How quickly can the corrective action be implemented?
- If the shortfall investigation reveals that it is not an isolated incident, or is systemic (i.e., department-wide), identify corrective actions that will correct the shortfall(s) for all affected areas.
- Define each corrective action in a clear, concise, and assignable statement of action(s).

BEST PRACTICE—Non-punitive Reporting Procedures

Accident and incident investigations are enhanced by instituting non-punitive reporting procedures. Future accidents are often prevented by forthright and honest reporting of circumstances leading up to an incident. Multiple airport operators discouraged immediate termination of an employee for a runway incursion or for a vehicle accident, except in the case of willful misconduct or prior history. Airports noted the significant investment in operator training and the loss of a valuable resource associated with unnecessarily rigid disciplinary action.

12.2.4 Preventive Action Identification

Preventive actions are proactive steps intended to prevent a shortfall from recurring. While some corrective actions can also be preventive actions, preventive actions typically differ in that they focus on addressing root causes. Preventive action considerations include the following:

- Determine if a preventive action is required for the shortfall. A preventive action may not be required for every shortfall.
- Emphasize preventive actions for recurring shortfalls.
- Associate each preventive action with a specific root cause.
- Ask the following questions to evaluate proposed preventive actions:
  - How does the preventive action relate to the root cause?
  - If this preventive action had been in place, would the shortfall have occurred?
  - Does the preventive action address identified human factors?
  - What staff and resources are required to implement the preventive action?
  - How quickly can the preventive action be implemented?

- If the shortfall investigation reveals that the shortfall is not an isolated incident, or is systemic (i.e., department-wide), identify preventive actions that will prevent the root cause(s) for all affected areas.
- Define each preventive action in a clear and concise statement of action(s).

12.3 Identify Performance Improvement Opportunities

Performance evaluations, significant performance shortfall investigations, and observations from airport personnel or SICC members may reveal a broad range of opportunities to improve a winter operation program. An improvement opportunity is simply another way to look at a performance shortfall, as illustrated in Figure 12-2. This is where the true value of performance management becomes evident. The collaboration with stakeholders that led to the creation of performance goals, objectives, and associated performance targets will facilitate consistency of performance expectations. If those expectations are not met due to a performance shortfall, the opportunity for improvement will be evident and should be supported by the airport and its stakeholders. A lack of viable improvement alternatives may require revision of the performance target to a preferred and achievable level. When resource constraints prevent the complete elimination of a shortfall, seek improvement through phased implementation of a series of actions as resources allow. Interim performance targets should be set to align with the expected outcome of each action (see Chapter 7). This clarity offered through performance management enables optimal investment in winter operations. Investment can occur at the strategic, tactical, or procedural level, as described below.

12.3.1 Strategy Opportunities

Opportunities to improve winter operations strategies can represent larger scale shifts in the execution of a winter operations program. Therefore, it is anticipated that this level of change will occur infrequently. Example strategy changes may include planning the incorporation of a performance measurement system, the incorporation of circuit routes for SRE, and the transition to dedicated runway and taxiway snow teams. The need for strategy change may occur when the associated goal is changed or a new goal is established (see Chapter 6). A strategy change may also be necessary when the performance limitations of an existing strategy are reached and all feasible opportunities to further performance improvement are exhausted. Strategy changes will, inevitably, result in new or cascading changes to tactics and supporting procedures.

12.3.2 Tactic Opportunities

The most frequent opportunities for winter operations program improvement are expected to occur at the tactical and procedural level. During a winter event, winter operations personnel must be equipped with an array of tactics to employ as conditions dictate. Because tactics represent the "tools" in an airport's winter operations toolbox, more and better tools will better enable effective implementation of specific strategies, achievement associated objectives, and attainment of overall goals. There are numerous potential opportunities to alter or improve

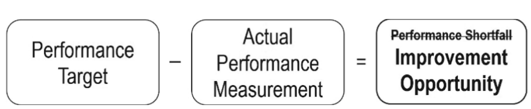


Figure 12-2. Illustration of an improvement opportunity.

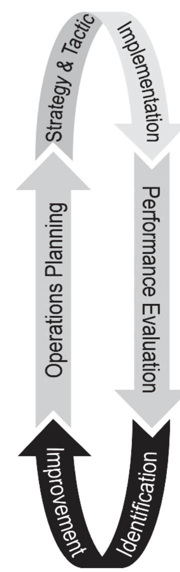
tactics. The reader is directed back to Chapters 8 through 11 for further consideration of alternative winter operations practices in use within the industry.

12.3.3 Procedure Opportunities

As the strategies and tactics that make up a winter operations program change or evolve, maintain written procedures that clearly describe how to effectively execute them. Procedures facilitate consistency in the execution of an activity under a fixed set of conditions so that the outputs and outcomes remain predictable. Procedure revisions may also be required when the root cause of a performance shortfall was determined to be an unanticipated set of circumstances not considered or addressed in the procedure. Depending upon the activities covered by a procedure, experienced personnel assigned responsibility for implementing revised and new procedures should review and provide input on the new content. These personnel represent the subject matter experts. All personnel assigned responsibility for implementing revised and new procedures must be made aware of and be trained on the final revisions and new procedures. Significant changes in operations should be rolled out as part of pre-season planning to maximize opportunities to get personnel familiar and comfortable with new requirements. If personnel are provided access to written procedures in hardcopy format, careful consideration should be given to implementing a document control system so that outdated versions of procedures can be replaced and are not inadvertently used.

CHAPTER 13

Investment to Reduce SRE Runway Occupancy Time



The results of performance evaluations described in Chapter 12 may indicate a need to invest in new or additional equipment to reduce SRE runway occupancy time. SRE runway occupancy time, or the time a runway is closed for snow and ice removal operations and subsequent pavement friction testing, is a commonly used measure of SRE performance. Runway occupancy time as an API can be associated with SRE operational effectiveness, operational efficiency, and aircraft flight delay. SRE clearance times for other pavement surfaces may contribute to delays, but the delays are more difficult to measure and attribute to SRE performance. Unless air carriers proactively reduce flight operations in anticipation of severe winter storm conditions, delays are likely to occur regardless of SRE efficiency and effectiveness, winter operations tactics employed, or resultant runway occupancy times. However, reducing runway occupancy times should result in a reduction in flight delays, particularly at medium- and large-hub airports with more frequent arrivals and departures.

SRE investment options should be thoroughly evaluated to justify the resources and capital investment to the decision makers and stakeholders involved in winter operations. This supporting information may be critically important to acquiring funding, particularly if it is to come directly or indirectly from the stakeholders (e.g., through rates and charges). This situation may occur if FAA and state agencies will not authorize equipment purchases through Airport Improvement Program grants, passenger facility charges, or state grants. The challenge for most airports needing to invest in SRE is the lack of industry guidance on how to determine an optimal level of investment.

BEST PRACTICE—Coordination with Stakeholders on Equipment Purchases

Some airports have reached out to ATC and key stakeholders in advance of a major equipment purchase to determine expectations for performance and capacity during snow and ice events. Airport operators can then better determine the appropriate number and type of vehicles needed to perform to customer expectations. Collaboration with air carriers regarding financing options has led to positive outcomes at several airports. Lease terms often obligate air carriers to finance airport vehicle purchases through rates and charges, so air carriers become interested in a proper return on their investment. An effort by airport operators to educate air carrier personnel on equipment options and performance factors will enhance air carrier support of needed equipment. For instance, when considering the cost of high-speed, multi-function SRE, cost savings associated with one operator doing the work of two operators can be factored into life-cycle costs. The speed of the vehicles will result in less runway occupancy time and increased airport capacity. Reduced delays and fewer cancellations are obvious cost savings for air carriers.

Table 13-1. FAA AC 150/5200-30 recommended clearance times.

Annual Airplane Operations (including cargo operations)	Clearance Times for Commercial Service Airports* (hours)	Clearance Times for Non-commercial Service Airports* (hours)
40,000 or more	0.5	2
10,000 but less than 40,000	1	3
6,000 but less than 10,000	1.5	4
Less than 6,000	2	6

* These airports should have sufficient equipment to clear 1 inch of falling snow weighing up to 25 lbs/ft^3 from priority 1 areas within the recommended clearance times.

Source: FAA (*2*)

13.1 FAA Guidance on SRE Procurement

Advisory Circular 150/5220-20, *Airport Snow and Ice Control Equipment*, represents FAA's current guidance for procuring the minimum SRE for commercial service and non-commercial service airports, as well as for procuring snow and ice removal equipment to meet the snow clearance time requirements of AC 150/5200-30, *Airport Winter Safety and Operations*, presented in Table 13-1. Spreadsheet tools based on both ACs are available from FAA regional offices and state agencies, and are accessible through the Internet. These tools facilitate estimating the number and size of displacement plows, rotary plows (i.e., snow blowers), and brooms to clear designated priority pavement surfaces within applicable clearance times and under the conditions noted in Table 13-1. However, the utility of AC 150/5200-30, AC 150/5220-20, and the related spreadsheet tools is limited for an airport operator attempting to estimate the amount of additional equipment required to reduce a runway occupancy time performance target shortfall.

13.2 Variables Affecting SRE Runway Occupancy Time

Reducing SRE runway occupancy time by investing in new or additional equipment requires an assessment of the variables that affect this performance measure. Figure 13-1 depicts the key variables. Viewing Figure 13-1 as a mathematical equation, accumulated snowfall depth and density would be in the numerator and represent the primary environmental variables that can increase runway occupancy time as they increase. There are other environmental variables that can increase this time, such as visibility and wind (e.g., drifting), but they cannot be mitigated by adding equipment as described below, and thus were not included. To decrease runway occupancy time, the denominator in the equation, shown as snow removal capacity in tons per hour, must increase.

Increasing snow removal capacity can be accomplished by adding additional similar equipment to the runway clearing operation, or replacing the slowest equipment with versions having a faster operating speed. Additional equipment can reduce runway occupancy time by reducing the total travel distance of the runway team. For example, if a team of two displacement plows travels the length of a runway four times to clear it from edge to edge, then adding a third plow may enable the team to complete the clearing process in three or fewer trips down the runway.

$$\frac{\text{Runway Surface Area (ft}^2\text{)} \times \text{Accumulated Snowfall Depth (ft)} \times \text{Snow Density (lbs/ft}^3\text{)} \times 0.0005}{\text{Snow Removal Capacity (ton/h)}} = \textbf{SRE Runway Occupancy Time (h)}$$

Figure 13-1. SRE runway occupancy time as determined by snow clearing capacity.

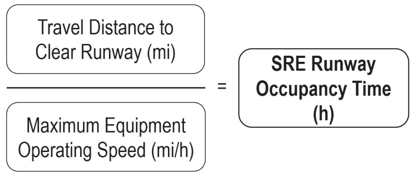


Figure 13-2. SRE runway occupancy time determined by maximum operating speed.

Faster equipment can reduce runway occupancy time by increasing the operating speed of the slowest piece(s) of equipment in the runway team. This is commonly the rotary plow (i.e., snow blower), when one or more are included on the team. Faster speed typically requires a greater snow removal capacity. These concepts are illustrated in Figure 13-2, which shows that increasing the denominator, decreasing the numerator, or doing both can reduce runway occupancy time.

13.3 Identify Runway Snow Removal Capacity Shortfall

To begin the process for determining the SRE needed to achieve a runway occupancy time performance target, first estimate the equipment snow removal capacity shortfall based on the current actual performance and the desired performance target. Advisory Circular 150/5220-20 presents graphical and mathematical methods that can be used to accomplish this task. The AC also addresses specific considerations for snow blowers, displacement plows, snowsweepers (i.e., brooms), and material spreaders. Figure 13-3 identifies a process for estimating equipment snow removal capacity shortfall. An identified shortfall is unique to the composition of the deployed snow team fleet and the operating procedures in use at the time the shortfall occurred.

Assumptions:

Runway Length: 9,500 ft
Runway Width: 150 ft
Accumulated Snowfall Depth: 1.50 in
Snow Density: 25 lbs/ft^3
Current Runway Occupancy Time: 45 min
Runway Occupancy Time Performance Target: 20 min

To estimate runway snow removal capacity shortfall:

Runway Surface Area (ft^2):
9,500 ft x 150 ft = 1,425,000 ft^2

Snow Volume (ft^3):
1,425,000 ft^2 x (1.5 in ÷ 12 in/ft) = 178,125 ft^3

Snow Mass (lbs):
178,125 ft^3 x 25 lbs/ft^3 = 4,453,125 lbs

Snow Mass (tons):
4,453,125 lbs ÷ 2,000 lbs/ton = 2,227 tons

Current Clearing Rate (tons/h):
2,227 tons ÷ (45 min ÷ 60 min/h) = 2,969 tons/h

Target Clearing Rate (tons/h):
2,227 tons ÷ (20 min ÷ 60 min/h) = 6,680 tons/h

Runway Snow Removal Capacity Shortfall (tons/h):
6,680 tons/h – 2,969 tons/h = **3,711 tons/h**

Figure 13-3. Example process for estimating snow removal capacity shortfall by comparing current and target runway occupancy times under defined winter event conditions.

13.4 Estimate SRE Needs to Reduce Snow Removal Capacity Shortfall

Once the runway snow clearing capacity shortfall is identified, AC 150/5220-20 can be used to assist with estimating additional equipment required to provide increased snow clearing capacity. It should be noted that the equations presented in the AC discount the capacities of SRE through the inclusion of an efficiency factor. The term "efficiency" is not defined in the AC. It appears to account for differences between equipment "design capacity" established through controlled performance testing and operations during winter operations events. These differences, or "inefficiencies," are associated with overlapping travel paths, equipment turnaround, spillage, and residual snow. While no specific direction is given in the AC as to what efficiency factor is appropriate to use in the calculations, the following values are included as stated assumptions in equipment selection charts and tables in AC 150/5220-20:

- Rotary plow efficiency: 70%,
- Displacement plow efficiency: 70%, and
- Snowsweeper: 80%.

Additional noteworthy assumptions included in the AC 150/5220-20 graphs and equations address snow depth, snow density, plow cutting angle, and broom angle. The guidance assumes a consistent 1-inch snow depth (presented in feet) and snow density of 25 lbs/ft^3. As described for Figures 13-1 and 13-2, increasing snow depths and densities may increase runway occupancy time, and an airport may set performance targets for conditions exceeding this depth and density. It is also important to consider plow blade and broom angles because the effective blade and broom width at an angle (e.g., 30 degrees) is shorter than the nominal width and, therefore, moves less snow.

Figure 13-4 continues the scenario presented in Figure 13-3 and presents a process for estimating additional equipment to eliminate a shortfall in snow removal capacity. The equations in AC 150/5220-20 can assist with translating snow removal capacity shortfall into equipment capacity. This process assumes that the same composition of equipment within a deployed snow team fleet will be maintained (e.g., plows and blowers), but with more equipment of similar capacity added to address the shortfall. However, estimating equipment needs in this manner is not a precise

Assumptions:
Runway Length: 9,500 ft
Runway Width: 150 ft
Accumulated Snowfall Depth: 1.50 in
Snow Density: 25 lbs/ft^3
Runway Occupancy Time Performance Target: 20 min
Current Runway Occupancy Time: 45 min
Current Runway Snow Removal Capacity Shortfall (tons/h): 3,711 tons/h

To estimate the minimum blower capacity to address the shortfall:
Blower Efficiency: 70%
Minimum Required Blower Capacity (tons/h):
3,711 tons/h ÷ 0.70 = **5,301 tons/h**

To estimate the displacement plow blade length needed to support the blower:
Plow Efficiency: 70%
Operating Speed (mph): 20 mph
Cutting Angle: 30 degrees
Effective Blade Length (ft):
3,711 tons/h ÷ (1.5 in x 25 lbs/ft^3 x 20 mph x 0.70) x (12 in/ft x 2,000 lbs/ton ÷ 5,280 ft/mile) = 32.1 ft
Actual Required Blade Length (ft):
32.1 ft ÷ (cosine 30 degrees) = **37 ft**

Figure 13-4. Example process for estimating additional blower capacity and plow blade length to address snow removal capacity shortfall for defined winter event conditions.

process and may not account for other factors that can affect runway occupancy time (e.g., pavement geometry and equipment turning radii). The estimated values for additional blower capacity and plow length may need to be attained through the acquisition of multiple pieces of equipment.

Addressing the option of changing SRE runway team composition by replacing existing SRE with new equipment having faster operating speeds and higher snow removal capacities requires airport-specific data on the current runway team and data on the individual SRE snow removal capacities. For example, an airport operator currently using three plows and three brooms to clear its runway may be interested in replacing the six vehicles with three high-speed multi-function vehicles, such as plow-broom-blower combination units. If a target runway clearing rate is estimated to be 6,680 tons per hour to achieve a runway occupancy time performance target of 20 minutes, as illustrated in Figure 13-3, the snow removal capacity of the three multi-function vehicles would need to also equal 6,680 tons per hour. Equipment vendors are the best source for product-specific information on capacities and operating speeds to confirm that a performance target can be met. However, evaluate equipment based on the midpoint of its design capacity rather than on the maximum design capacity. Maximum design capacities are measured under controlled, ideal conditions that may not be representative of actual storm event conditions.

Source: Oshkosh Corporation

13.5 Estimate Benefits of New or Additional SRE

Chapter 7 identified that the primary impacts of a longer runway occupancy time are increased aircraft flight delays and associated delay costs to air carriers and passengers. It logically follows that the primary benefits of adding SRE to an existing fleet in order to shorten runway occupancy time are reduced aircraft delays and the associated savings. The approach to estimating these potential benefits is best suited for hub airports and airports with substantial cargo traffic that may experience the benefits of aircraft arrival and departure delay savings for passenger and cargo air carriers. The approach is less applicable to small-hub and non-hub airports with fewer flight operations. Similarly, airports without scheduled commercial service and general aviation airports may find the approach of limited value because of the limited opportunity for delay cost savings. This does not suggest that smaller facilities or their tenants will receive no benefit from reduced runway occupancy times, but rather that these benefits (e.g., safety, customer service, etc.) are less predictable, more individualized, and difficult to quantify monetarily.

Compare delay and cost baseline data described in Chapter 7 to projected delay and delay cost data after the additional SRE are in operation to estimate the benefits of adding SRE to reduce runway occupancy time. If an aircraft delay simulation model was used to generate the delay baseline data, then the same model can be used to simulate delays with a new, shorter runway occupancy time performance target. However, if another method was used to generate delay data (e.g., airport operations log or RITA TranStats data), then use the delay data and a set of operational assumptions to project

BEST PRACTICE—Coordination with Air Carriers to Determine Staffing Needs

Airports reported success in coordinating with air carriers on financial assumptions and financial modeling in determining appropriate staffing levels for snow and ice control operations. The identification of airline expectations for capacity and operations during winter events is a key factor in determining airport crew complements. A subsequent cost-benefit analysis comparing airport staffing costs against airline delay and/or cancellation costs will lead to better decision making regarding the optimum crew size necessary to meet customer expectations.

Table 13-2. Example summary of ATC runway closure duration, estimated aircraft delay per runway closure, and associated aircraft delay cost data.

Winter Event Date	Average Event ATC Runway Closure Duration (min)	Number of Event ATC Runway Closures	Estimated Aircraft Delayed / ATC Runway Closure	Weighted Average Aircraft Block Time Cost / Minute	Total Delay Cost / Aircraft	Total Event Delay Cost / ATC Runway Closure	Total Event Delay Cost
3/3/2011	71	17	12	$74.39	$5,282	$62,500	$1,062,500
1/23/2011	44	16	7	$74.39	$3,273	$24,003	$384,051
1/17/2011	34	12	6	$74.39	$2,529	$14,332	$171,990
12/11/2010	28	6	5	$74.39	$2,083	$9,720	$58,322
2/14/2011	23	3	4	$74.39	$1,711	$6,559	$19,676
12/22/2011	24	2	4	$74.39	$1,785	$7,141	$14,283

new delay data and delay cost savings. This approach offers potentially less accurate estimations than modeling, but the rough analysis may be sufficient to support an investment decision.

This rough approach uses the spreadsheet summary of past winter season runway closures, estimated aircraft delays per runway closure, and associated aircraft delay costs shown in Table 13-2 (originally presented as Table 7-7 in Chapter 7). By replacing the estimated average event ATC runway closure duration values in the second column of the table with an ATC runway closure duration performance target (assuming the runway closure duration does not include significant additional time for ATC runway reopening) and maintaining all other data, new delay costs can be calculated, as seen in Table 13-3. This table shows that consistent, shorter ATC runway closure durations can result in significant delay cost savings.

The estimated delay costs savings, as summarized in Table 13-4, can be compared to the anticipated cost of the additional or faster SRE needed to achieve the runway occupancy time performance target. This comparison will assist in the alternatives selection process described in Chapter 14. The delay cost savings should also be evaluated against the meteorological data recurrence intervals. This evaluation will further the understanding among the airport operator and its stakeholders of the percent chance that the event conditions will occur and subsequent delay cost savings realized.

13.5.1 Additional Benefits of Multi-Function Equipment

High-speed, multi-function equipment offers benefits in addition to reducing runway occupancy time. As aging SRE reaches the end of its useful life, multi-function equipment provides

Table 13-3. Example summary of runway closures, estimated aircraft delays, and associated aircraft delay costs based on an assumed 20-minute ATC runway closure duration with increased SRE capacity.

Winter Event Date	Average Event ATC Runway Closure Duration (min)	Number of Event ATC Runway Closures	Estimated Aircraft Delayed / ATC Runway Closure	Weighted Average Aircraft Block Time Cost / Minute	Total Delay Cost / Aircraft	Total Event Delay Cost / ATC Runway Closure	Total Event Delay Cost
3/3/2011	20	17	3	$74.39	$1,488	$4,959	$84,309
1/23/2011	20	16	3	$74.39	$1,488	$4,959	$79,349
1/17/2011	20	12	3	$74.39	$1,488	$4,959	$59,512
12/11/2010	20	6	3	$74.39	$1,488	$4,959	$29,756
2/14/2011	20	3	3	$74.39	$1,488	$4,959	$14,878
12/22/2011	20	2	3	$74.39	$1,488	$4,959	$9,919

Table 13-4. Example summary of aircraft delay costs, delay cost savings, and meteorological data for multiple winter storm events sorted by total event snowfall recurrence interval.

Winter Event Date	Total Event Delay Cost		Delay Cost Savings with Increased SRE Capacity	Event Duration		Total Event Snowfall			Average Event Intensity	
	Current SRE Capacity	Increased SRE Capacity		Hours	Recurrence Interval	Snow Type	Depth (in)	Recurrence Interval	Inches/ Hour	Recurrence Interval
3/3/2011	$1,062,500	$84,309	$978,191	14	4.0	Wet	9.9	10	0.71	7.0
1/23/2011	$384,051	$79,349	$304,701	13	1.3	Dry	5.1	3.4	0.39	1.0
1/17/2011	$171,990	$59,512	$112,478	11	1.1	Dry	4.2	2.7	0.38	0.9
12/11/2010	$58,322	$29,756	$28,566	4	0.8	Wet	1.3	1.1	0.33	0.7
2/14/2011	$19,676	$14,878	$4,798	2	0.6	Dry	0.9	0.8	0.45	1.3
12/22/2011	$14,283	$9,919	$4,364	3	0.7	Dry	0.7	0.7	0.23	0.6
Total	**$1,710,821**	**$277,723**	**$1,433,099**							

an opportunity to switch out two pieces of equipment for one (e.g., one plow and one broom for one combination plow-broom-blower). It also offers potential savings on operator labor, as only one operator is required. If the acquisition of each piece of multi-function equipment results in needing one fewer full-time operator, the savings in salary and benefits can be compared to the annualized capital cost of each piece of equipment. An example of this comparison is provided in Figure 13-5.

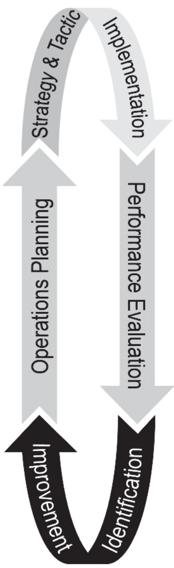
Annualized Capital Cost = (Capital Cost/$A_{t,r}$)
Where:
$A_{t,r} = (1 - 1/(1 + r)^t)/r$
t = expected useful life
r = percentage cost of capital rate expected (finance rate)

Example:
$A_{t,r} = (1 - 1/(1 + 0.05)^{10})/0.05$
t = 10 years
r = 5%
Assumed Multi-function Vehicle Capital Cost = $750,000
Assumed Full-time Operator Salary = $60,000
Assumed Total Operator Costs (salary, benefits, training, etc.) = 1.5 x Salary
$A_{t,r} = 7.72$
Annualized Capital Cost = $750,000/7.72
Annualized Capital Cost of Multi-function Vehicle = $97,150
Annual Total Operator Costs = 1.5 x $60,000
Annual Total Operator Cost Savings = $90,000

Figure 13-5. Example comparison of the annualized cost of a multi-function vehicle purchased to replace an aging plow and broom, and the resulting employee cost savings.

CHAPTER 14

Selecting Winter Operations Improvement Alternatives



Opportunities to improve winter operations performance will require changes to current strategies, tactics, or procedures. There may be multiple alternatives that can effectively reduce or eliminate performance shortfalls. However, the diversity of airports, winter operations programs, and operating environment prevents a one-size-fits-all alternatives selection process that can apply to every airport and improvement opportunity. The necessary level of evaluation as part of the selection process must be determined by individual airports, but will likely be influenced by the following:

- Importance of the investment to the airport and/or its stakeholders,
- Size of the investment relative to the size of the airport,
- Number of alternatives being considered, and
- Consequences of an incorrect decision.

No matter the scale of the improvement opportunity, improving performance requires thoughtful, purposeful, and planned change. This chapter presents high-level considerations for implementing an alternatives selection process.

14.1 Establish Evaluation Criteria

Evaluation criteria assist in the application of an evaluation process by ensuring that alternatives are evaluated consistently and against measures of strategic importance to the airport and its stakeholders. Evaluation criteria can be identified prior to or after improvement alternatives are identified. Identifying criteria in advance may help ensure that necessary information about each alternative is collected before starting the evaluation. Criteria for consideration in evaluating winter operations improvement alternatives are summarized in Table 14-1 and categorized as implementation, safety, and financial.

14.2 Develop Alternatives

To facilitate effective application of the evaluation process, alternatives must be adequately developed. Seek out relevant information from product vendors or other airports utilizing similar equipment or practices. If evaluation criteria were established in advance, ensure that data are collected that align with that criteria. Document the scope of alternatives, as well as key assumptions.

14.2.1 Scope

Defining the scope of alternatives for improving winter operations performance will facilitate consistency in understanding for all involved in the process. It will also mitigate the potential for

Table 14-1. Example evaluation criteria.

Category	Criteria	Description
Implementation	Ease	Anticipated effort required to implement an alternative (e.g., high, medium, or low)
	Demonstrated	Equipment or procedures have been proven effective and reliable at a similar airport under similar conditions
	Effectiveness	Anticipated percentage of performance shortfall eliminated through the implementation of an alternative
	Potential Disruption	Potential risk of disruption to airport operations if alternative is ineffective (e.g., high, medium, or low)
	Compatibility	Compatibility with current and planned future systems or infrastructure
Safety	New Hazard	Alternative introduces a new potential safety hazard requiring a risk assessment and risk mitigation, if determined necessary by the airport
	Hazard Mitigation	Alternative mitigates the risk of a known safety hazard by reducing its likelihood of occurrence or potential consequences
Financial	Life-cycle Cost	Estimated total cost including total capital, operating, maintenance
	Equivalent Annual Cost	Annualized capital, operating, and maintenance costs (excluding labor)
	Labor	Net change in staff required for implementation, operation, and maintenance (may be negative, zero, or positive)
	Impact	Impact on airport fees, rates, and charges

critical components of a proposed alternative from being inadvertently excluded from evaluation. Identify how the proposed alternative will meet new or existing performance goals and supporting objectives, and address the root cause of a significant performance shortfall, if applicable. Example components required to fully implement a proposed alternative may include:

- Equipment (e.g., mobile, fixed, electronic, etc.);
- Infrastructure (e.g., modifications to existing or construction of new);
- Staffing (e.g., equipment operators, mechanics, supervisors);
- Training;
- Tactical changes; and
- Procedural changes.

14.2.2 Key Assumptions

Define and document key assumptions upon which the subsequent evaluation will be based. This will facilitate consistency and further shared understanding throughout the evaluation. The level of confidence in key assumptions should be considered when evaluating risk posed by improvement alternatives. Example assumptions related to a proposed investment may address:

- Traffic forecasts,
- Air service changes,
- Aircraft flight schedule,
- Aircraft fleet mix,
- Airfield improvements,

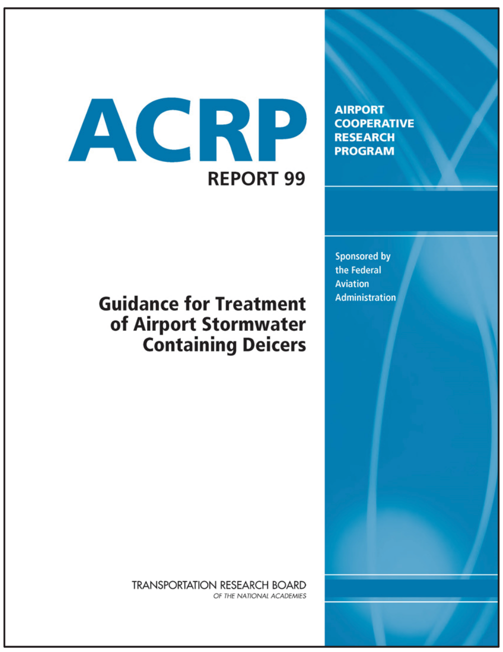
BEST PRACTICE—SRE Procurement Analysis

Close coordination is required between maintenance staff and airport finance staff in the procurement of SRE and in the development of an equipment replacement program. The lowest priced vehicle may not be the most cost-effective vehicle. Maintenance can assist finance by providing guidance, equipment performance reliability, actual maintenance costs, and other data (e.g., airline delay costs) that could be used to conduct more thorough analyses when considering the type and number of vehicles required to meet snow removal goals and objectives. In addition to standard financing costs, other factors that must be considered when specifying equipment include airport geometry, vehicle maneuverability, airfield egress and ingress, fueling requirements, warranty periods, life-cycle maintenance costs, and additional required maintenance and storage facility space and layout. It is highly recommended that initial and ongoing training costs be written into equipment specifications and into subsequent purchase agreements.

- Target winter event,
- Climate change,
- Technology advancements,
- Fuel and material costs, and
- Labor costs.

14.3 Evaluate Alternatives

Each set of alternatives should be evaluated independently. The evaluation process using defined evaluation criteria should result in the identification and elimination of non-viable alternatives and ultimately the selection of a preferred alternative. However, many potential improvement alternatives incorporate tactics or procedures that present an obvious low operational risk and cost of implementation. These alternatives can be defined, planned, and implemented without extensive evaluation on a trial and error basis because they do not present serious ramifications should they fail to achieve a desired outcome. Additionally, they may require the reallocation of existing resources rather than a significant new investment. Avoid overanalyzing these alternatives since it may unnecessarily tie up staff resources and offer little benefit in return.



14.3.1 Comparative Analysis of Alternatives

Some alternatives require a more rigorous evaluation due to their potential implementation, safety, or financial implications. The comparative analyses presented in this section will apply criteria described earlier to a range of alternatives. The analyses can facilitate alternative comparison by enabling ranking or numerically rating of each alternative. Figure 14-1 presents methods for comparing alternatives originally presented in *ACRP Report 99: Guidance for Treatment of Airport Stormwater Containing Deicers.*

Comparative analysis methods are intended to assist in the evaluation of multiple alternatives and the selection of the preferred alternative. If the implementation, safety, and financial criteria categories are used in comparative analyses, it is suggested that the analyses be conducted in the following sequence:

1. **Implementation**—Eliminate alternatives that are technically infeasible or unacceptable,
2. **Safety**—Eliminate alternatives that present an unacceptable safety hazard that cannot reasonably be mitigated, and
3. **Financial**—Eliminate alternatives that present unacceptable costs.

14.4 Plan Alternative Implementation

Once an alternative is selected, the planning process begins. The amount and duration of planning required for implementation of an alternative is dependent on the nature and scale of the alternative. Equipment procurement may take a year or more depending upon funding available, while other changes in operation may take days, weeks, or months. As part of the planning process, revisit winter operations goals, objectives, and performance measures and make any necessary adjustments to accommodate the changing winter operations program (see Chapter 6). Additionally, update winter operations documentation to reflect the changes.

Pros and Cons

This method is one of the simplest comparison methods to evaluate alternatives. Pros and cons are developed for each alternative. The lists of the pros and cons for each alternative are compared directly to one another, and a somewhat qualitative assessment is made. The alternative with the strongest pros and weakest cons is preferred. Decisions are often made through iterative discussion and analysis. The process may be supported by outside experts. Users may want to weight the relative importance of each criteria category. Features of the pro/con method include:

- It is the fastest and simplest method.
- It is familiar to users and allows for written analysis of complex topics.
- It has difficulty quantitatively demonstrating the basis for the choice.
- It does not easily assess the relative and interactive effects of criteria.

Weighted-sum Scoring

In the weighted-sum scoring method, weights are assigned to various evaluation criteria categories based on the relative importance of the criteria, and values are assigned to the individual criteria for each alternative. To accurately use this process, all criteria values must be in the same units, or total scores will be meaningless. Depending on the criterion, the assessment may be objective (factual) with respect to some commonly shared and understood scale of measurement (e.g., money), or it can be subjective (judgmental), reflecting the subjective assessment of the evaluator. Features of the weighted-sum ranking method include:

- It provides simple numeric means of ranking alternatives.
- It promotes discussion of relative importance of criteria.
- It provides limited comparison of alternatives directly to each other.
- It uses criteria weighting that is somewhat arbitrary.
- It requires that criteria values have the same units.

Analytical Hierarchy Process

The analytic hierarchy process (AHP) is one of several quantitative selection processes that are based on head-to-head or pair-wise comparisons of criteria. In the AHP process, subjective assessments of the relative importance of criteria to the success of the alternative are made. The method assumes that evaluators are more capable of making judgments of relative importance between two choices than absolute judgments among all choices. The pair-wise comparisons are used to quantify the most promising alternatives. The AHP process can be executed with individual decision makers providing their own evaluation or in a collaborative fashion as a group. The AHP has proven to be very good for framing the discussion of alternatives, identifying key criteria, understanding the relative importance of criteria, providing a structure for discussion and consensus, and providing some quantitative guidance for the decision-making process. Features of the analytical hierarchy process include:

- It adds a high level of quantification to selection to help demonstrate basis for choice.
- It is more complex mathematically.
- It promotes discussion of relative importance of criteria.
- It promotes discussion of all alternatives against each other.
- It breaks the evaluation down into small steps.
- It promotes comprehensive discussion.
- It uses a weighting of criteria that is somewhat arbitrary but allows for more precise determination than other methods.

Figure 14-1. Methods for comparative analysis of alternatives (8, pp. 59–60).

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Acronyms

AAR	Aircraft Arrival Rate
AC	Advisory Circular
ACM	Airport Certification Manual
ADP	Airline Data Project
ADS-B	Automatic Dependent Surveillance Broadcast
AHP	Analytic Hierarchy Process
AOC	Airport Operations Center
API	Airport Performance Indicator
Apps	Applications
ARTCC	Air Route Traffic Control Center
ASDE	Airport Surveillance Detection Equipment
ATCSCC	Air Traffic Control System Command Center
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
AWOS	Automated Weather Observing Systems
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BOD_5	5-day Biochemical Oxygen Demand
CBP	Customs and Border Protection
CCP	Crisis Communication Plan
CDM	Collaborative Decision-Making
CFME	Continuous Friction Measuring Equipment
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CMMS	Computerized Maintenance Management System
CTF	Common Traffic Frequency
CWA	Clean Water Act
EG	Ethylene Glycol
ELG	Effluent Limitations Guideline
EMAS	Engineered Materials Arresting Systems
EPA	U.S. Environmental Protection Agency
FAR	Federal Aviation Regulations
FBO	Fixed-Base Operator
FY	Fiscal Year
ICP	Incident Command Post
IP&A	FAA Office of Investment Planning and Analysis
IROPS	Irregular Operations
ISD	Integrated Surface Database, Hourly, Global

LHR	London Heathrow Airport
LOA	Letter of Agreement
mg/L	Milligram per Liter
MIT	Massachusetts Institute of Technology
MS4	Municipal Separate Storm Sewer System
NCDC	National Climatic Data Center
NIMS	National Incident Management System
NWS	National Weather Service
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
OCC	Operations Control Centers
PG	Propylene Glycol
PIO	Public Information Officer
POTW	Publicly Owned Treatment Works
PR	Public Relations
RITA	U.S. Department of Transportation, Research and Innovative Technology Administration
RIWS	Runway Incursion Warning Systems
ROI	Return on Investment
SCC	Snow Control Center
SICC	Snow and Ice Control Committee
SICP	Snow and Ice Control Plan
SMART	Specific, Measurable, Assignable, Realistic, Time-based
SMGCS	Surface Movement Guidance and Control System
SOC	Systems Operations Centers
SRE	Snow Removal Equipment
SWPPP	Storm Water Pollution Prevention Plan
TDS	Total Dissolved Solids
TMU	Traffic Management Unit
TOC	Total Organic Carbon
TRACON	Terminal Radar Approach Control
TSA	Transportation Security Administration
TSS	Total Suspended Solids

APPENDIX A

Accessing Meteorological Data

Meteorological data is widely available for most geographic regions across the United States. Because many airports are designated NWS monitoring stations, airport-specific data may be available. The NOAA NCDC provides access to digital historical weather and climate data for numerous monitoring stations through its website at: http://www.ncdc.noaa.gov/data-access/quick-links.

Of the accessible databases offered by NOAA, the following two databases provide hourly meteorological data:

- ISD, hourly, global database.
- Hourly Precipitation Data Publication/Database.

A.1 Accessing Meteorological Data through the ISD, Hourly, Global Database

To illustrate how to navigate and request data from NOAA's ISD database, the following steps were required as of the writing of this guidebook:

1. Upon selecting the ISD database within the NOAA quick links site, the database interface will provide an option to select an embedded link to "*ISD/CDO*."
2. Upon selecting "*ISD/CDO*," the "*WMO Resolution 40 NOAA Policy*" and terms of use must be agreed to before being directed to the "*NCDC Climate Data Online*" page.
3. At this point, a "*Simplified*" or "*Advanced*" option, with descriptions available of each, can be selected.
4. Assuming the "Simplified" option was selected, select "*United States*" in the "*Retrieve data for: Country*" field and then select "*Continue*."
5. In the available "*Select a State/Province*" dropdown list select the state of interest, select "*Retrieve for Selected Stations in the State*," and select "*Continue*."
6. Select the desired airport monitoring station or closest station to airport. Check the data period of record and, if acceptable, select "*Continue*."
7. Enter the desired date range, check the "*Inventory Review*" box, enter an email address and select "*Submit Request*."
8. Access the data through the link in the NCDC email.

A.2 Accessing Precipitation Data through Hourly Precipitation Data Publication/Database

Similar to requesting data from NOAA's ISD, navigating and requesting data from the Hourly Precipitation Data Publication/Database includes the following steps:

1. Upon selecting the Hourly Precipitation Data Publication/Database within the NOAA quick links site, the database interface will provide an option to select an embedded link to "*Hourly Precipitation*."
2. Upon selecting "*Hourly Precipitation*," within the "*Select Weather Observation Type/Dataset*" dropdown list, select "*Precipitation Hourly*." Within the "*Select Date Range*" calendars, enter the desired starting and ending years, months and days. Within the "*Enter a Search Term*" dropdown list, enter the desired airport code designation or city name. When completed, select "*Search*."
3. On the "*Search Results: Precipitation Hourly*" page, select the desired station and select "*Add*." Note that the available period of record is indicated beneath the Station ID.
4. Select the "*Cart (Free Data)*" icon and then select "*View All Items*."
5. On the "*Cart: Precipitation Hourly*" page, confirm the desired date range under "*Select the Date and Time Range*," and make a selection under "*Select the Output Format*."
6. On the "*Custom Options*" page, under "*Station Detail & Data Flag Options*," select the "*Include Data Flags*" and "*Date Filter*" checkboxes; under the "*Date Filter*" and with the keyboard shift key held down, highlight all of the years, months, and days of interest; select the "*Precipitation*" checkbox under "*Select Data Types for Custom Output*"; then select "*Continue*."
7. Enter an email address and select "*Submit Order*."
8. Access the data through the link in the NCDC email.

APPENDIX B

Example Airport Performance Indicators

B.1 Snow and Ice Removal

- **Snow Removal Equipment Runway Occupancy Time**—The duration that a runway is closed to aircraft while occupied by SRE and friction testing equipment (*22*, p. 24).
- **Runway Closure Duration**—The duration a runway is closed due to winter weather-related surface conditions and snow removal operations.
- **Follow-up Friction Measurement Value**—The results of a friction test after snow and/or ice removal and/or chemical and/or sand application operations, and an indicator of snow and/or ice removal and chemical application effectiveness.
- **Time to Complete Airside Priority 1 Pavement**—The time it takes to complete clearing the specified areas that are defined within an airport's SICP as priority 1 areas. Similar to runway occupancy time, but extends beyond the performance of clearing the runway.
- **Hours Runway is Available**—The total number of hours that the runway is available during a specified period (e.g., winter event). Opposite of Runway Closure Duration.
- **Missed Runway Reopening Time**—Occurs when the coordinated runway reopening time between the airport and ATC is not met due to a longer than anticipated runway occupancy time by SRE.
- **Signage/Lighting/Infrastructure Damage**—A measure of airport documented damage of key infrastructure caused by SRE. Indicates the level of equipment operator situational awareness and training, as well as equipment effectiveness.
- **Fuel Usage**—The volume of fuel used for winter event operations over a specified period. Indicates the efficiency of SRE operation and area cleared.
- **Airport Entrance to Terminal Passenger Travel Time**—The average time it takes for a passenger to travel from the main airport entrance to the terminal. Indicates the condition of landside roadways and the effectiveness of landside winter operations.
- **Time to Complete Airside Non-priority 1 Pavement**—The time it takes to clear airside areas that are not identified as priority 1 surfaces.
- **Time to Complete Landside Pavement**—The time it takes to complete clearing the specified areas of the airport that are not part of the aircraft operating area, including terminal buildings, roadways, parking lots, and garage decks.

B.2 Chemical and Sand Application

- **Unit Volume/Mass Applied per Unit Area Treated**—The unit volume or mass of material and/or chemical applied per the unit surface area treated.

B.3 Equipment

- **Snow Removal Equipment Maintenance Down Time**—The total time a piece of SRE is not in operation due to maintenance requirements.

- **Snow Removal Equipment Operation and Maintenance Cost**—The operation and maintenance cost for the SRE fleet over a specified time period (*22*, p. 168).
- **Snow Removal Equipment Average Age**—The average age of airport SRE based on type. This can be an age assessment by year manufactured, miles driven, or hours of operation.
- **Snow Removal Equipment Age**—The age of airport SRE based on type. This can be an age assessment by year manufactured, miles driven, or hours of operation (*22*, p. 162).
- **Snow Removal Equipment Maintenance Labor Cost**—The total cost of labor directly associated with maintaining SRE over a specified period.
- **Snow Removal Equipment Airside Operator Labor Cost**—The total cost of part-time and full-time airport labor employed to operate airside SRE during the winter season.
- **Snow Removal Equipment Landside Operator Labor Cost**—The total cost of part-time and full-time airport labor employed to operate landside SRE during the winter season.
- **Snow Removal Equipment Fleet Operating Speed**—The average travel speed of the SRE fleet while in operation. Speeds may be identified for varying groups assigned different functions (e.g., runway teams, taxiway teams, etc.).

B.4 Safety

- **Aircraft Excursions**—The number of times an aircraft goes off dedicated pavement surfaces due to surface conditions during a winter season.
- **Snow Removal Equipment Incursions**—The number of times that there is an incorrect presence of a snow removal vehicle or operator on a runway that is open for aircraft operations (*22*, p. 215).
- **"NIL" Pilot Braking Action Report**—The number of occurrences when braking action conditions indicating that the degree of braking is zero on the airport movement area is reported by pilots within a pilot report.
- **Aircraft Snow Damage Incident**—The number of incidents over a specified time period for which an aircraft is damaged due to the results of pavement snow removal operations, such as snow piles scraping the tips of an aircraft wing, or landing gear damaged by windrows (*22*, p. 226).
- **Snow Removal Equipment Damage Incident**—The number of incidents where a piece of SRE is damaged while in operation over a specified time period (*22*, p. 226).
- **Snow Removal Equipment Operator Windshield Time**—The total amount of time a snow removal operator spends operating equipment during an event.
- **Annual Snow Removal Equipment Operator Training Hours**—The total training hours received per operator over a calendar year or winter season.

B.5 Stakeholder Coordination

- **Time between Runway Reopening and First Aircraft Operation**—The amount of time after all snow removal and friction testing equipment has left a runway cleared to be reopened and the first aircraft operation.
- **Missed Approach/Go Around**—The number of occurrences when a pilot is directed by ATC to abandon his/her approach to landing due to a longer than anticipated runway occupancy time by SRE.
- **Missed Holdover Times/Repeat Deicing**—The number of occurrences when an aircraft exceeds its deicing holdover time and must repeat deicing because of taxiway or runway unavailability caused by snow/ice accumulation or active snow removal operations.
- **Taxi-Out Time**—The average time to taxi from gate to runway end (*22*, p. 25).
- **Taxi-In Time**—The average time to taxi from runway end to gate.
- **Percent Arrival Flights Delayed**—The percent of arriving flights delayed by 15 or more minutes due to airport winter operations (*22*, p. 233).
- **Percent Departure Flights Delayed**—The percent of departing flights delayed by 15 or more minutes due to airport winter operations (*22*, p. 235).

B.6 Financial

- **Cost/Unit Depth of Snow**—The sum of applied runway chemical and material costs, labor costs (including regular and premium pay), contractor costs for both equipment and labor, cost of fuel used by the equipment, and costs associated with the snow melting operation (excluding operating or amortized capital cost of equipment) incurred during a snow event, divided by the unit depth of snow per event.
- **Cost/Unit Area Cleared**—The sum of applied runway chemical and material costs, labor costs (including regular and premium pay), contractor costs for both equipment and labor, cost of fuel used by the equipment, and costs associated with the snow melting operation (excluding operating or amortized capital cost of equipment) incurred during a snow event, divided by the surface area cleared during the event.
- **Contract Labor Cost**—The total cost of contractor labor for winter operations services during a winter event or over the winter season.

B.7 Environmental Compliance

- **Permit Violations**—The number of exceedances of permitted numeric limits for environmental protection, such as in a NPDES permit.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation